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Digitizing Manufacturing Workflows: Lessons from Deploying a Low-Code Reporting Tool in an SME Assembly Line

Sakraan Sitcharangsie
Department of Sustainable Industrial Management Engineering
Rajamangala University of Technology Phra Nakhon
Bangkok, Thailand
sakraan.s@rmutp.ac.th

Abstract

This study explores the implementation of a low-code application using AppSheet to improve production data reporting in the assembly department of the participating company. The objective was to replace a manual, paper-based process with a real-time digital system that enhances operational efficiency. The project involved system design, user-centered development, testing, and evaluation. Results showed significant reductions in reporting time, workflow steps, and manual effort, along with improved data accuracy and real-time visibility for supervisors. The findings highlight the effectiveness of low-code platforms in enabling rapid digital transformation for small and medium-sized manufacturing environments.

Keywords
AppSheet, low-code, digital transformation, workflow optimization, manufacturing SMEs

1. Introduction
This research addresses the persistent inefficiencies in manual reporting systems within manufacturing environments, especially in small and medium enterprises. Traditional paper-based methods lead to delayed communication (Thanuja et al., 2024), data inaccuracies (Kong et al., 2018), and limited supervisory oversight (Rzevski and Farrar, 1984). These issues not only reduce production efficiency but also hinder the ability of supervisors to respond promptly to emerging problems. The increasing demand for real-time information and operational transparency highlights the need for digital transformation using accessible tools (Sonar et al., 2025). Enterprises are turning to digital solutions that offer immediacy, accuracy, and efficiency without requiring large capital investments. However, for many SMEs, the cost and complexity of traditional software development remain significant barriers (Sonar et al., 2025).

Low-code platforms such as AppSheet offer a promising avenue for digitization without heavy IT investments. These platforms enable non-programmers to develop applications that automate workflows and enhance data management (Kolovos et al., 2023). This research emerged from observed reporting inefficiencies at a participating company's assembly department, where delays in problem reporting and tracking impacted productivity. Operators relied on handwritten logs, which were then manually processed by supervisors. This caused duplication of work, data loss, and miscommunication. The central problem lies in the absence of a real-time, reliable reporting system capable of reducing waste, enhancing efficiency, and supporting data-driven decision-making.

The objectives of this research are presented below.

- Develop a real-time reporting tool through a low-code platform tailored for an assembly department.
- Evaluate the system's effects on workflow efficiency, data accuracy, and user satisfaction.

- Introduce improvements driven by user feedback and validate enhancements using quantitative analysis.

2. Literature Review

Small and medium-sized enterprises (SMEs) face several key barriers to digital transformation. One of the most prominent challenges is resource constraints. Many SMEs lack the financial and human capital needed to implement advanced digital solutions comparable to those adopted by larger organizations. The costs associated with acquiring new technologies and providing employee training present significant obstacles (Koumas et al.,2021). In addition, cultural resistance to change is common, often stemming from limited digital literacy and fear of technological disruption among staff (Koumas et al.,2021).

Low-code development platforms (LCDPs) significantly lower the barrier to software creation by enabling individuals without formal programming backgrounds to build functional applications. This democratization of software development expands participation across organizations, fostering innovation and accelerating digital transformation efforts (Upadhyaya, 2025). In addition to enhancing accessibility, LCDPs offer notable advantages in cost and time efficiency. By reducing the need for complex coding, these platforms streamline the development process, allowing for faster deployment and lower development expenses. Such efficiencies are particularly advantageous for small and medium-sized enterprises (SMEs) and internal business teams, as they enable quicker delivery cycles and improved return on investment (Korada, 2022; Velásquez et al., 2024).

While most prior low-code applications of AppSheet have been in the healthcare sector—such as in the works of Elsayed et al. (2023), Pinargote-Celorio et al. (2023), and Chan et al. (2022). Relatively few studies have explored its use in manufacturing contexts. For example, Hassan et al. (2023) demonstrated the effectiveness of low-code platforms like AppSheet in digitizing manual order processing in an SME automotive warehouse. Their work highlights the potential of such tools in resource-constrained environments. However, research remains limited on low-code implementation in other SME manufacturing contexts, especially at the department level and in production-focused areas such as assembly lines.

Moreover, few papers address the practical challenges of rolling out low-code systems, such as staff training(Korada, 2022), integration with existing tools (Upadhyaya, 2025), or resistance to change(Korada, 2022). This paper contributes to the field by offering a real-world pilot case that explores the structured implementation of a low-code solution within a constrained operational environment.

