JKT Jurnal Komputer Terapan
ISSN : 2443-4159 (Print) ISSN: 2460-5255 (Online)
Politeknik Caltex Riau
Empower You to Global Competition

QUEUE MANAGEMENT SYSTEM FOR COMMUNITY HEALTH CENTRE (CASE STUDY: PUSKESMAS UMBAN SARI)

Heni Rachmawati*[1], Wenda Novayani[2], Indah Lestari[3], Afifah Putri[4]
Politeknik Caltex Riau, Pekanbaru, 28265, Indonesia[1,2,3,4]
henni@pcr.ac.id*[1], wenda@pcr.ac.id[2], indah@pcr.ac.id[3]

**Corresponding Author*

ABSTRACT

The Community Health Center Queue Management System is an Android and website-based online queuing system. The purpose of this research is to help Puskesmas Umban Sari who faces difficulty in managing patient queues. The main process handled by the system is registration and data recapitulation. The system has two queuing features that can be activated or not as needed, namely the priority queue and linear queue. The development method in this research is done by using the Rational Unified Process (RUP). The tests carried out are black box testing, usability testing, and performance testing. Based on the outcomes obtained from black box testing, it can be determined that the system is functioning very well. The Usability testing with a total of 50 respondents shows a score of 84%, which means that this system is quite satisfactory and useful for users. Whereas in performance testing, the Load Testing and Stress Testing processes were obtained by 67%, which means that the performance of this system is quite good when given heavy pressure and many users access simultaneously. The system successfully reduced waiting times and improved service efficiency.

Keywords: *Performance Testing, Queue Management System, RUP Method*

Histori Artikel
Diserahkan: 05 Okt 2024 Diterima setelah Revisi: 22 Nov 2024 Diterbitkan: 3 Des 2024

1. INTRODUCTION

Puskesmas (Community Health Center) is a public facility that serves for medical treatment, care, and health check-ups. According to the Minister of Health Regulation No. 43 of 2019, Puskesmas is categorized as a Public Health Service Facility (Faskes). A Public Health Service Facility is a place used to provide various health services, including preference, precautionary, therapeutic, and rehabilitative efforts imposed by the governance, local authorities, or the community [1]. Puskesmas has the responsibility for organizing health policies to achieve health development goals in its working area. Health policies encompass a series of decisions, plans, and actions to accomplish specific health outcomes within the community, including healthcare services to treat and care for patients.

In its daily operations, the Puskesmas is frequently visited by the community for medical treatment and medication collection. Several patients are admitted to the Emergency Unit. If a patient arrives without a medical card, the Puskesmas staff manually registers the new patient and creates a new medical card. Once the card is created, the administrative and reception staff store the patient's medical records and card in hardcopy or paper form. Sometimes, the manual process of creating new cards and managing the queue takes considerable time, leading to patient congestion.

Another challenge is the duplication of medical cards, resulting in duplicate patient records, further hampering efficient queue management and medical record-keeping. Additionally, patients face difficulty scheduling appointments at the Puskesmas, as they must arrive early to take a physical queue number to expedite the process. Queue management systems in Puskesmas are long waiting times, inadequate availability of personnel, and less effective queue models [2][3].

Based on an interview with Mrs. Nurhayati, the Head of Administration at Puskesmas Umban Sari, it can be concluded that the queue system at Puskesmas Umban Sari still relies on paper-based methods. The manual process hampers efficiency, increases errors like duplicate patient cards, and prolongs data compilation for paper-based records. A virtual queue management system arranges convenience and

improves user experience. It also enhances employee efficiency, service quality, and storewide sales. [4] aimed to resolve the impact of reliability and flexibility level, security level, and staff training on automated queue management systems on the performance of the National Cement Company. The study suggested that the company increase the reliability and flexibility of the automated systems, improve the security level at the IT department, and routinely progress their staff on basic and advanced ICT competency. [5] in their article "Design and Build a Web-Based Online Queue for the Rumbai Community Health Center." use CodeIgniter Framework and Zanziva as SMS gateways. The system has a limit, including the registration process is valid only for one day. A patient cannot register for a different day. A patient will get a notification for their queue number through SMS. Queue management entrenched priority and location-based service (LBS) is applied to spot students in the lecturer's geofence area in the KP Guidance and Final Project Queue Management application. Students with more distance close to the predetermined radius will be in the priority queue for guidance in the current era of information and communication [8]. Apart from solving problems in everyday life, queues are also used in computer systems, including handling work on one computer processor, print roll, and sending information packets to the computer network [6]

