Journal of Industrial Engineering
Scientific Journal on Study and Application of Industrial System
Volume 10 No 02 - September 2025
http://e-journal.president.ac.id/presunivojs/index.php/journalofIndustrialEngineerin
ISSN 2527-4139 (*online*) – ISSN 2503-3670 (*print*)

Development and Optimization of a Real-Time Tracking System for Toy Plastic Assembly Using Object-Oriented Analysis and Design

Hery Hamdi Azwir[1], Mutiara Hasnadya Tasrif[2], Herwan Yusmira[3]
[1,2,3]Faculty of Engineering, Industrial Engineering Department, President University
Jl. Ki Hajar Dewantara
Kota Jababeka,Cikarang, Bekasi - Indonesia 17550
Email: [1]hery.azwir@president.ac.id, [2]mutiara.tasrif@student.president.ac.id, [3]herwan.yusmira@president.ac.id

ABSTRACT

PT ABC Toy Company, a global toy manufacturer known for fashion dolls, faced significant production delays in its Plastic Assembly department, averaging 5-7 days per product due to an inefficient manual tracking system. These delays resulted in production bottlenecks and missed deadlines, affecting the company's ability to meet market demands. This study aimed to develop and implement a web-based tracking system using Object-Oriented Analysis and Design (OOAD) to minimize delays, improve material management, and optimize production scheduling. The new system provided real-time monitoring of materials, piloting status, and production schedules, automating manual processes and enhancing interdepartmental communication. Implementation of the system led to a 62.36% reduction in delays, decreasing the average delay from 5–7 days to approximately 2 days. This improvement increased production capacity, reduced overtime and penalty costs, and facilitated more timely product deliveries. The findings highlight how an optimized tracking system can enhance operational efficiency, improve customer satisfaction, and strengthen the company's market position.

Keywords: Real-time tracking, Cycle Time, Plastic Assembly, OOAD, Web-Based System, Toy Company.

ABSTRAK

PT ABC Toy, produsen mainan global yang terkenal dengan boneka fashion, menghadapi penundaan produksi yang signifikan di departemen Perakitan Plastik, rata-rata 5-7 hari per produk karena sistem pelacakan manual yang tidak efisien. Keterlambatan ini mengakibatkan kemacetan produksi dan tenggat waktu yang terlewat, sehingga mempengaruhi kemampuan perusahaan untuk memenuhi permintaan pasar. Penelitian ini bertujuan untuk mengembangkan dan mengimplementasikan sistem pelacakan berbasis web menggunakan Analisis dan Desain Berorientasi Objek untuk meminimalisir keterlambatan, meningkatkan manajemen material, dan mengoptimalkan penjadwalan produksi. Sistem baru ini menyediakan pemantauan material, status uji coba, dan jadwal produksi secara real-time, mengotomatiskan proses manual dan meningkatkan komunikasi antar departemen. Implementasi sistem ini menghasilkan pengurangan penundaan sebesar 62,36%, mengurangi rata-rata penundaan dari 5-7 hari menjadi sekitar 2 hari. Peningkatan ini meningkatkan kapasitas produksi, mengurangi biaya lembur dan denda, serta memfasilitasi pengiriman produk yang lebih tepat waktu. Temuan ini menyoroti bagaimana sistem pelacakan yang dioptimalkan dapat meningkatkan efisiensi operasional, meningkatkan kepuasan pelanggan, dan memperkuat posisi pasar perusahaan.

Kata kunci: Pelacakan waktu nyata, Waktu Siklus, Perakitan Plastik, Analisis dan Desain Berorientasi Objek, Sistem Berbasis Web, Perusahaan Mainan.

1. Introduction

Information systems play a crucial role in modern manufacturing by enhancing data visibility, improving decision-making, and streamlining operations (K.Shobha, 2024). In production environments, an effective tracking system ensures real-time monitoring of materials, schedules, and processes, minimizing delays and optimizing workflow (Chang et al., 2013). A well-integrated tracking system is essential for managing complex operations, particularly in industries that handle high product variability and frequent new product introductions. Without a reliable system, inefficiencies arise, leading to production delays and increased operational costs (Li & Li, 2000).

 DOI: https://doi.org/10.33021/jie.v10i02.167

ABC Toy Company, one of the largest toy manufacturers globally, introduces an average of 37 new toy designs per month. To maintain efficiency, each new toy undergoes a piloting stage before mass production to test materials, tools, and processes. However, delays in piloting can significantly impact subsequent processes, particularly in the Plastic Assembly department, which directly affects the Final Assembly stage (Jiménez-Martín et al., 2021). Internal data shows that Plastic Assembly experiences an average delay of 5-7 days per project due to issues in material availability and previous processes. These delays disrupt production schedules and hinder timely product delivery.

Currently, Plastic Assembly relies on Excel for tracking, which lacks real-time updates, is prone to errors, and is inefficient in monitoring material status and piloting progress. A previous attempt to implement a website system failed due to an unsuitable user interface and frequent data inconsistencies. As a result, the department struggles to track delays and identify issues promptly, leading to inefficiencies across production stages. A more reliable and automated tracking system is required to ensure better coordination and minimize production disruptions.

To address this issue, a web-based tracking system will be developed, integrating AS/400 data on schedules, materials, and piloting status in real-time. This system will enable the Plastic Assembly team to detect delays faster and make more informed decisions. The development process will apply Object-Oriented Analysis and Design (OOAD), which provides a modular and flexible approach tailored to the department's specific needs. By implementing this system, the company aims to reduce delays, enhance tracking accuracy, and improve overall production efficiency (Pelawi, 2013).

2. Methods

The study framework will apply the outcomes of the study measurements. It is used as a guide to assist them in narrowing their study focus. For a clearer understanding of the study, the study flow structure is shown in Figure 1.