Recent studies highlight the value of digital tools in manufacturing, especially under the Industry 4.0 framework. Industry 4.0 encourages the integration of smart technologies into production to achieve intelligent and interconnected environments. Digitized reporting systems are critical enablers in lean and Industry 4.0 initiatives.

While Manufacturing Execution Systems are effective in large enterprises, they often demand significant investment and technical expertise. SMEs frequently struggle with resource constraints. Research increasingly points to low-code platforms as viable alternatives. Successful applications in logistics and healthcare demonstrate potential, yet practical evidence in the manufacturing domain remains limited. This study provides an original contribution by applying a low-code solution within a real SME production setting.

3. Methods

3.1 Root Cause Analysis Using Fishbone Diagram

To investigate the underlying causes of delays and errors in data recording, a Fishbone Diagram was employed. This visual tool helped categorize potential causes into four main groups: manpower, machinery, methods, and materials. The structured analysis allowed for a systematic identification of root causes and helped in formulating targeted, practical solutions.

3.2 Design and Development of the Real-Time Production Reporting Application Using AppSheet

Based on the defined project scope, a real-time production reporting application was both designed and developed using AppSheet, a low-code development platform suitable for rapid deployment. The objective was to transform the manual, paper-based data entry process into a digital system that improves accuracy and timeliness.

The development process began with replicating the original paper form in a digital interface, as illustrated in Figure 1. A centralized database was created using Google Sheets to record essential production data, including time, operator name, machine ID, quantity produced, and number of defects. Interfaces were designed to be user-friendly and aligned with operational needs, drawing on feedback from interviews with assembly-line staffs.

The completed application enabled operators to enter production data directly from their mobile devices. These inputs were automatically synced with the Google Sheets database and displayed in real time on management dashboards. This integration allowed supervisors to monitor operations continuously and make faster, data-driven decisions (Figure 1).

Daily Production Report & Assembly Issues					
Date: ....../....../.......... Employee Name: Number of Good Units (per person): Number of Defective Units (per person):					
Number of Units					
Time	7:00 - 9:00	9:00 - 11:00	12:00 - 14:00	14:00 - 16:00	16:30 - 18:30
Good Units					
Defective Units					
Total Good Units					
Total Defective Units					
Additional Activities / Issues					
Time	7:00 - 9:00	9:00 - 11:00	12:00 - 14:00	14:00 - 16:00	16:30 - 18:30
- Meeting:					
- Jig Change / Machine Setup:					
- Machine Breakdown:					
- Power Outage					
- Low Air Pressure:					

Figure 1. Original paper-based form

3.3 Application Testing at the Assembly Station of a Participating Company

The application was tested in a real production environment to evaluate its functionality and impact. The first phase of testing focused on verifying the stability and performance of the application. This included three trials of recording production data (both acceptable and defective items) through the app, checking for accuracy in database updates and real-time dashboard visualization. Additionally, three trials were conducted to test the malfunction reporting function by logging machine issues and confirming correct database entries. Another three tests evaluated the system's speed and data synchronization reliability.

In the second phase, a comparison was made between the previous manual process and the new digital process using flow process charts. These diagrams revealed redundant steps and helped redesign the workflow to be more streamlined and centralized, eliminating unnecessary actions and consolidating reporting activities into a single interface.

In the third phase, user satisfaction was assessed through structured interviews and surveys. A total of 12 users—10 operators and 2 supervisors—participated in both quantitative and qualitative evaluations. Surveys employed a 5-point Likert scale (5 = very satisfied, 1 = dissatisfied) to rate the application across four key criteria: ease of use, clarity of display, speed and accuracy of data recording, and convenience compared to the previous manual system. The results provided valuable insights into the system's usability and efficiency, as well as areas requiring further enhancement.

4. Results and Discussion

4.1 Root Cause Analysis (Fishbone Diagram)

Root cause analysis was performed using a Fishbone Diagram as seen in Figure 2, which revealed that delays and errors stemmed from multiple factors such as machine reliability, human error, unclear processes, and environmental conditions. This structured analysis helped in identifying improvement opportunities that directly informed application design (Figure 2).

