

Digitalization of Academic Facility Maintenance from QR Code Reporting to Automated Scheduling

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Abstrak — This paper presents a comprehensive solution to improve the maintenance process of academic facilities at the TULT Building of Telkom University by shifting from a manual to a digital system. The traditional approach relied heavily on physical media, such as checklists and control cards, resulting in issues such as data loss, delayed reporting, and poor monitoring. The proposed digital monitoring system leverages modern web and mobile technologies, including Vue.js for the frontend, Express.js for the backend, PostgreSQL for the database, and Genetic Algorithms for technician scheduling optimization. This system enables real-time damage reporting via QR code scans and ensures preventive maintenance through automatic scheduling and notifications. Results from alpha testing showed a 100% feature success rate, while beta testing yielded positive user feedback regarding usability, interface design, and system responsiveness. This study demonstrates that digitalization significantly enhances maintenance efficiency and the quality of academic services.

Keywords — maintenance system, genetic algorithm, QR code academic facilities, Vue.js.

I. INTRODUCTION

Facility maintenance in academic settings plays a vital role in ensuring a conducive and uninterrupted learning environment. In the TULT Building at Telkom University, maintenance was traditionally handled using paper-based checklists and manual control sheets. These methods presented limitations such as difficulty in data retrieval, susceptibility to data loss, and lack of integration, which compromised efficiency and quality of service delivery[1].

With the increasing reliance on digital solutions across educational institutions, implementing a monitoring system that automates reporting and scheduling becomes critical. Digitalization allows for structured data management, real-time access to asset status, and predictive scheduling, thus enhancing preventive maintenance strategies[2].

This research proposes a web-based and mobile-accessible digital monitoring system that integrates QR code scanning and intelligent scheduling using a Genetic Algorithm. The primary aim is to provide an efficient, automated, and scalable solution that improves maintenance management for academic facilities[3].

II. THEORETICAL BACKGROUND

- a. **Limitations of Manual Systems**
Manual systems often fail to capture real-time information and hinder timely action, increasing the probability of breakdowns and unscheduled downtimes. Their dependence on human input makes them error-prone, especially in environments with large volumes of equipment.
- b. **Benefits of Digital Systems**
Digital maintenance platforms enable automation, centralized monitoring, and structured historical tracking. Systems utilizing QR codes facilitate immediate equipment identification and fault logging[4].
- c. **Genetic Algorithms for Optimization**
Genetic Algorithms (GAs) simulate biological evolution to solve optimization problems. Their stochastic nature and ability to handle multiple constraints make GAs effective in scheduling technicians based on availability, priority, and task location[5].
- d. **Web Technology Stack in System Design**
Vue.js and Express.js offer a modular and scalable approach to building responsive interfaces and robust APIs[6][7]. PostgreSQL supports transactional integrity and complex queries required for facility data management[8].

III. METHODOLOGY

- 1) **Requirement Analysis**
User needs were gathered through interviews with TULT facility staff and maintenance personnel. Critical issues included response delays, misplacement of checklists, and lack of preventive schedules.
- 2) **System Design**
 - Use Case diagrams and ERD models were created.
 - UI/UX prototypes were developed for both admin and mobile users[9].
 - The scheduling logic incorporated constraints such as technician skill level and time windows.
- 3) **Implementation**

- Frontend: Vue.js for web and mobile interface[6]
 - Backend: Express.js with RESTful APIs[7]
 - Database: PostgreSQL with relational schema[8]
 - Optimization: Genetic Algorithm coded in JavaScript and integrated into task allocation logic.[5]
- 4) Testing
- Alpha Testing was conducted internally to validate all modules[10].
 - Beta Testing involved external users including admin staff, technicians, and general users[10].
 - Stress Testing measured system performance under high user concurrency.

IV. RESULT AND DISCUSSION

1) Alpha Testing Results

Internal tests showed 100% feature functionality. QR code scanning, data retrieval, and scheduling worked seamlessly across platforms.

TABEL 1
(Alpha Testing)

Role	Jumlah Uji Fitur	Jumlah Berhasil	Tingkat Keberhasilan
Admin	12	12	100%
Technician	10	10	100%
User	8	8	100%

2) Beta Testing Feedback

- Over 90% of users rated the system as “very easy” to use.
- Reporting via QR codes reduced manual form entry time by over 70%.
- Technicians reported increased efficiency due to auto-generated schedules aligned with their availability.

TABEL 2
(Beta Testing)

No	Pertanyaan	Skor Rata-rata	Interpretasi Skor
1	Apakah fitur mudah digunakan?	4.47	Sangat Baik
2	Apakah tampilan nyaman dan mudah	4.60	Sangat Baik

No	Pertanyaan	Skor Rata-rata	Interpretasi Skor
	dibaca?		
3	Apakah proses pengisian cepat dan efisien?	4.53	Sangat Baik
4	Apakah sistem berjalan tanpa gangguan?	4.47	Sangat Baik
5	Apakah Anda puas dengan sistem secara keseluruhan?	4.47	Sangat Baik

3) Stress Testing Results

The system supported up to 100 concurrent users with average response times under 1 second, indicating strong backend optimization and data indexing in PostgreSQL.

TABEL 3
(Stress Testing)

Metrik	Nilai
Jumlah Total Permintaan	33.725 request
Jumlah Iterasi	33.725 iterasi
Jumlah Pengguna Maksimal	300 Virtual Users
Rata-rata Waktu Respon	224.11 ms
Waktu Respon Maksimal	1.18 ms
Median Waktu Respon	145.56 ms
Error (Failed Requests)	0% (semua permintaan sukses)
Throughput	124.62 request/s
Data Diterima	117 MB
Data Dikirim	28 MB

4) System Advantages Identified

- Real-time tracking and historical logs of maintenance actions.
- Structured communication via notifications.
- Scalability for future integration with IoT or BIM systems.

V. KESIMPULAN

The digitalization of the maintenance system at TULT Building significantly transformed the facility management process. Through QR code-based reporting and algorithm-based scheduling, the project addressed long-standing inefficiencies in data handling, responsiveness, and documentation.

The integration of web technologies and artificial intelligence algorithms provided a scalable framework applicable to other campuses or similar infrastructures. Future work can explore integration with IoT sensors for automatic anomaly detection and real-time environmental feedback.

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