Mobile applications are among the most important and quick improvements. Utilizing mobile applications is made easier by individual mobile users [7]. Mobile queuing is a queuing system that allows customers to join a virtual line via their mobile devices. It enables businesses to manage customer queues and services through the use of mobile phones. Customers can join the queue remotely, giving them the freedom to wait anywhere they like while still being connected with the business. [8] created a system that aims to improve academic service efficiency by minimizing waiting time for students without any service process. The paper highlights the importance of queuing management in the student academic service system. The queuinguing system guarantees the occurrence of service processes following the scheduled time. [9] develop a mobile application that facilitates the learning activity in secondary and high schools. The experiment proved the effectiveness of mobile applications can simplify the educational process significantly.

To address these issues and enhance the queueing, registration, and data management system at Puskesmas Umban Sari, an innovation in the form of a web and Android-based Patient Queue Management System is required. This system will be more user-friendly for patients as they can use the mobile application to book appointments well in advance, eliminating the need to visit the facility and wait. The queuing system in this application utilizes the First In First Out (FIFO) and Priority Queue methods. A priority queue is an extended version of the normal queue with priorities for each element. It stores objects and releases the object with the greatest value on request. There are two types of priority queue: ascending priority queue and descending priority queue. An ascending priority queue is a collection of items into which items can be inserted arbitrarily and from which only the smallest item can be removed. A descending priority queue is similar but allows the deletion of only the largest item [10]. If the maximum quota for daily appointments is reached, the patient will be scheduled for the next available day. The smartphone application also provides a feature to view the current queues, enabling patients to estimate their travel time to the Puskesmas. Previous studies highlight the critical role of digital queue systems in improving service efficiency and reducing patient waiting times in healthcare settings. Research has demonstrated that such systems streamline operations, minimize errors, and enhance patient satisfaction. These findings support the argument that implementing a digital queue system in Puskesmas can address operational challenges and improve overall service quality.

The website-based system will also ease the burden on Puskesmas staff in managing the queue, reducing patient congestion. Patient queue data can be summarized and analyzed, helping the staff to understand daily visit patterns and facilitating report generation when needed. Through this website, it is hoped that the data processing and queue management needs of Puskesmas staff will be streamlined, preventing patient congestion during peak periods.

2. RESEARCH METHOD

Rational Unified Process (RUP) is a software engineering method developed by gathering various best practices found in the software development industry. Its main characteristic is using a use-case-driven and iterative approach to the software development life cycle [11]. Several developments of the RUP model have been carried out, one of which is research conducted by [12] that develops a hybrid software

development model that combines the best of both worlds, Agile and plan-driven methods. The study concluded that the new hybrid model, which is based on RUP and Crystal Clear, has considerable capabilities in small and medium projects compared to its parents' methods. The new hybrid model can solve the inefficiency of software development methods against new and changing customer requirements. However, combining such methods may lead to organizational overheads and challenges as well. The study recommends further research to be conducted to establish other factors that influence the performance of the new hybrid model.

RUP employs object-oriented concepts, with activities focusing on developing models using the Unified Model Language (UML). In this method, there are four stages of software development:

i) Inception: During this stage, developers define activity boundaries, conduct user needs analysis, and perform initial software design (architectural design and use cases).
ii) Elaboration: This stage involves designing the software, from specifying software features to releasing a Beta version prototype.
iii) Construction: Implementation of the software design created earlier takes place in this stage. At the end of this stage, the final version of the software, approved by administrators, is released along with software documentation.
iv) Transition: Deployment and socialization of the software occur during this stage

3. RESULT AND ANALYSIS

3.1 INCEPTION PHASE

The following stages of the RUP method focus on interviews to obtain information about the required business processes and the definition of system requirements. In the Inception phase, the design of business diagrams "as-is" and "to-be" is conducted. The "as-is" business diagram represents the current business processes before the existence of the system, while the "to-be" business diagram illustrates the proposed business processes within the system being developed. In addition to the business diagrams, this phase also analyzes the functional requirements of the clients.

