

Design and Development of a Web-Based Calibration Management Application to Improve Calibration Data Recording and Scheduling

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ABSTRACT

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Calibration activities play an important role in maintaining the accuracy and reliability of measurement equipment. However, in many workplaces, calibration data recording is still performed manually using paper documents or spreadsheet files. This manual approach causes several problems, such as repetitive editing of calibration forms for new machines, duplication of files for each calibration period, difficulties in managing historical data, and the absence of automatic reminders for upcoming calibration schedules. These issues reduce work efficiency and increase the risk of human error. This study aims to design and develop a web-based calibration management application that facilitates calibration data recording, data storage, and calibration scheduling. The system is developed using a web-based approach to enable centralized data management and easier access for users. The development method follows a system development life cycle consisting of requirement analysis, system design, implementation, and functional testing. The results show that the proposed application is able to simplify the calibration data recording process, reduce repetitive form editing, and provide automatic reminders for upcoming calibration schedules. Therefore, the developed system can improve efficiency and support better calibration data management.

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1. Introduction

Calibration of measurement equipment is an essential process to ensure the accuracy and reliability of machines used in operational activities. In addition to the calibration process itself, proper recording and management of calibration data are critical to support traceability, reporting, and decision-making regarding equipment usage.

In practice, calibration data recording is often still carried out manually using spreadsheet files or paper-based forms. This condition creates several challenges. Each time a new machine requires calibration, the existing spreadsheet form must be edited manually. Furthermore, when a new calibration period begins, a new form must be created again, resulting in multiple files that are difficult to organize and maintain. This manual process increases the risk of data inconsistency, duplication, and loss of historical calibration records.

Another major issue is related to calibration scheduling. The next calibration schedule is usually determined and recorded manually without any automated reminder mechanism. As a result, calibration activities may be delayed or overlooked, which can potentially affect equipment performance and compliance with calibration requirements.

These problems indicate the need for a more effective and structured system to manage calibration data and schedules. A web-based application can serve as a suitable solution by providing centralized

data storage, easier data retrieval, and automated scheduling features. Web-based systems also allow users to access calibration information efficiently without relying on multiple spreadsheet files.

Therefore, this research focuses on designing and developing a web-based calibration management application that aims to simplify calibration data recording, reduce manual form handling, and provide automatic reminders for upcoming calibration schedules. The proposed system is expected to improve work efficiency and support better management of calibration data.

2. Literature Review

Calibration management is an essential process to ensure the accuracy and reliability of measurement instruments used in industrial and technical environments. In many organizations, calibration records are still managed manually using paper-based documents or spreadsheet applications. This manual approach often leads to data redundancy, inconsistencies, and difficulties in tracking historical calibration information, especially as the number of instruments increases (Saha & Mukherjee, 2019).

Several studies have reported that spreadsheet-based calibration systems require frequent modification of templates whenever new devices are introduced or calibration periods change. This practice increases the risk of human error and complicates data management (Rahman et al., 2020). In addition, manual record-keeping makes it difficult to retrieve calibration history efficiently and may result in missing or duplicated data.

Web-based information systems have been widely adopted to address these challenges. Research in (Sari & Nugroho, 2021) shows that web-based calibration management systems provide better data accessibility and traceability compared to manual methods. Centralized databases allow calibration records to be stored systematically, enabling faster data retrieval and improved consistency across calibration activities.

Calibration scheduling is another critical issue identified in previous studies. According (Lee & Park, 2019), the absence of automated scheduling and reminder mechanisms often causes delays in calibration execution, which may affect equipment performance and compliance with quality standards. Similar findings were reported in (Putra et al., 2020), where reminder-based systems were shown to improve timeliness and reliability of calibration activities.

The application of Internet of Things (IoT) concepts in industrial systems has also influenced calibration management practices. Although not all calibration systems involve direct sensor connectivity, IoT principles support system integration, centralized access, and digital data management through web platforms (Xu et al., 2014). These concepts contribute to improved visibility and coordination of calibration data across different departments.

From a system development perspective, structured web-based applications have been proven to reduce human error and improve operational efficiency. Research in (Kurniawan & Setiawan, 2021) emphasizes that role-based access control and structured data input forms enhance data accuracy and system security. Such approaches are particularly relevant in calibration systems where data integrity is crucial.

User interface design also plays a significant role in system usability. Studies in (Nielsen & Molich, 2017) indicate that intuitive interfaces and categorized data input forms reduce user workload and minimize input errors. Effective UI design is essential for calibration personnel who frequently perform repetitive data entry tasks.