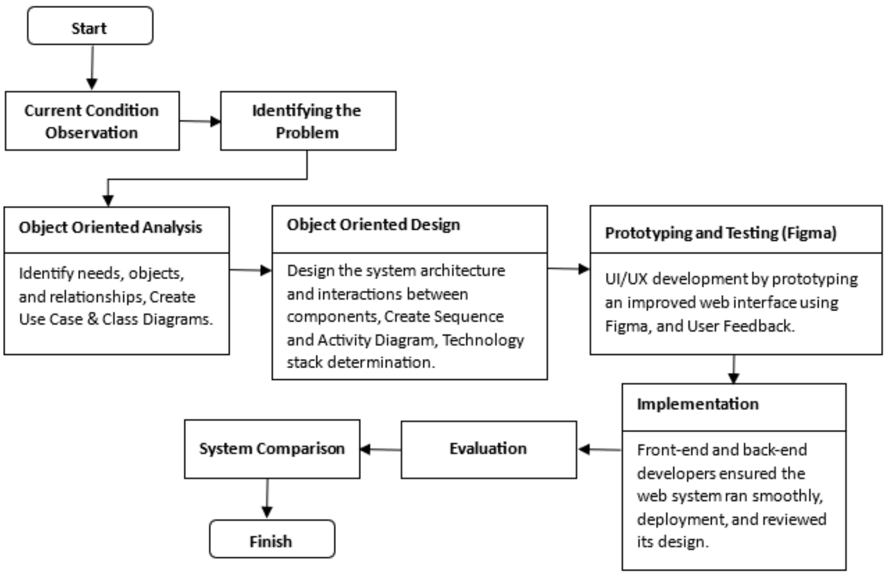

Figure 1. Study Framework

2.1 Current Condition

The first stage is the current condition observation, where the processes and operations of the existing system are carefully observed and analysed. Baseline data is collected to understand how the current system operates, with the goal of identifying inefficiencies, bottlenecks, and areas for potential improvement. This analysis provides crucial insights into the issues that need to be addressed in the new system.

2.2 Problem Identification

The results from the previous observation are analyzed to uncover the root causes of delays and inefficiencies, offering a deeper understanding of the challenges faced by the current system. This understanding is used to formulate appropriate solutions that will guide the subsequent stages of the project.

2.3 Object Oriented Analysis

Once the problems are identified, the next step is the Object-Oriented Analysis (OOA) phase, where system requirements are defined using an object-based approach by identifying key objects, their attributes, and their relationships within the system (Roebuck, 2012).

2.4 Object Oriented Design

In this phase, the system architecture is developed based on the findings from Object-Oriented Analysis (OOA). Use Case Diagrams illustrate user interactions, Class Diagrams define the system's structure, Sequence Diagrams map communication flows between objects, and Activity Diagrams outline processes and workflows (Koç et al., 2021). Additionally, the appropriate technology stack is selected to ensure efficient system development.

2.5 Prototyping and Testing

Following the design phase, the next stage is prototyping and testing. The front-end developer creates a system prototype using tools like Figma, which is then subjected to usability testing. This process gathers user feedback to ensure the design meets user expectations and helps identify areas for improvement before proceeding with further development (Nguyen et al., 2023).

2.6 Implementation

In this phase, the system is developed based on the finalized design and specifications. Close collaboration between the front-end and back-end teams is essential to ensure seamless integration. The back-end team focuses on database management and system integration (Chapke et al., 2024), while the front-end team develops the user interface using technologies such as C#, SQL, and ASP.NET. The primary goal is to enhance system functionality, productivity, and efficiency in the Plastic Assembly area (Noble & Biddle, 2023).

2.7 Evaluation

Once the system is developed, it undergoes a thorough testing and evaluation phase. This includes continuous testing to identify and resolve bugs or technical errors, along with User Acceptance Testing (UAT) to assess user satisfaction. Rigorous testing is conducted to ensure system reliability and minimize potential issues after deployment (Bhuiyan, 2011).

3. Result and Discussion

3.1 Current Condition

Discipline in each department (Mold, Painting, Assembly, and Packaging) is crucial to meeting product launch targets at PT ABC Toys. To evaluate compliance, Kaizen is applied to assess each department's adherence to the launch schedule. However, data from January to August 2024 shows that 68.5% of new toy launches fail to meet the target schedule, indicating significant inefficiencies in the production process.

An analysis of delay contributions from each department reveals that Assembly is the primary source of delays, particularly in terms of time efficiency, material availability, labor, and equipment. Despite using a tracking system, Final Assembly remains affected by delays originating from the Plastic Assembly sector, which plays a crucial role in handling the main plastic parts.

Field observations further indicate that Plastic Assembly experiences an average delay of 5–7 days per new toy, primarily due to inefficiencies in the tracking system. The current system lacks real-time monitoring, making it difficult to manage scheduling and production flow effectively. Given its direct impact on Final Assembly and overall production efficiency, Plastic Assembly has been identified as the key focus for process improvements, particularly in optimizing tracking systems and scheduling methods.

Meanwhile, below is figure 2 and 3 shows the workflow of tracking tooling system and each stage of the ongoing piloting. This process has long stages and still involves a lot of manual operations and manual inputs in the current workflow. The current website is ineffective due to several significant obstacles. Firstly, the database is outdated, containing only data up to 2022. Additionally, data input issues have resulted in incomplete part lists for Plastic Assembly. The website also lacks detailed information, displaying only toy numbers without a breakdown of required parts.

3.2 Object Oriented Analysis

3.2.1 Weakness of Current System

The flaws in the current system significantly disrupt the workflow in the Plastic Assembly department. To address these issues, modifications were introduced to reduce system vulnerabilities. Table 1 outlines the specific weaknesses of the current system in detail.