3.1.1 Functional Requirement Analysis

From the interview results, the functional requirements are as follows:

i) Super Admin Requirement Scenarios: Manage access rights for employee accounts and Manage employee data.
ii) General Admin Requirement Scenarios: Manage patient queues, Manage patient data and Perform data recapitulation and patient queue reports
iii) Patient Requirement Scenarios: Reserve a queue online, View the ongoing queues and View previous visit history
iv) Healthcare Staff Requirement Scenarios (Nurses and Doctors): Manage patient treatment actions.

3.2 ELABORATION PHASES

The next stage of the RUP method is the Elaboration phase, which focuses on designing the system according to UML diagrams, such as ERD (Entity-Relationship Diagram), Sequence Diagram, Class Diagram, and Prototyping User Interface. In this phase, team gathered user requirements through interviews and observations, then mapped them into system features using UML diagrams, such as use case diagrams. For example, the need for automatically displaying queue numbers on the mobile app was designed to allow users to monitor the current queue status without being physically present at the Puskesmas. Team also created prototypes to test key features and ensure they aligned with user needs, reducing the risk of errors.

3.3 CONSTRUCTION PHASES

The next stage of the RUP method is Construction, which focuses on program implementation or coding, as well as testing the developed system. In this phase, various aspects of system testing are explained, including black box analysis, usability testing, implementation of FIFO and Priority Queue, and performance testing of the system.

3.3.1 FIFO and Priority Queue Implementation

i) Priority Queue

The system has two queue methods, namely FIFO and Priority Queue, which can be adjusted according to the needs of the Puskesmas (General Admin actor). The first step is to use the priority queue as the default queue system. In the priority queue, there are three comparison indicators: elderly age (above 60 years old), toddler age (below five years old), and pregnant women.

Assuming 5 patients will register with the comparison indicators according to the priority queue in the following table:

Table 1. Patient Data Simulation

Participant	Old	Pregnancy Status
Sarah	27	True
Tyo	84	False
Putri	12	False
Ibrahim	3	False
Bagas	34	False

Process 1: Patient Sarah registers for the first time and receives queue number 1 in the database. The process involves adding weights based on age and pregnancy status. Sarah's age ranges from 6 to 59 years old, and she is pregnant (True). Sarah's weight is 7, with the third highest priority.

1	2	3	4	5
Sarah				

Process 2: The second patient, Tyo, registers for the queue. Since Tyo is 84 years old and falls into the elderly category, his weight has increased to 9. A comparison is made between Tyo's weight and Sarah's weight. As Tyo's weight is higher, which is 9, Tyo's queue will be prioritized.

1	2	3	4	5
Tyo	Sarah			

Process 3: The third patient, Putri, registers for the queue. Putri is 12 years old and not pregnant (False). Her age is within the range of 6-59 years, which gives her a weight of 6 in the database. Another comparison is made with the queues of Tyo and Sarah. Tyo weight 9, and Sarah has a weight of 7, so Putri's weight is 6, which is the smallest weight. Putri is placed in queue number 3.

1	2	3	4	5
Tyo	Sarah	Putri		

Process 4: The fourth patient, Ibrahim, registers for the queue. Ibrahim is three years old and not pregnant (False). Since Ibrahim's age is below five years old, he is categorized as a toddler. Toddlers have a weight of 8, which is the second highest weight after the elderly patients. A comparison is made with the weights of the previous patients. As Tyo weight 9, Sarah has a weight 7, and Putri has a weight 6, Ibrahim occupies queue number 2 with his weight 8.

1	2	3	4	5
Tyo	Ibrahim	Sarah	Putri	Bagas

Process 5: The last patient is named Bagas, who is 34 years old and not pregnant (False). Bagas's age is 34 years, which falls within the range of 6-59 years. In this age range, Bagas has a weight of 6 in the database. A comparison is made with the weights of the previous queues. As Bagas's weight is the same as Putri's, a further comparison is made based on the time of the first patient registration. Since Putri registered earlier, Bagas is placed in queue position number 5.