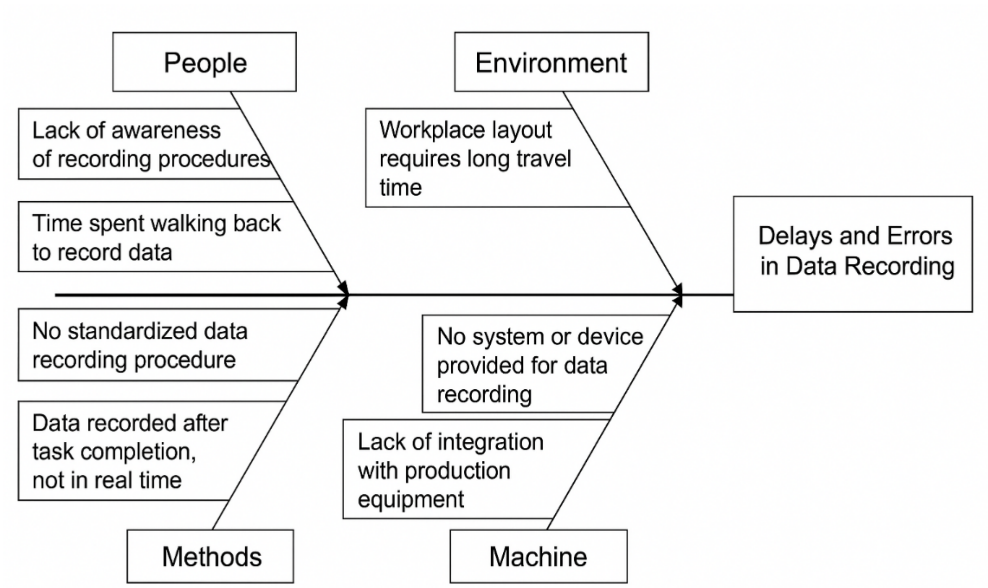

Figure 2. Root Cause Analysis (Fishbone Diagram)

4.2 Application Development Results

Based on user interviews and operational requirements, the application was developed with the following key features:

- Data Entry Screen

Allows operators to input production data for both good and defective parts, as well as log machine issues (e.g., power outages, low air pressure, or other disruptions).

- Cumulative Production Calculation

Automatically calculates the total production by adding new entries to the machine's previous production count.

- Real-Time Data Display

Shows all recorded production data from machines on the main screen in real time, enabling immediate visibility for staff and supervisors.

- Graphical Data Visualization

Presents production information in real-time graph format to support monitoring and performance analysis.

- Cloud-Based Synchronization

Seamlessly integrates with Google Sheets, ensuring all data is synchronized in the cloud and instantly updated on dashboards.

4.3 System Testing Results

The application was tested in a real production environment at the assembly workstation, following the methodology outlined in Chapter 3. A total of ten production operators and two supervisors participating in the evaluation. Each key function of the application was tested three times to ensure consistency and to reflect typical usage scenarios.

The testing covered three main areas: production data entry, machine malfunction reporting, and system stability. Operators recorded both good and defective items through the application across three trials. All entries were accurately stored in the connected Google Sheets database and immediately displayed on the supervisor dashboard, confirming the reliability of real-time data synchronization. For malfunction reporting, three additional entries were made to log issues such as power outages and low air pressure. These incidents were correctly captured and reflected in the system without delay. In terms of performance under load, three rounds of simultaneous input by multiple users demonstrated that the application remained stable, responsive, and free from lag.

In addition to functionality, data accuracy was evaluated through ten focused trials. Each entry was verified against the stored values in the database, and no discrepancies were detected. This confirmed a 0% error rate, demonstrating the system's capability to maintain high data integrity during regular use. Overall, the results validated that the application could perform reliably under real-world conditions, with consistent accuracy and seamless data handling.

4.4 Process Improvement Analysis

Flow process charts were used to compare the manual and digital workflows before and after implementation (see Figure 3 and Figure 4). The manual process involved seven steps, took 17 minutes, and required operators to walk approximately 60 meters to complete data recording.

In contrast, the new digital process required only three steps, completed in 7 minutes, with no walking distance (Figure 3 and Figure 4).
This reflects:

- 71% reduction in process steps
- 59% reduction in operation time
- 100% reduction in unnecessary movement

These results validate the application's impact in simplifying production tasks and reducing physical workload.

	Description	Time (minutes)	Distance (meters)	Activity Type				
				Operation	Transportation	Inspection	Delay	Storage
1	Place workpieces in the box	2.5	0					
2	Check number of good/defective workpieces	2.5	0					
3	Walk to get the data recording paper	2	20					
4	Walk back to the workstation	2	20					
5	Record data	5	0					
6	Calculate total including previous quantity	1	0					
7	Walk to deliver the form to the supervisor	2	20					
Total		17	60	3	3	1	0	0

Figure 3. Flow process before deploying Appsheet

	Description	Time (minutes)	Distance (meters)	Activity Type				
				Operation	Transportation	Inspection	Delay	Storage
1	Put the workpiece in a box	2.5	0	○				
2	Check for good/defective workpieces	2.5	0			□		
3	Record data	2	0	○				
Total		7	0	1	0	1	0	0

Figure 4. Flow process after deploying Appsheet

4.5 User Satisfaction and Insights

To assess satisfaction with the implemented application, both quantitative surveys and qualitative interviews were conducted with all 12 users (10 operators and 2 supervisors). Participants rated the system on four key criteria using a 5-point Likert scale: ease of use, display clarity, speed and accuracy of data recording, and convenience compared to the previous manual process. The Figure 5 demonstrates the full distribution of scores across all criteria.