Table 1. Weaknesses of the Current System

Weakness	Explanation
Input data schedule to Excel Spreadsheet	The process takes a long time due to the lengthy steps: searching for the partlist data based on the toy name on the PE website; If unavailable, looking for the design sheet and requesting the partlist to be created. After that, sorting the partlist related to plastic assembly, entering the data into Excel, and inputting the date based on the piloting schedule in final assembly using an H-7 calculation. These lengthy steps often lead to human errors.
Check the tooling readiness for each part.	IE must track the tooling status for each toy with multiple part lists. The process is still very manual because IE has to check using the workshop website and remember the work order descriptions for the various parts.
View Piloting PA Schedule	The piloting schedule can be viewed through Power BI, but it cannot reflect real-time changes or unexpected schedule adjustments due to Power BI's limitations in data refresh.
Report assembly process findings and assembly status from each piloting stage.	It will require too many steps. Forgetfulness often occurs due to the need to input findings notes and the status of the piloting stage and partlists that have been assembled.

To evaluate improvements, Table 2 compares the tracking process duration in the existing and proposed systems. To enhance efficiency, an audit time matrix was developed to monitor the time required for each task in the assembly process per 5 units of product (toy). This matrix acts as a control tool to analyze and optimize processing time. Table 2 details the average total processing time for tracking and assembly.

Table 2. Time Required Current System Table

No	Process	Tracking Schedule time processing (Minutes)				
		Day 1	Day 2	Day 3	Day 4	Day 5
1	Input data part list plastic assembly in excel	75	80	70	85	83
2	Input data schedule piloting in excel	60	55	65	62	58
3	Check Material Readiness	90	85	92	88	90
4	Report the result to Whatsapp Group	25	30	20	28	25
5	Update Status piloting to Excel	45	50	40	48	46
6	Create design tooling	125.6	130	120	128	126
7	Submit design tooling trough website and email to workshop team	102	100	105	98	101
8	Check Tooling Readiness	35	42	25	33	45
Total time		432	572	537	570	574
Average		537				

Audit process from day 1 to day 5 result is 537 minutes or approximately 8 hours and 57 minutes. The weakness in the current system can be seen from the time taken to complete each task, which indicates inefficiency. In such a situation, technicians are unable to perform other work simultaneously, which can hamper overall productivity.

3.2.2 RACI Matrix

The RACI matrix for the website improvement project defines the roles and responsibilities of each team member, ensuring clarity and alignment with project goals (Leach, 2018). The Project Manager is responsible for executing key tasks, including UI prototype design, user feedback analysis, and user acceptance testing. The Developer Team handles technical aspects such as system development and maintenance while also providing input on UI design and cycle time analysis (Singhal et al., 2022). Stakeholders contribute by offering feedback during prototype design and testing but are primarily informed about project progress rather than involved in daily decisions. Table 3 presents the detailed RACI Matrix for the Tracking Plastic Assembly System development.

Table 3. RACI Matrix

Task/Activity	Supervisor Project Manager	Project Manager	Developer Team	Stakeholder
Analysis current condition of the problem	R	A	C	C
Planning for improving website system	R	A	C	C
Analysis system needs	R	A	C	C
Design the user interface (UI) Prototype	R	I	C	C
User Feedback for prototype	C	I	C	R
Develop the new website system	I	C	R	I
Implementing and maintenance the new system	I	C	R	I
Compare the required cycle time before and after the system is in place	R	A	I	C
Make user acceptance test and analysis the result	R	A	C	I

3.2.3 User and Stakeholder Requirement

User requirements play a crucial role in the development of a new system as they reflect the needs and expectations of users and stakeholders (Leach, 2018). A system designed with user needs in mind will be more aligned with their expectations, improve efficiency, and reduce development costs by minimizing changes in later stages.

In this study, user requirements were gathered through observations of the current system. Understanding user needs from the beginning ensures that the future system is designed more effectively and meets specific requirements. Users in this study are categorized into four groups, so the user requirements are also grouped accordingly. The detailed user requirements for the new system are presented in Table 4.

Table 4. User requirement for New System

User	Pain point (user story)	Requirement
Industrial Engineer & Technician PA	1. Time is wasted finding design sheets and contacting the Product Engineer. 2. No real-time schedule. 3. Missing part lists in TL&FS piloting force Industrial Engineers to use design photos. 4. Material list identification takes too long. 5. Inefficient tooling handover makes tracking status difficult. 6. Miscommunication in piloting causes delays. 7. A task tracking system is needed to prevent miscommunication and missed tasks.	1. View toy list with designs, part numbers, responsible persons, and schedules. 2. View & edit target and dynamic calendars. 3. Part Sync menu for manual entry of plastic assembly parts, linked to toy info. 4. View material details, including mold numbers, inventory, and quantity. 5. Tooling status dashboard based on toy number. 6. Edit piloting comments with a checkbox for status (done/not yet). 7. Backlog/adherence dashboard to track task progress. 8. Checkbox to track FC & method sheet status for each part number.
Supervisor	1. Time is wasted finding design sheets and contacting the Product Engineer. 2. No real-time schedule. 3. Missing part lists force engineers to use design photos. 4. Identifying material lists takes too long. 5. Inefficient tooling handover complicates tracking. 6. Piloting miscommunication causes delays. 7. A task tracking system is needed to prevent issues.	1. View toy list with designs, part numbers, responsible persons, and schedules. 2. View target and dynamic calendars. 3. Edit Part Sync for PA parts, linked to toy info, with a manual part list. 4. View material details, including PA parts, mold numbers, inventory, and quantities. 5. View tooling status dashboard by toy number. 6. Add/view piloting comments with a checkbox for status (done/not yet). 7. Track progress with the backlog/adherence dashboard. 8. Checkbox to confirm FC & method sheet status for each part.

Stakeholders need different features than users, focusing on reports from system-collected data. Data analysis converts raw data into meaningful reports. Table 5. lists stakeholder needs for the new system.

Table 5. Stakeholder Needs

Stakeholder	Requirements
Dashboard	Forecast new toy Backlog for Piloting Status
New Toy Menu	List New Toy • Toy Information (Summary) • The description of the toy • The design photo product • Engineer R+ • List of Child/Part Number of Plastic Assembly • Information Piloting Stage date and preparation Tooling Status of each child number.
Part Sync	Adjustment Part List
Calendar	Calendar dynamic for Balancing Fixed calendar for the new toy launch target

3.2.4 Proposed System Plastic Assembly

To improve data organization and efficiency, a web-based system is proposed. Figure 4 illustrates its workflow. The system integrates automated queries to sync data. The PE website will handle new toy data entry and tracking, automatically updating the Primary Database. The Workshop Website will also update tooling readiness status in real-time.