1	2	3	4	5
Tyo	Ibrahim	Sarah	Putri	Bagas

ii) FIFO (First In First Out)
In FIFO, there is no specific comparison in sorting the queue. The queue will be arranged based on the data that was input first. Below is the comparison of data using FIFO and Priority Queue.

Table 2. Priority Queue and FIFO Comparison

	1	2	3	4	5
Priority Queue	Tyo	Ibrahim	Sarah	Putri	Bagas
FIFO	Sarah	Tyo	Putri	Ibrahim	Bagas

3.3.2 Testing and Analysis
In this study, two testing methods were employed, namely Black Box Testing, Usability Testing, and Performance Testing. (Mahendra, 2022) evaluates the usability and functionality of an Android-based application for preserving the Kidung Dharma Gita culture in Bali, which is a Balinese song that is sung by many parents during the Yadnya ceremony. The paper uses black box testing to test the entire page display with 16 test cases and a system usability scale (SUS) to measure user satisfaction and acceptance.

i) Black Box Testing
Based on the results of Black Box Testing conducted on June 16, 2023, using test cases for the Super Admin, General Admin, Patient, and Healthcare Staff actors, it was found that there were some errors in the test cases for Super Admin, General Admin, and Healthcare Staff. Subsequently, another round of testing was conducted on June 17, 2023, and it resulted in all the test cases functioning properly.

ii) Usability Testing
Usability Testing was conducted by distributing questionnaires directly to the users, containing questions regarding their opinions on the Puskesmas Queue System. A total of 50 respondents provided their feedback on the questionnaire. Table 3 is the results of the Usability Testing:

Table 3. Questionnaire for Usability Testing

No	Question	Answer				
		STS	TS	N	S	SS
1	Is the system interface visually appealing?	1	0	2	15	31
2	Is the system easy to operate?	0	1	8	27	14
3	Is the color selection appropriate and not monotonous?	2	1	7	24	16
4	Are the menu displays within the system easy to navigate?	1	0	8	22	20
5	Is the process of queuing reservations easy to use?	2	3	5	25	16
6	Are the available menus easy to understand?	0	0	4	20	28
7	Are the symbols/icons easy to understand?	1	0	8	16	25
8	Does the system meet the users' needs?	0	2	3	23	21
9	Do users find the system easy to use?	0	0	8	20	21
10	Does the system make it convenient to make queue reservations?	2	1	3	24	21
11	Is the system beneficial?	3	0	10	17	20
12	Does the system provide user satisfaction?	1	1	6	25	16
13	Did users enjoy using the system?	0	3	5	22	20

After calculating the scores from all 50 respondents, calculations are performed to determine the Total Score, Minimum Score, Maximum Score, and Percentage Score in Figure 1. Based on the results of the usability testing percentage score for each question, an overall average is calculated, which determines the aspect of user satisfaction with the system. The obtained average is 84%, which falls under the "Sangat Setuju/SS" category (strongly agree).

The conclusion from the above percentage is that the system that has been developed has provided benefits and has helped make queue reservations at Puskesmas Umban Sari. This indicates that the users are highly satisfied with the system, and it has proven to be beneficial in