4.5.1 Survey Results

The two highest-rated aspects were display clarity and speed and accuracy, each receiving a perfect average score of 5.00 with no standard deviation, indicating unanimous satisfaction. All respondents agreed that the interface was easy to read and that data entry was fast and reliable compared to the previous paper-based method.

Ease of use earned an average score of 4.75 with a standard deviation of 0.45. While most users (9 out of 12) rated it the maximum score, a few reported needing minor orientation at the start.

Convenience compared to the old system also scored 4.75, but with a slightly higher standard deviation of 0.62. While most users found the app significantly more convenient, two users noted occasional challenges with selecting correct options, such as machine numbers or time entries.

4.5.2 Interview Findings

Semi-structured interviews provided deeper insights into the user experience with the application. Operators highlighted that the workflow became significantly more streamlined, as they no longer needed to walk to retrieve or submit paper forms, effectively reducing non-productive movement on the shop floor. Supervisors noted that the availability of real-time production updates enhanced transparency, improved traceability, and allowed for more effective oversight of operations. Additionally, most users reported that the application was easy to adopt, with many becoming comfortable using it within five to ten minutes, which minimized the need for formal training.

4.5.3 Suggestions for Improvement

Although feedback was generally positive, users suggested several enhancements to further improve the application's usability and performance. One commonly requested improvement was to increase the font size to enhance readability, particularly in low-light environments where visibility can be limited. Users also recommended adding notification features, such as SMS or email alerts, to promptly inform supervisors of machine downtime or other critical events. Additionally, there were suggestions to improve system stability, ensuring that the application remains responsive and performs reliably during periods of peak usage when multiple users are accessing the system at the same time (Figure 5).