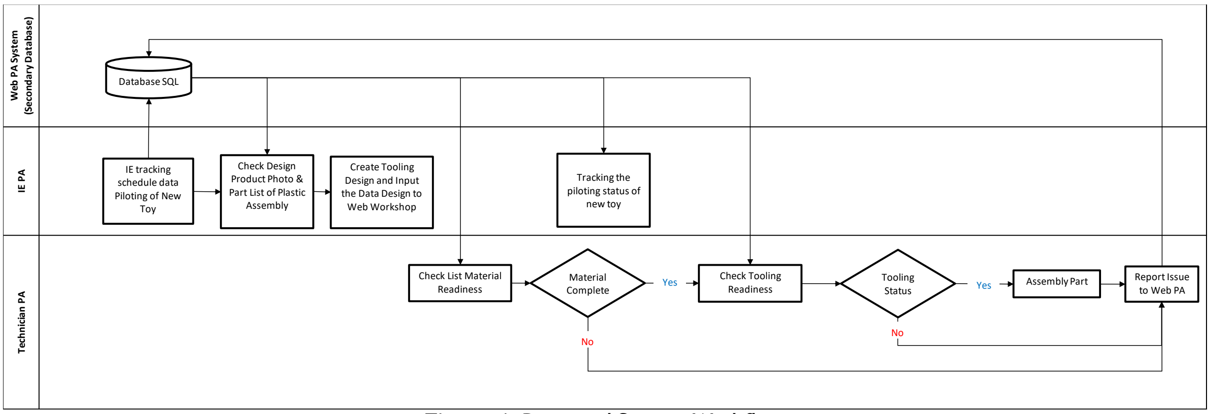

Figure 4. Proposed System Workflow

With centralized data in the Primary Database, the Tracking PA System provides real-time updates through an improved website. The backend processes data from the PE and Workshop Websites to verify material and tooling readiness, automatically notifying users of any issues. This system enhances efficiency, reduces errors, enables real-time tracking, and speeds up decision-making, ensuring a smooth assembly process (Samoylov et al., 2017).

3.3 Object Oriented Design

3.3.1 System Architecture

System architecture is essential for defining a software system's structure and interactions. It determines data flow and communication between components, ensuring efficiency and user satisfaction. Figure 5. illustrates the system architecture.

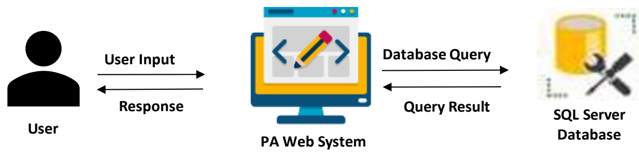

Figure 5. System Architecture of Plastic Assembly System

In this architecture, users interact with the PA Web System, which processes input and responds accordingly. The system communicates with the SQL Server Database to retrieve or store data through queries. This client-server model ensures efficient data processing and real-time updates.

3.3.2 Data Extraction

The system extracts data from two sources: AS/400 for New Toys Information and the Workshop Website for Tooling Status Updates. This data is sent to SQL System Management Studio, which manages and stores it. The PA System Web (Front-End/UI) then presents the data in a user-friendly format. Figure 6 illustrates this process.

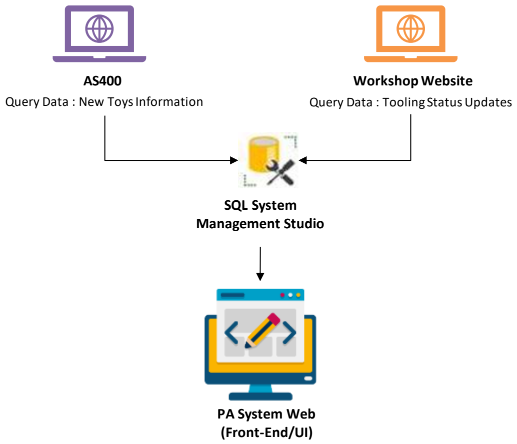

Figure 6. Data Extraction

This data extraction flow keeps the PA System Web updated and centralized. Data from AS/400 and the Workshop Website is processed in SQL System Management Studio for consistency before display. This improves production monitoring by ensuring accurate, real-time information.

3.3.3 Data Structure

SQL database structures are essential, storing metadata like foreign keys, constraints, tables, columns, and indexes. The Tracker Plastic Assembly System uses a data dictionary to organize data. Table 6 summarizes the Data Structure.

Table 6. Data Structure of Database SQL

Table Name	Column Name	Data Type	Description
USER	userID	INT (Primary Key)	Unique identifier for each user
	username	VARCHAR(255)	Username for user login
	password	VARCHAR(255)	User's password
	role	VARCHAR(50)	User's role (admin, user, etc.)
ACCESS	userID	INT (Foreign Key)	References userID from USER table
	role	VARCHAR(50)	Role for accessing different parts of the system

3.3.4 Use Case Diagram

A Use Case Diagram shows how users interact with a system, defining functionality and roles (Djaoui & Chaoui, 2024). Figure 7 illustrates the Contributor Website, where IE Staff manage and maintain plastic assembly data & Technicians update and verify technical information. Both ensure data accuracy and smooth operations, helping developers and stakeholders understand system behavior.