facilitating the queue reservation process at Puskesmas Umban Sari

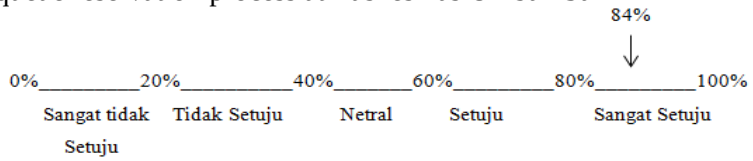

Figure 1. Result for Usability Testing

iii) Performance Testing

The Performance Testing results were conducted using two tools: Google PageSpeed Insight to assess speed, accessibility, speed index, total blocking time, and first contently paint. Google PageSpeed Insights is a tool developed by Google to measure the performance of web pages on both mobile and desktop devices [16]. K6 tool used for Stress Testing and Load Testing. Stress Testing involves testing the website by simultaneously simulating multiple page visits. Load Testing is conducted to assess the system's resilience when accessed simultaneously [11].

```
import http from 'k6/http';
import { sleep, check } from 'k6';
export let options = {
stages: [
{ duration: '3m', target: 100 },// Load Testing
{ duration: '5m', target: 500 },// Stress Testing
{ duration: '3m', target: 100 },
{ duration: '1m', target: 0 },
],
};
export default function () {
let loadResponse = http.get('https://siaps.pocari.id/');
check(loadResponse, { 'Load Test status is 200': (r) => r.status === 200 });
let stressResponse = http.get('https://siaps.pocari.id/');
check(stressResponse, { 'Stress Test status is 200': (r) => r.status === 200 });
sleep(1);
}
```

Figure 2. K6 Load And Stress Testing Script

In Load Testing and Stress Testing, virtual users were simulated, with 500 virtual users for a duration of 5 minutes and 100 virtual users for a duration of 3 minutes. The testing was conducted using the K6 tool in Figure 2 script:

Table 4. Result Load Testing and Stress Testing

LOAD TESTING		
Success Rate	*Request Succeeded*	*Request Failed*
66%	9822	4868
In this Load Testing, it is reported that the test was successful with a success rate of 66%. Out of 14690 requests, 9822 requests were successfully accessed, and 4868 requests failed to be accessed. This indicates that the system's capacity and performance are **GOOD** enough when given a high load in real time if users access it simultaneously.		
STRESS TESTING		
Success Rate	*Request Succeeded*	*Request Failed*
67%	9873	4770
In this Stress Testing, it is reported that the test was successful with a success rate of 67%. Out of 14643 requests, 9873 requests were successfully accessed, and 4770 requests failed to be accessed. This indicates that the system is **GOOD** enough to handle requests exceeding its normal capacity.		

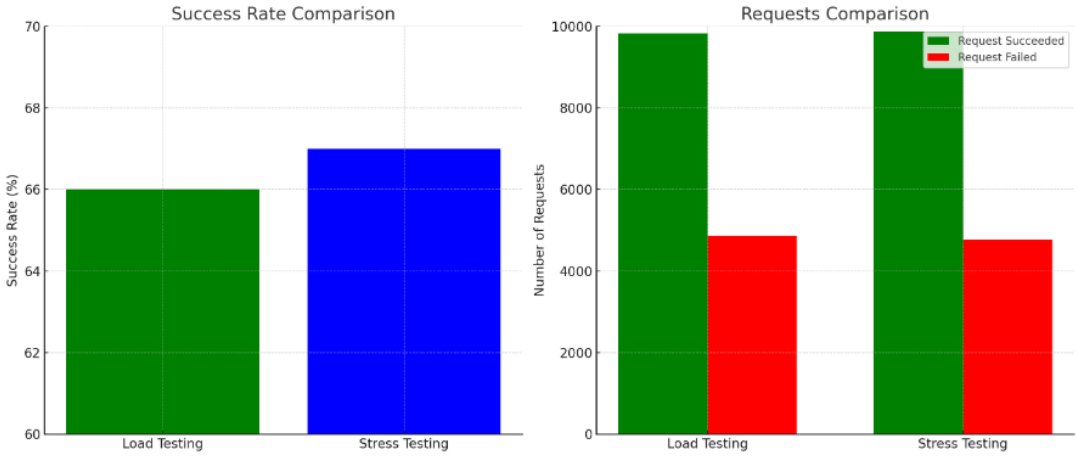

Figure 3. Result Comparison for Load Testing and Stress Testing

The results of the performance testing using PageSpeed Insight, which is useful for checking the system's performance at once shown in Table 5.