In addition, automated reporting and data export features are important for supporting audits and documentation requirements. Research in (Prasetyo & Santoso, 2020) highlights that digital reporting systems simplify audit preparation and ensure compliance with quality management standards. Exportable calibration data also support long-term record keeping and performance analysis.

Despite the availability of various calibration management solutions, several studies indicate that many systems focus only on data storage without integrating scheduling, reminder, and monitoring features into a single platform (Widodo & Ramadhan, 2022). This research addresses this gap by developing a web-based calibration management application that integrates device master management, calibration data input, scheduling, monitoring, and data export functionalities.

3. Research Methods

3.1. Research Approach

This research applies a system development approach focusing on the design and implementation of a web-based calibration management application. The study emphasizes practical problem-solving by transforming a manual calibration recording process into a structured and centralized information system. The development process follows the System Development Life Cycle (SDLC) method to ensure systematic and well-organized system construction.

3.2. System Development Method

The system development process is conducted using the SDLC method, which consists of the following stages :



Fig.1. System Development with SDLC

1. Requirement Analysis

At this stage, system requirements are identified through observation of the existing calibration recording process. The analysis reveals that calibration data are recorded manually using spreadsheet files, requiring repetitive form editing for new devices and new calibration periods. In addition, calibration scheduling is performed manually without automatic reminders. Based on these findings, the system is required to support centralized data storage, structured data input, calibration scheduling, and data export functionality.

2. System Design

The system design stage focuses on defining the system architecture, data flow, and user interactions. The application is designed as a web-based system to allow easy access and centralized management. Several modules are defined, including device master data, calibration data input, calibration scheduling, monitoring, and data export. The user interface is designed to support structured input for different types of measurement devices, such as temperature controllers, pressure gauges, and temperature recorders.

3. Implementation

In this stage, the system design is implemented into a functional web application. The application provides features for device registration, calibration data input, scheduling management, and monitoring of calibration status. Each calibration record is stored in a centralized database, allowing users to retrieve historical calibration data efficiently. The system also supports data export to facilitate documentation and reporting processes.

4. Testing

Functional testing is conducted using the black-box testing method to ensure that each system function operates according to the specified requirements. The testing process focuses on validating input forms, data storage, schedule generation, and data export features. The test results indicate that the system functions correctly and meets the defined requirements.

3.3. System Architecture

The proposed system adopts a web-based architecture consisting of three main components: client, application server, and database server. Users interact with the system through a web browser, while the application server processes user requests and manages business logic. The database server stores device information, calibration records, and scheduling data in a centralized manner. This architecture supports scalability and simplifies system maintenance.

3.4. Data Collection

The data used in this study consist of calibration data obtained from measurement devices, including device identity, calibration values, calibration dates, and environmental parameters such as room temperature. The data are collected through the system input forms during calibration activities and stored in the database for further processing and reporting.

3.5. Evaluation Method

System evaluation is conducted by verifying the functionality of each module and observing the system's ability to address the identified problems. The evaluation focuses on improvements in data organization, reduction of manual form handling, and ease of calibration schedule monitoring. The results show that the developed system effectively supports calibration data management and scheduling activities.

4. Results and Discussions

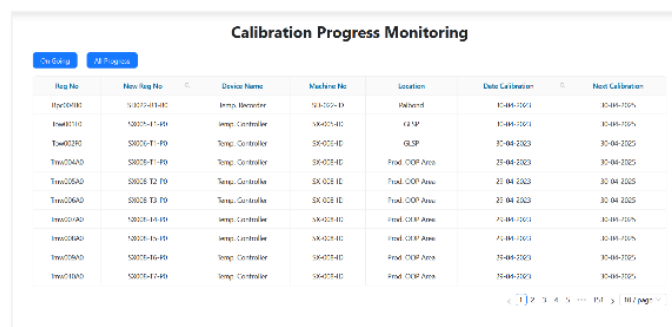
4.1. System Implementation Results

This section presents the implementation results of the proposed web-based calibration management application. The developed system successfully transforms the manual calibration recording process into a structured and centralized digital system. The application consists of several main modules, including export calibration monitoring, device management, calibration data input, scheduling, and data export.

4.2. Calibration Monitoring

The calibration monitoring module provides an overview of calibration progress for all registered devices. This module displays essential information such as device registration number, device name, machine number, location, calibration date, and next calibration schedule. By centralizing calibration information, users can easily monitor calibration status and identify devices that require upcoming calibration.

Figure 1 shows the calibration progress monitoring interface implemented in the proposed system.