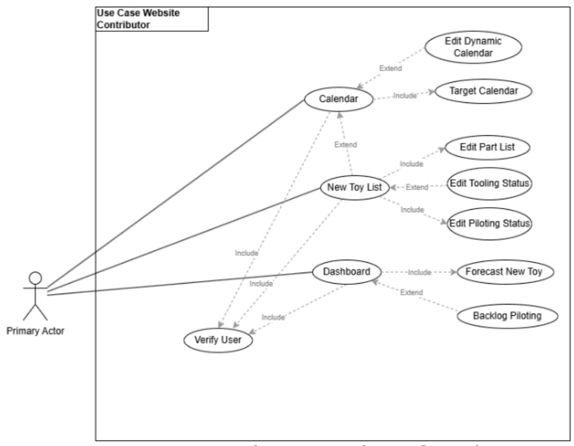

Figure 7. Use case diagram Website Contributor

Besides the Website Contributor, there is also a Website Viewer for monitoring progress and tracking. This feature is used by Staff IE PA & Technician PA to review the piloting phase performance of the New Toy Plastic Assembly team.

Actor determination helps define user roles and access within the system. The table 7 below outlines each actor, their description, and the features they can access.

Table 7. Actor Determination for New System

No	Actor	Description
1.	Staff IE & Technician PA (Primary Actor)	1. Dashboard Monitoring: View new toy forecasts and piloting backlog/adherence to monitor task progress. 2. Schedule Management: View targets schedule and customizable dynamic calendar/schedule. 3. Toy Information: View and edit the toy list, including part numbers, responsible person (IE/PE), and tooling status by toy number. 4. Update Piloting Status: View and edit comments and piloting status (completed/not yet), including FC & method sheet updates for each part number. 5. Material Menu: View the materials for each new toy, including mold number, inventory location, and material quantity.
2.	New Toy Supervisor (Secondary Actor)	1. Dashboard Monitoring: View new toy forecasts and piloting backlog/adherence to monitor task progress. 2. Schedule Monitoring: View targets schedule and dynamic calendar/schedule. 3. Toy Information: View the toy list, including part numbers, responsible person (IE/PE), and tooling status by toy number. 6. Check Piloting Status: View comments and piloting status (completed/not yet), including FC & method sheet updates for each part number.

3.3.5 Activity Diagram

The proposed website system enhances data management, monitoring, and tracking by providing features tailored to user needs (Seidl et al., 2015). It streamlines workflows through four key activities represented in Figure 9, an Activity Diagram Dashboard Monitoring

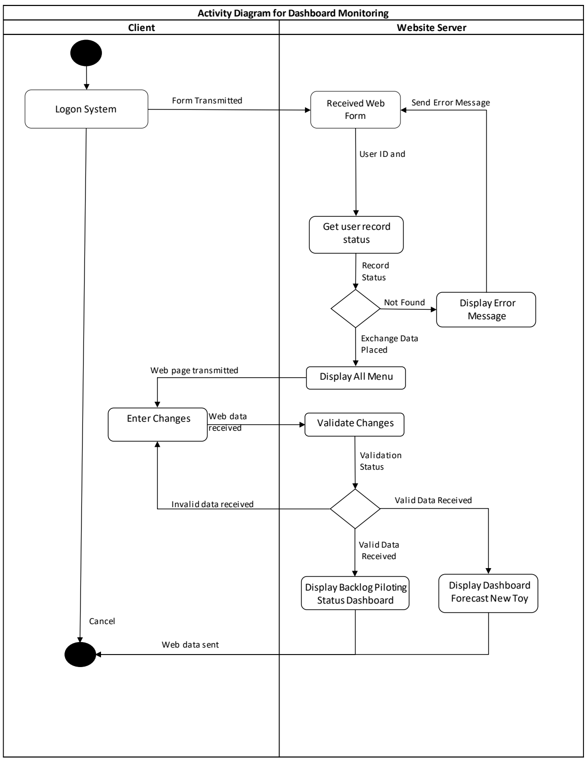

Figure 9. Activity Diagram for Dashboard Monitoring

The system improves efficiency through four key activities: Dashboard Monitoring, Schedule Management, Tooling Status Update, and Part Management. These features streamline data access, scheduling, tooling tracking, and part management in the Plastic Assembly department.

Dashboard Monitoring provides real-time access to new toy data, piloting status, and adherence forecasts. Schedule Management allows users to update piloting schedules, reducing delays and improving coordination.

Tooling Status Update enables users to track and update tooling status in real time, ensuring accurate progress monitoring. Part Management allows users to edit and manage child numbers for plastic assembly parts, ensuring proper tracking before piloting. These features enhance automation, reduce errors, and support real-time decision-making, improving overall efficiency.

3.3.6 Class Diagram

The Class Diagram in Figure 14 provides a structured representation of the New Website System, ensuring efficient toy development management (Fauzan et al., 2021). At the core is the User Class, responsible for authentication and user data. The Dashboard Class acts as the interface for displaying reports and updates.

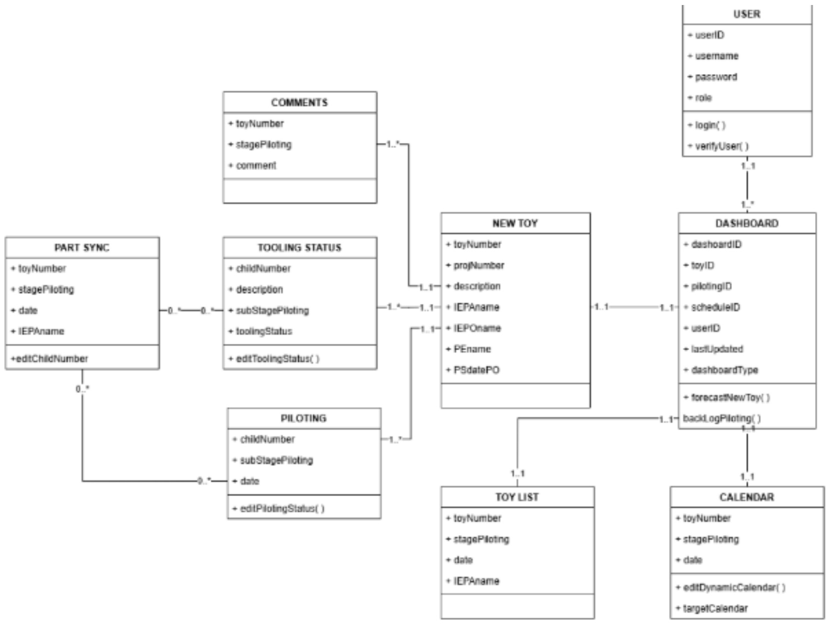

Figure 14. Class Diagram for New System

For project planning, the Schedule Class manages timelines, while the New Toy Class tracks part availability, tooling, and development progress. The Material Readiness Class ensures materials are available, and the Tooling Status Class monitors tool readiness. During testing, the Piloting Status Class oversees piloting updates and issue reporting. These interrelated classes create a well-integrated system that streamlines the entire toy development process, from planning to testing.