Table 5. Result of Google PageSpeed Insight for Performance Testing

NO	Testing Scenarios	Performance (%)	Accessibility (%)	Speed Index (s)	Total Bloking Time (ms)	First Contently Paint (s)
Website						
1	Login Page	98	95	0.9	0	0.9
2	Employee Page	96	69	0.9	30	0.9
3	Add Employee	97	79	1.0	30	1.0
4	Delete Employee	98	69	1.0	30	1.0
5	Edit Employee	94	80	1.5	30	1.8
6	Add Access Type	90	68	1.0	30	1.0
7	Edit Account	97	82	1.0	30	0.9
8	Delete Account	98	69	1.0	30	1.0
9	Add Account	93	79	1.0	30	1.0
10	Queue Page	70	71	10.6	430	3.0
11	Family Member Page	78	67	3.3	220	2.8
12	Family Member Detail Page	98	82	0.8	20	0.8
13	Medical Record Page	81	67	2.5	490	2.5
14	Edit Medical Record	96	69	1.1	0	1.1
15	Delete Medical Record	96	69	1.1	0	1.1
16	Report Page	59	70	3.6	750	2.7
17	Account Page	73	67	3.2	400	2.9
18	Access Type Page	86	67	2.8	320	2.6
19	Employee Page	78	67	2.8	460	2.7
20	Polyclinic Queue Page	82	77	2.8	440	2.5
21	Procedure Page	87	76	2.1	210	2.3
22	Add Procedure	85	80	2.7	260	2.7

NO	Testing Scenarios	Performance (%)	Accessibility (%)	Speed Index (s)	Total Bloking Time (ms)	First Contently Paint (s)
Mobile						
1	Booking Page	78	64	1.2	120	2.3
2	Real-Time Home Update	76	56	2.3	234	2.5
3	Booking History Page	87	67	2.8	240	2.7
4	Family Member List Page	73	67	3.2	400	2.9
5	Update Profile	80	75	3.2	200	2.7
6	Update Family Member Profile	80	74	3.0	200	3.0
7	Family Member Detail	85	80	2.7	260	2.7
8	Notifications	93	79	1.9	70	1.2
AVERAGE		**86**	**73**	**2.3**		
MAXIMAL		**98**	**95**	**10.6**		
MINIMAL		**59**	**56**	**0.8**		

The performance testing was conducted using two methods: PageSpeed Insight to test the system's performance with a single access and Load Testing and Stress Testing to test the system's performance under heavy user loads.

In the PageSpeed Insight testing, it was concluded that the website's performance has an average score of 86%, indicating that the system's performance is VERY GOOD when accessed by a single user. The website's accessibility scored 73%, meaning that accessing and using the website is considered GOOD. The Speed Index showed an average loading speed of 2.3 seconds per load, with the longest load time on the Queue Page, which is 10.6 seconds, considered good.

During the Load Testing and Stress Testing, conducted over 3-5 minutes with virtual users ranging from 100 to 500, there was a decrease in performance from 86% to 67% for Stress Testing and 66% for Load Testing. In Stress Testing, the system's ability to handle excessive request data simultaneously is measured, while Load Testing is useful to measure the system's resilience when accessed by many users simultaneously.

4. CONCLUSION

Based on the testing and analysis conducted on the Queue Management System, the following conclusions can be drawn The Android and Website-based Queue Management System can be effectively used by the staff and healthcare professionals at Puskesmas Umban Sari, with four different roles available: Super Admin, General Admin, Healthcare Professionals, and Patients. The system supports both priority queue and FIFO queue, with the General Admin having the capability to enable or disable the queueing system. Based on the testing results, Puskesmas Umban Sari decided to implement the FIFO queue system, as it caters to the needs of their specialized clinics for elderly, pediatric, and maternal care. The black box testing analysis showed that the system functions well and aligns with the planned requirements. The usability testing, conducted through offline questionnaires, resulted in an overall satisfaction score of 84% from the users, indicating a high level of user satisfaction with the system. Performance testing indicated a slight decrease in system performance when accessed by a single user compared to simultaneous access by 100 users within 5 minutes. The system achieved an average performance score of 84% during single access, while the Load Testing and Stress Testing resulted in a performance decrease to 67%.

REFERENCES

[1] Ministry of Health Republic of Indonesia, Peraturan Menteri Kesehatan Nomor 43 Tahun 2019 tentang Pusat Kesehatan Masyarakat, Jakarta, Indonesia, 2019.