Reg No	New Reg No	Device Name	Machine No	Location	Date Calibration	Next Calibration
Inst00180	13027-411-481	Temp. Controller	SK-020-10	Palbond	15-04-2024	15-04-2025
Inst01110	13027-411-491	Temp. Controller	SK-021-10	CI MP	15-04-2024	15-04-2025
Inst00280	13026-11-100	Temp. Controller	SK-021-10	GLSP	15-04-2023	15-04-2025
Inst00430	13026-11-100	Temp. Controller	SK-021-10	Prod. COOP Area	15-04-2023	15-04-2025
Inst00540	13026-12-100	Temp. Controller	SK-021-10	Prod. COOP Area	21-04-2023	21-04-2025
Inst00640	13026-12-100	Temp. Controller	SK-021-10	Prod. COOP Area	21-04-2023	21-04-2025
Inst00740	13026-14-101	Temp. Controller	SK-021-10	Prod. CEAP Area	15-04-2024	15-04-2025
Inst00840	13026-14-101	Temp. Controller	SK-021-10	Prod. CEAP Area	15-04-2024	15-04-2025
Inst00940	13026-14-101	Temp. Controller	SK-021-10	Prod. COOP Area	15-04-2024	15-04-2025
Inst01040	13026-14-101	Temp. Controller	SK-021-10	Prod. COOP Area	15-04-2024	15-04-2025

Fig. 2. Calibration Progress Monitoring Interface

This feature directly addresses the problem identified in the manual system, where calibration schedules were difficult to track and lacked automatic reminders. The monitoring module improves data visibility and supports better planning of calibration activities.

4.3. Device Selection and Calibration Input

The system provides a device selection interface that allows users to choose the type of measurement device before entering calibration data. The application supports multiple device categories, including temperature controllers, pressure gauges, and temperature recorders. This design enables structured data input and eliminates the need to manually modify spreadsheet forms for different devices.

Figure 2 shows the device selection interface used to select the measurement device type prior to calibration data entry.

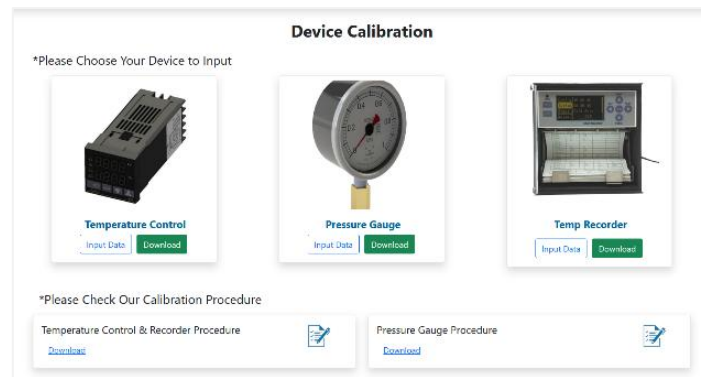


Fig.3. Device selection interface for calibration

Each device type is equipped with a dedicated calibration input form tailored to its measurement characteristics. The structured input fields ensure data consistency and reduce the risk of input errors compared to manual data entry.

4.4. Calibration Data Input Forms

The calibration data input module is designed to support structured and consistent recording of calibration results. To maintain clarity and focus, this study presents two representative calibration input forms, namely the pressure gauge and temperature control calibration forms.

The pressure gauge calibration form allows users to input calibration results systematically. The form supports multiple measurement points, repeated readings, and both upward and downward calibration sequences. Environmental parameters such as room temperature and calibration date are also recorded to support calibration traceability.

The Figure 3 shows the pressure gauge calibration data input form implemented in the proposed system.

User	Room Degree	New Reg No	No Machine	Calibration Date
JES.Farf	23	181044101	1903043	26/01/2020
Nilai standard atas				
R1 20	R2 20	R3 20		
R1 40	R2 40	R3 40		
R1 60	R2 60	R3 60		
R1 80	R2 80	R3 80		
R1 100	R2 100	R3 100		
Nilai standard bawah				
R1 20	R2 20	R3 20		
R1 40	R2 40	R3 40		
R1 60	R2 60	R3 60		
R1 80	R2 80	R3 80		
R1 100	R2 100	R3 100		

Fig.4. Pressure gauge calibration data input

In addition, the temperature control calibration form is designed to record calibration results at predefined temperature setpoints. The form supports repeated measurements and enables users to validate calibration results before saving the data.

Fig.5. Temperature control calibration input

These structured input forms replace manual spreadsheet-based calculations and help ensure data consistency, completeness, and accuracy before the calibration data are stored in the system.