3.3.7 Sequence Diagram

The Sequence Diagram visualizes interactions between users, system components, and data flow, ensuring efficient operations in the Plastic Assembly department (Chen et al., 2020). It illustrates key workflows such as login authentication, monitoring, scheduling, and status updates. The login process ensures secure access by verifying user credentials before granting entry. Once logged in, users can access the dashboard to view real-time data, including new toy forecasts and piloting status. For scheduling, users select target schedules from a dynamic calendar, and the system retrieves relevant data to facilitate efficient planning.

Users can also update piloting and tooling statuses by selecting a specific toy, entering the necessary changes, and confirming updates, ensuring accurate tracking of progress. Additionally, part synchronization is streamlined through the Edit Child Number feature, where users retrieve and modify child number data, which the system updates accordingly. These processes enhance workflow automation, improve real-time tracking, and ensure data accuracy, ultimately increasing efficiency in the Plastic Assembly department. Figure 15 below presents an example of a Sequence Diagram, demonstrating the structured interaction between users and the system.

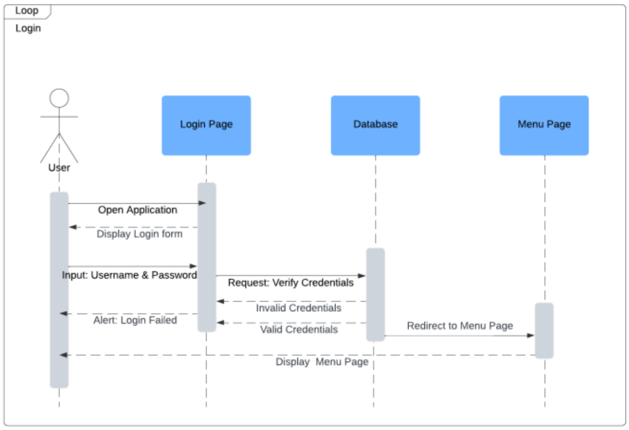

Figure 15. Login to Website Sequence Diagram

3.3.8 Database Relationship

The new toy development management system was designed using a relational database on SQL Server to enhance data management efficiency and support decision-making in toy development projects (Pulungan et al., 2023). Figure 21 The Entity Relationship Diagram illustrates the database structure, where each table represents a key entity with logical relationships reflecting business processes.

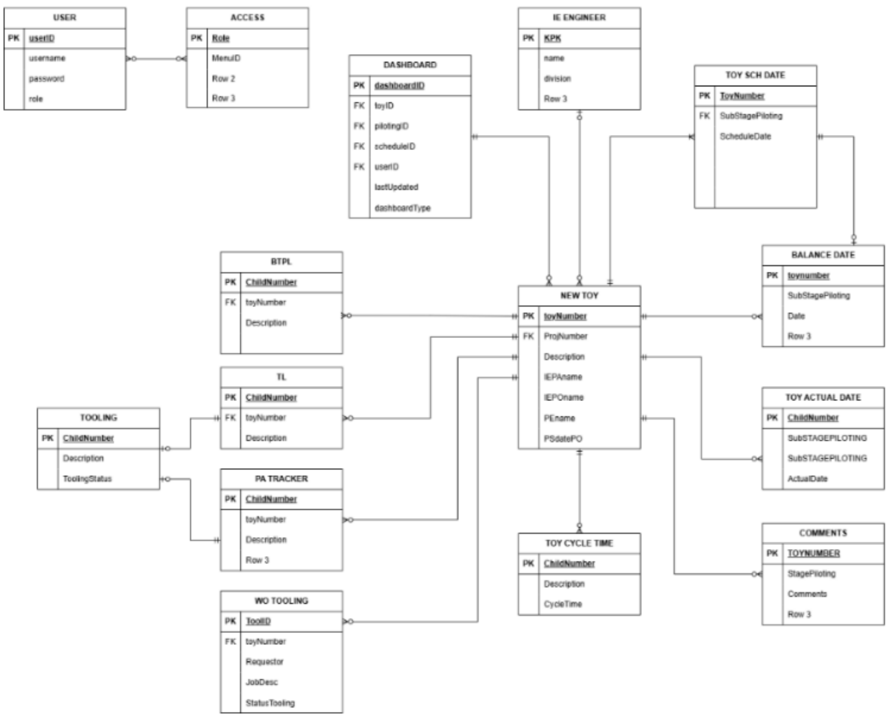

Figure 21. Entity Relationship Diagram

The user table functions as an authentication center, managing user information. The new toy table connects to other key tables, including material, which stores material data, and piloting status, which tracks toy trial progress. The schedule table manages project timelines, while the dashboard table integrates data from various tables for real-time insights. These relationships ensure structured data management, streamlined workflows, and efficient data access across the system.

3.3.9 User Interface Design

The website interface was designed using Figma, focusing on design, flow, and prototyping to ensure user-friendly navigation and workflow efficiency (Yassine et al., 2017). Figures 22 illustrate the interface, showcasing structured layouts tailored to user needs.