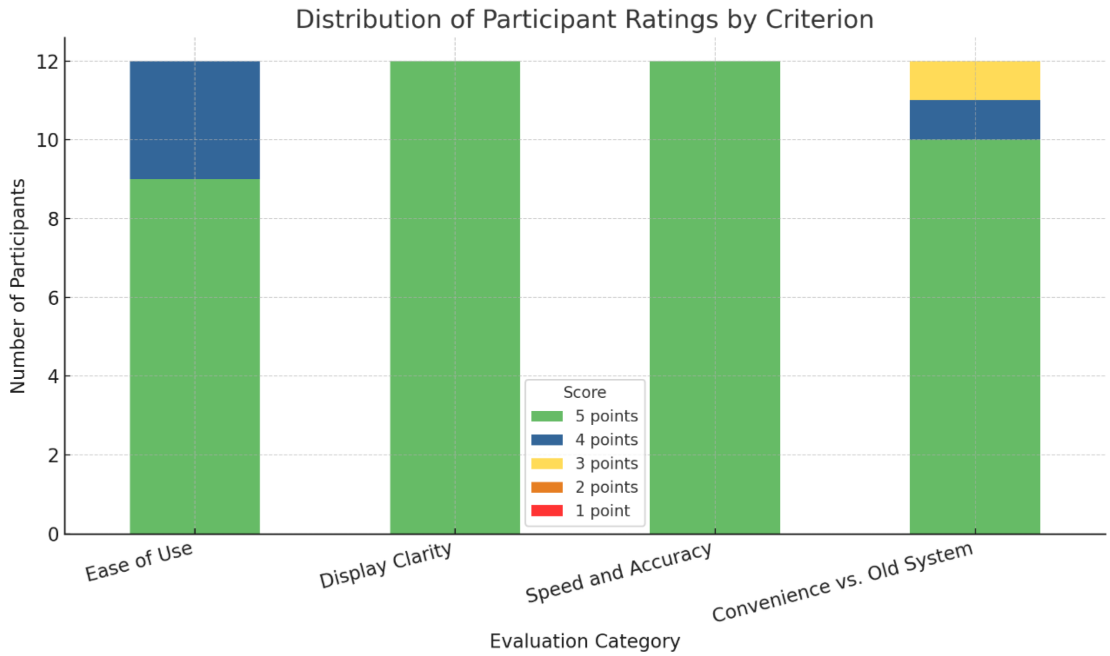

Figure 5. Full distribution of scores across all criteria

4.5.4 Role-Based Experience Comparison

Analysis of feedback revealed differences in how operators and supervisors perceived the application's value. Operators emphasized ease of use and reduced physical effort. The app helped eliminate repetitive manual tasks and allowed them to stay focused on core production duties. Supervisors valued the ability to access and interpret real-time data easily. The graphical dashboard and instant updates supported more informed and timely decision-making. These role-specific insights confirm that the application successfully addressed both frontline operational needs and managerial oversight requirements.

4.6 Cost-Benefit Analysis from the Company's Perspective

The application was developed and implemented by the researcher, who also served as the developer. The total cost incurred during the development and deployment process was 720 Baht, which was personally covered by the researcher. As a result, the company did not bear any financial cost related to the application's development, deployment, or training.

The application was built using the AppSheet platform, which is free for up to 10 users. No additional software licenses, hardware, or external consultants were required. Employees were able to learn to use the app in approximately 10 minutes, eliminating the need for formal training sessions and minimizing learning curve costs.
On the benefit side, the application reduces task completion time by an average of 10 minutes per employee per use. With 10 users, this results in a total time saving of 100 minutes per use. Based on a labor cost of 350 Baht per 8-hour workday (or 43.75 Baht per hour), the estimated value of the time saved is approximately 72.92 Baht per use.
Although the researcher's expense was 720 Baht, the return on this investment is realized after just a few uses of the application. Thereafter, the company continues to benefit from ongoing efficiency gains without any additional cost. This demonstrates that the application is highly cost-effective and sustainable, especially from the company's standpoint, where no investment was required.

4.7 Limitaions and Future Work

Although the study achieved its objectives and demonstrated clear benefits, it is important to acknowledge certain limitations. The implementation and testing were conducted with a limited group of 12 users at a single workstation. While the results indicated immediate efficiency gains, these outcomes may not be fully representative of performance across different workstations, departments, or production lines. Broader deployment and multi-site testing were beyond the scope of this study due to time constraints and resource limitations. Consequently, the scalability and generalizability of the application remain open for further investigation.

In addition, the evaluation primarily focused on short-term outcomes observed immediately after deployment. Longer-term factors such as user retention, adaptation over time, and trends in data accuracy or error rates were not assessed. These aspects are essential for evaluating the sustained effectiveness and real-world impact of the solution in dynamic production environments.

Future research should aim to implement the application across multiple work environments and extend the observation period to include long-term usage patterns. Such studies would provide deeper insights into system scalability, user behavior over time, and the overall reliability of low-code solutions in manufacturing settings. This would contribute meaningfully to the evolving discourse on digital transformation strategies for small and medium-sized enterprises.

5. Conclusion

This research demonstrated the successful development and implementation of a real-time production reporting application using a low-code platform within a live manufacturing environment. The project fulfilled all key objectives, including the design, deployment, and refinement of the application based on user input and practical use.

The study provides clear evidence of the practicality and value of low-code application platforms such as AppSheet for small and medium-sized enterprises. These tools enable organizations to achieve digital transformation in a cost-effective manner, while minimizing technical complexity and reducing the need for extensive training or external support.

By facilitating real-time data access and improving communication between operators and supervisors, the application contributed to a more responsive and informed production process. The experience gained through this implementation highlights the potential for similar solutions to enhance operational efficiency in other industrial settings.

The outcomes of this study offer useful insights for both practitioners and researchers interested in digital innovation for manufacturing environments. Future work should explore broader applications across multiple departments and assess the long-term impact of such technologies on organizational performance and user engagement.

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Biography

Sakraan Sitcharangsie is a lecturer in the Department of Sustainable Industrial Management Engineering at Rajamangala University of Technology Phra Nakhon, Thailand. She has a PhD in Design, Manufacture and Engineering Management from the University of Strathclyde. Her research interests encompass sustainable manufacturing, the circular economy, engineering management, decision-making, and data science. She focuses on various aspects of industrial engineering and management. In the area of sustainable industrial management, her work often addresses energy conservation, environmental impact, and lifecycle assessments in industrial settings. She also utilizes machine learning techniques to optimize industrial processes. Her research includes developing decision-making frameworks to improve the efficiency of remanufacturing activities. Additionally, she investigates the readiness and investment feasibility of Industry 4.0 technologies in small and medium-sized enterprises (SMEs).