4.5. Calibration Scheduling

The calibration scheduling module is designed to support systematic planning and monitoring of calibration activities. The module integrates a scheduling plan with a calendar-based interface, enabling users to visualize scheduled calibration dates and upcoming calibration tasks in an organized manner.

The Figure 5 the calibration scheduling and calendar interface implemented in the proposed system.

Reg No	New Reg No	Device Name	Machine No	Location	Date of Service
HP01ABP	20240101	Temp. Control	20240101	Lab01	20240101
HP01B1	20240102	Temp. Control	20240102	Lab01	20240102
HP01C1	20240103	Temp. Control	20240103	Lab01	20240103
HP01D1	20240104	Temp. Control	20240104	Lab01	20240104
HP01E1	20240105	Temp. Control	20240105	Lab01	20240105
HP01F1	20240106	Temp. Control	20240106	Lab01	20240106
HP01G1	20240107	Temp. Control	20240107	Lab01	20240107
HP01H1	20240108	Temp. Control	20240108	Lab01	20240108
HP01I1	20240109	Temp. Control	20240109	Lab01	20240109
HP01J1	20240110	Temp. Control	20240110	Lab01	20240110
HP01K1	20240111	Temp. Control	20240111	Lab01	20240111
HP01L1	20240112	Temp. Control	20240112	Lab01	20240112
HP01M1	20240113	Temp. Control	20240113	Lab01	20240113
HP01N1	20240114	Temp. Control	20240114	Lab01	20240114
HP01O1	20240115	Temp. Control	20240115	Lab01	20240115
HP01P1	20240116	Temp. Control	20240116	Lab01	20240116
HP01Q1	20240117	Temp. Control	20240117	Lab01	20240117
HP01R1	20240118	Temp. Control	20240118	Lab01	20240118
HP01S1	20240119	Temp. Control	20240119	Lab01	20240119
HP01T1	20240120	Temp. Control	20240120	Lab01	20240120
HP01U1	20240121	Temp. Control	20240121	Lab01	20240121
HP01V1	20240122	Temp. Control	20240122	Lab01	20240122
HP01W1	20240123	Temp. Control	20240123	Lab01	20240123
HP01X1	20240124	Temp. Control	20240124	Lab01	20240124
HP01Y1	20240125	Temp. Control	20240125	Lab01	20240125
HP01Z1	20240126	Temp. Control	20240126	Lab01	20240126

Fig.6. Calibration scheduling and calendar

The system automatically generates the next calibration schedule based on the predefined calibration period of each device. By replacing manual scheduling practices that relied on human memory and handwritten notes, this module enhances scheduling reliability and helps ensure that calibration activities are performed on time.

4.6. Device Master Data Management

The device master data module functions as a centralized repository for storing essential information related to measurement devices used in calibration activities. The stored data include device brand, model, capacity, resolution, tolerance limits, calibration interval, and installation location. The Figure 6 presents the device master data management interface implemented in the proposed system.

Fig.7. Device master data management interface

By maintaining device information in a centralized database, the system ensures consistency of data usage across calibration input, scheduling, and monitoring modules. This approach minimizes data redundancy and simplifies the maintenance of calibration records, particularly when managing a large number of devices.

4.7. Calibration Data Export Feature

To support documentation and reporting needs, the developed system includes a calibration data export feature. This feature allows users to download calibration results in a structured format for further use in reporting, archiving, or audit preparation.

DATA HASIL KALIBRASI									
Pembacaan Alat (Kgf/cm ²)	Posisi	Pembacaan Standard (Kgf/cm ²)			Rave	Stdev	Koreksi Standard (Calibration Tester)	Penunjukan Standard terkoreksi	Koreksi
		R1	R2	R3					
20	Naik	50.0	50.0	50.0	50	0.00	0.0	50.0	30.0
40		100.0	100.0	100.0	100	0.00	0.0	100.0	60.0
60		150.0	150.0	150.0	150	0.00	0.0	150.0	90.0
80		200.0	200.0	200.0	200	0.00	0.0	200.0	120.0
100		300.0	300.0	300.0	300	0.00	0.0	300.0	200.0
20	Turun	51.0	51.0	51.0	51	0.00	0.0	51.0	31.0
40		100.0	100.0	100.0	100	0.00	0.0	100.0	60.0
60		151.0	151.0	151.0	151	0.00	0.0	151.0	91.0
80		201.0	201.0	201.0	201	0.00	0.0	201.0	121.0
100		301.0	301.0	301.0	301	0.00	0.0	301.0	201.0
Max Stdev					0.000				