[2] K. Safdar, A. Emrouznejad, and P. Dey, "An optimized queue management system to improve patient flow in the absence of appointment system," Int. J. Health Care Qual. Assur., 2020. DOI: https://doi.org/10.1108/IJHCQA-03-2020-0052
[3] Tenwave Healthcare, "How hospital queue management systems are reshaping patient experiences," Tenwave Healthcare, Aug. 2, 2023. Retrieved from https://www.tenwavehealthcare.com
[4] J. Kiplagat, P. W. Kamaku, and S. N. Paul, "Influence of automated queue management system optimization on performance of National Cement Company Limited," Int. Acad. J. Inf. Syst. Technol., vol. 2, no. 1, pp. 221-244, 2020.
[5] M. Fadhli, D. Nurmalasari, and M. Akbar, "Penggunaan metode FIFO pada real-time monitoring antrian pendaftaran pasien puskesmas berbasis web," J. Politeknik Caltex Riau, vol. 9, no. 1, pp. 39-49, 2023. DOI: https://doi.org/10.35143/jkt.v9i1.5915
[6] WaitWell, "Comprehensive queue management solutions for digital healthcare: Enhancing patient experience and workflow efficiency," 2023. Retrieved from https://waitwell.ca
[7] M. R. Islam, M. R. Islam, and T. A. Mazumder, "Mobile application and its global impact," Int. J. Eng. Technol. (IJET-IJENS), vol. 10, no. 6, pp. 104-107, 2010. DOI: https://doi.org/10.1108/IJHCQA-03-2020-0052
[8] S. Putri, A. Rosadi, and M. Rezky, "Rancang bangun sistem antrian pelayanan mahasiswa berbasis Android di Fakultas Teknik Universitas Persada Indonesia Y.A.I," J. IKRA-ITH Inf., vol. 4, no. 2, 2020.
[9] G. M. Abildinova, A. K. Alzhanova, N. N. Ospanova, Z. Taybaldievac, D. S. Baigojanovaa, and N. O. Pashovkina, "Developing a mobile application 'Educational Process Remote Management System' on the Android operating system," Int. J. Environ. Sci. Educ., vol. 11, no. 12, pp. 5128-5145, 2016.
[10] P. Kroll and P. Kruchten, Rational Unified Process Made Easy: A Practitioner's Guide to the RUP. Addison-Wesley, 2003.
[11] T. Javdani Gandomani, M. Mollahoseini Ardakani, and M. Shahzeydi, "A reliable hybrid software development model: CRUP (Crystal Clear & RUP)," in Int. Conf. Emerg. Appl. Technol. Ind. 4.0 (EATI'2020), J. H. Abawajy, K. K. R. Choo, and H. Chiroma, Eds. Cham: Springer, vol. 254, pp. 5, 2021. DOI: https://doi.org/10.1007/978-3-030-80216-5_5
[12] J. Rhodes and E. De Doncker, "Design and implementation of an efficient priority queue data structurer," presented at the 11th Int. Conf. Math. Model. Phys. Sci., vol. 2872, 120038, 2023. DOI: https://doi.org/10.1063/5.0163703
[13] G. S. Mahendra and I. K. A. Asmarajaya, "Evaluation using black box testing and system usability scale in the Kidung Sekar Madya application," J. Penel. Tek. Inf., vol. 7, no. 4, pp. 2292-2302. DOI: https://doi.org/10.33395/sinkron.v7i4.11755
[14] M. Rizky, M. A. Fahrul, A. Oktaviana, and M. A. Lestari, "Testing the Website Performance of SMA Muhammadiyah 4 Yogyakarta Using K6 Tools and GTMetrix," J. Syst. Inf. Technol. Inf., vol. 1, no. 1, pp. 26-30, 2022. Retrieved from https://journal-siti.org/index.php/siti/article/view/8
[15] N. A. Rosa and S. Ramadhani, "Pengembangan aplikasi mobile berbasis Android untuk manajemen antrian bimbingan KP dan proyek akhir dengan memanfaatkan fitur location based service," JAIC, vol. 6, no. 1, pp. 78-86, 2022. DOI: https://doi.org/10.30871/jaic.v6i1.3379
[16] F. J. Wangsa, Marlina, and Renny, "Optimization of Website Toko Kerja Using Performance Test Google PageSpeed Insights," KHARISMA Tech, vol. 18, no. 2, pp. 41-54, 2023. DOI: https://doi.org/10.55645/kharismatech.v18i2.403