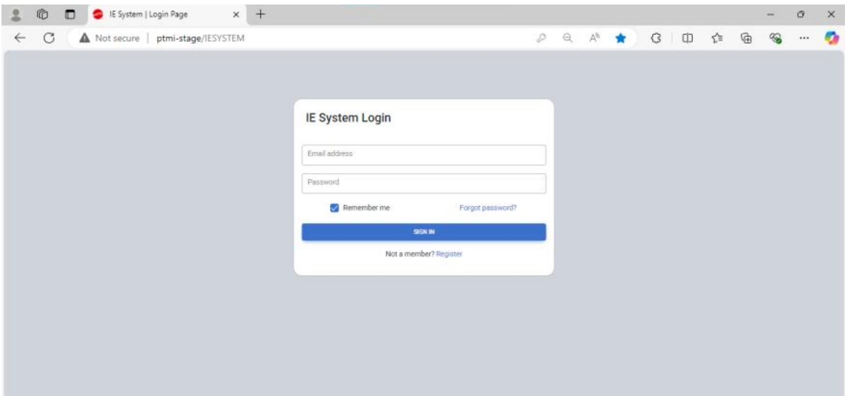

Figure 22. Login Page Website Tracker Assembly

The Login Menu is the first screen users encounter, requiring a username and password to ensure secure access. Upon successful login, users are directed to the Dashboard Menu, which provides real-time insights into new toy development. This dashboard integrates the New Toy Forecast Dashboard and the Backlog Update Dashboard, helping users track project status, manage workloads, and optimize schedules.

The Calendar Menu offers Target Calendar and Balance Calendar views for scheduling efficiency. Users can set expected launch dates, adjust workloads, and reschedule tasks with a drag-and-drop feature. The New Toy Information Menu centralizes data, displaying toy progress through the New Toy Board, List Toy, and Piloting Information pages. Additionally, the Work Order Tooling page enables monitoring of tooling development without switching platforms.

Lastly, the Part Sync Menu ensures accurate part list updates by allowing direct synchronization. Users can verify, update, or remove obsolete parts, simplifying final assembly revisions. These features enhance real-time tracking, data accuracy, and operational efficiency. Figure A below presents an example of the website interface.

3.4 Implementation

The system development team, comprising back-end and front-end developers, played a key role in building and integrating a web-based system for managing toy data, test schedules, and tool status. The implementation process involved several steps to ensure smooth system deployment and functionality.

3.4.1 System Implementation

The team developed a web-based system for managing toy data, schedules, and tool status using SQL Server, ASP.NET, and C#. The database connection was established via web.config, linking to IESystemDB and PDS, with data retrieved through SQL queries and processed using C# controllers and LINQ.

On the front-end, HTML tables displayed toy lists, schedules, and tool status, with AJAX enabling dynamic updates. Data was rendered using @foreach in .cshtml files. The system was fully deployed in December 2024, improving tracking, scheduling, and production monitoring.

3.4.2 Website Optimization by IE Team

After implementation, the IE team optimized system usage through task reassignment and retraining. Each member took on a specific role: Data Manager (monitors toy data), Trial Scheduler (manages piloting schedules), and Tooling Manager (updates tooling status).

The team underwent retraining, focusing on dashboard access, tooling updates, and piloting management, with real-life simulations to ensure smooth adaptation. Post-training feedback helped refine system functionality, improving efficiency and ensuring better workflow integration.

3.5 Evaluation

The system evaluation ensures that it meets user needs and aligns with study objectives. This is done by comparing user requirements with the implemented features. The evaluation results, presented in Table 8, highlight how well the system addresses user expectations and supports operational efficiency.

Table 8. Evaluation Results of User Acceptance Test

User	Pain Point	Requirement	System Evaluation	
			Fulfilled	Unfulfilled
IE PA & Technician	Searching for design sheets and following up with Product Engineers takes too much time.	New Toy Info – Displays and updates toy details.	O	
	The schedule is not real-time or visible.	Calendar – Manages schedules and piloting.	O	
	Missing part lists during piloting force IEs to use design photos.	Part Sync – Adds plastic assembly parts manually.	O	
	Finding material lists is slow.	Material – Monitors material availability.		O
	Miscommunication during piloting causes delays.	Piloting Status – Updates progress with comments and checkboxes.	O	
	A task-tracking system is needed to avoid missed tasks.	Dashboard – Tracks key tasks and progress.	O	
	Tracking FC & method sheets is slow and error-prone.	Piloting Status – Updates progress with comments and checkboxes.	O	
Supervisor New Toy	Lost time searching for new toy designs & following up	Toy Information Menu: View & edit toy details, including designs, part numbers, and schedules.	O	
	No real-time schedule visibility	Calendar Menu: Manage & track piloting schedules dynamically.	O	
	Inefficient tooling design handover	Tooling Status Dashboard: Track tooling status by toy number.	O	
	Lack of task tracking causes miscommunication	Backlog Dashboard: Monitor pending tasks & adherence.	O	
	Tracking FC & method sheets is slow & error-prone	Checkbox in Toy Info: Mark FC & method sheet updates.	O	

3.6 System Comparison

The new system improves efficiency, technology, and workflow compared to the old system. Previously, manual processes caused delays and errors. The new system automates tasks, making operations faster and more accurate.

3.6.1 Process Comparison

The new system reduces manual work, making data tracking and problem identification easier. It uses modern technology like integrated databases and cloud-based systems for better flexibility and scalability. The user-friendly interface allows quick access to important information.

3.6.2 Cycle Time Comparison

A key measure of the new system's success is the reduction in cycle time, which reflects improved efficiency in operations. The web-based system automates previously manual tasks, saving time and resources.

Table 9 presents a comparison of process cycle times before and after implementing the new system, highlighting the improvements in speed and efficiency.