DATA UNCERTAINTY										
No.	Komponen	Unit	Distribusi	U	Divisor	v ₁	v ₂	v ₃	U _{rel} ²	(U _{rel}) ² /v _n
1	Repeatability	Kgf/cm ²	Normal	0.000	1.73	2	0.0000	0.00000	0.000000	0.000000
2	Resolusi alat	Kgf/cm ²	Segi-4	0.5	1.73	1000	0.2887	0.2887	0.083333	0.000007
3	Standar Test Gauge	Kgf/cm ²	Normal	0.4	2	60	0.2000	0.2000	0.040000	0.000027
Sums									0.123333	0.000034
Combined Standard uncertainty, u _c									0.3512	
Effective degree of freedom, v _{eff}									452.56	
Coverage factor, k=Student's for u _c and CL 95%									2.00	1.97
Expanded uncertainty, U = k · u _c (dalam mm)									0.70	

Fig.8. Calibration data export feature

The availability of this feature eliminates the need for manual data copying from spreadsheets and improves the efficiency of report generation. As a result, calibration data can be accessed and processed more efficiently when required for internal review or external audits.

4.8. Discussion

Based on the system implementation results, the developed web-based calibration management application demonstrates a clear improvement over the previous manual calibration recording process. A comparison between the manual approach and the proposed system is summarized in Table 1.

Table 1. Manual vs Proposed calibration system

Aspect	Manual System	Proposed System
Data recording method	Spreadsheet-based	Web-based database
Form modification	Manual editing required for each device	Automatic form generation based on device type

Calibration scheduling	Manual tracking using notes or files	Automated scheduling based on calibration period
Schedule visibility	Limited and fragmented	Centralized monitoring interface
Data export	Manual data copying	Automated data export feature

The comparison highlights that the integration of structured calibration input forms, centralized device master data, automated scheduling, and data export features significantly reduces repetitive administrative tasks that were previously performed using spreadsheet-based documents. In addition, the proposed system improves data consistency and minimizes the need for manual form modification when handling different types of calibration devices.

Furthermore, the enhanced visibility of calibration schedules enables users to identify upcoming calibration activities more effectively, reducing the risk of missed or delayed calibrations. These findings indicate that the implementation of a web-based information system can support more efficient and reliable calibration data management in practical operational environments.

5. Conclusion

This study has presented the design and development of a web-based calibration management application to overcome the limitations of manual calibration data recording. The proposed system provides structured calibration data input, centralized data storage, calibration schedule monitoring, and data export functionality. The implementation results show that the system is able to reduce repetitive manual form editing, improve data organization, and support more effective monitoring of calibration schedules. Overall, the study demonstrates that a web-based approach can enhance efficiency and reliability in managing calibration data. Future work may focus on integrating notification mechanisms, improving system security, or extending the application to support additional types of measurement devices.

References

- A. K. Saha and S. Mukherjee, "Design of calibration data management systems for industrial applications," *International Journal of Engineering Research*, vol. 8, no. 4, pp. 215–220, 2019.
- M. A. Rahman, N. Hassan, and R. Ahmad, "Spreadsheet-based calibration management: Challenges and limitations," *Journal of Industrial Engineering Studies*, vol. 6, no. 2, pp. 101–108, 2020.
- D. P. Sari and R. Nugroho, "Web-based calibration information system for manufacturing instruments," *Journal of Information Systems Engineering*, vol. 7, no. 1, pp. 45–52, 2021.
- J. Lee and K. Park, "Automated scheduling systems for equipment calibration," *International Journal of Industrial Automation*, vol. 5, no. 3, pp. 88–94, 2019.
- S. Putra, A. Wijaya, and T. Handoko, "Reminder-based maintenance and calibration system using web technologies," *Indonesian Journal of Applied Computing*, vol. 4, no. 2, pp. 60–67, 2020.
- L. Da Xu, W. He, and S. Li, "Internet of Things in industries: A survey," *IEEE Transactions on Industrial Informatics*, vol. 10, no. 4, pp. 2233–2243, 2014.
- R. Kurniawan and D. Setiawan, "Role-based access control in web-based industrial applications," *Journal of Software Engineering*, vol. 9, no. 1, pp. 12–18, 2021.
- H. Nielsen and J. Molich, "Usability principles for web application interfaces," *International Journal of Human–Computer Interaction*, vol. 33, no. 6, pp. 489–497, 2017.
- A. Prasetyo and Y. Santoso, "Automated reporting systems for quality management compliance," *Journal of Quality Engineering*, vol. 11, no. 2, pp. 134–141, 2020.
- T. Widodo and F. Ramadhan, "Evaluation of digital calibration systems in manufacturing industries," *Journal of Industrial Information Technology*, vol. 6, no. 3, pp. 77–84, 2022.