Table 9. Cycle Time Audit with New System Web Based

No	Process	Tracking Schedule time processing (in Minutes)				
		Day 1	Day 2	Day 3	Day 4	Day 5
1	Synchronize data part list with drag and drop	20	18	22	19	21
2	Update the result status piloting to Website	24	27	25	28	21
3	View and adjust schedule on web calendar	15	12	17	16	14
4	Create design tooling	80	65	83	76	88
5	Submit design tooling trough website and email to workshop team	58	65	59	62	63
6	Check Tooling Readiness	10	8	12	9	11
Total time		207	195	218	210	218
Average		209,6				

Automation has significantly reduced cycle time. Efficiency improved by 62.36%, reducing plastic assembly delays from 5-7 days to 2.26 days. Production delays dropped from 40% to 15% across 89 toy projects.

While external factors like late material deliveries still cause some delays, the new system minimizes internal inefficiencies, improving decision-making and productivity.

4. Conclusion

The implementation of the new tracking system significantly reduced delays in the Plastic Assembly department, addressing the problem of inefficient production timelines. Prior to the system upgrade, the department experienced delays averaging 5-7 days per product, impacting the overall production process. However, after optimizing the tracking system, the delays were reduced by 62.36%, bringing the average delay down to just 2 days. This reduction in delay allowed for more timely completion of products, increased production capacity, and a decrease in costs associated with delays, such as overtime and penalties. The improvements in the system not only streamlined production but also ensured that the company could better meet market demands and improve its overall efficiency.

In addition to reducing delays, the new tracking system addressed the limitations of the previous Excel-based system. The old system lacked real-time tracking and was prone to errors, making it difficult to monitor progress accurately. By implementing a web-based system using Object-Oriented Analysis and Design (OOAD), the team was able to introduce a more reliable and user-friendly interface. This improvement allowed for real-time tracking of materials, piloting statuses, and production schedules, enhancing decision-making and communication across departments. As a result, the production process became more efficient, leading to timely product launches, higher customer satisfaction, and stronger company performance.

References

1. Bhuiyan, N. (2011). A Framework for successful new product development. *Journal of Industrial Engineering and Management*, *4*(4), 746–770. https://doi.org/10.3926/jiem.334
2. Chang, A.-Y., Hu, K.-J., & Hong, Y.-L. (2013). An ISM-ANP approach to identifying key agile factors in launching a new product into mass production. *International Journal of Production Research*, *51*(2), 582–597. https://doi.org/10.1080/00207543.2012.657804
3. Chapke, D., Akant, K., & Chandankhede, P. (2024). Strategic Approaches to Modern Data Management Leveraging Relational Database Systems. *2024 International Conference on Inventive Computation Technologies (ICICT)*, 353-358. https://doi.org/10.1109/ICICT60155.2024.10544431
4. Chen, C., Zhang, C., Wang, T., Li, D., Guo, Y., Zhao, Z., & Hong, J. (2020). Monitoring of Assembly Process Using Deep Learning Technology. *Sensors*, *20*(15), 4208. https://doi.org/10.3390/s20154208
5. Djaoui, C., & Chaoui, A. (2024). Formalization And Analysis of UML 2.0 Interaction Overview Diagram Using Maude Rewriting Logic Language: Using Maude Rewriting Logic Language. *Computer Science*, *25*(3). https://doi.org/10.7494/csci.2024.25.3.5964
6. Fauzan, R., Institut Teknologi Sepuluh Nopember, Rochimah, S., Institut Teknologi Sepuluh Nopember, Triandini, E., & ITB STIKOM Bali. (2021). Automated Class Diagram Assessment using Semantic and Structural Similarities. *International Journal of Intelligent Engineering and Systems*, *14*(2), 52–66. https://doi.org/10.22266/ijies2021.0430.06
7. Jiménez-Martín, A., Mateos, A., & Hernández, J. Z. (2021). Aluminium Parts Casting Scheduling Based on Simulated Annealing. *Mathematics*, *9*(7), 741. https://doi.org/10.3390/math9070741
8. K., Shobha. (2024). Design and Implementation of the Music Website Design using Figma. *International Journal of Innovative Science and Research Technology (IJISRT)*, 3335–3340. https://doi.org/10.38124/ijisrt/IJISRT24MAY2501
9. Koç, H., Erdoğan, A. M., Barjakly, Y., & Peker, S. (2021). UML Diagrams in Software Engineering Research: A Systematic Literature Review. *The 7th International Management Information Systems Conference*, 13. https://doi.org/10.3390/proceedings2021074013
10. Leach, R. J. (2018). *Introduction to Software Engineering* (2nd ed.). Chapman and Hall/CRC. https://doi.org/10.1201/9781315371665
11. Li, H., & Li, L. X. (2000). Integrating systems concepts into manufacturing information systems. *Systems Research and Behavioral Science*, *17*(2), 135–147. https://doi.org/10.1002/(SICI)1099-1743(200003/04)17:2<135::AID-SRES289>3.0.CO;2-7

12.Nguyen, K., Loh, F., Nguyen, T., Doan, D., Thanh, N. H., & Hoßfeld, T. (2023). Serverless Computing Lifecycle Model for Edge Cloud Deployments. *2023 IEEE International Conference on Communications Workshops (ICC Workshops)*, 145–150. https://doi.org/10.1109/ICCWorkshops57953.2023.10283589

13.Noble, J., & Biddle, R. (2023). programmingLanguage as Language; *Proceedings of the 2023 ACM SIGPLAN International Symposium on New Ideas, New Paradigms, and Reflections on Programming and Software*, 191–204. https://doi.org/10.1145/3622758.3622885

14.Pelawi, D. (2013). Pembuatan Sistem Informasi dengan Analisis dan Perancangan Berorientasi Objek. *ComTech: Computer, Mathematics and Engineering Applications*, *4*(1), 213. https://doi.org/10.21512/comtech.v4i1.2711

15.Pulungan, S. M., Febrianti, R., Lestari, T., Gurning, N., & Fitriana, N. (2023). Analisis Teknik Entity-Relationship Diagram Dalam Perancangan Database. *Jurnal Ekonomi Manajemen Dan Bisnis (JEMB)*, *1*(2), 98–102. https://doi.org/10.47233/jemb.v1i2.533

16.Roebuck, K. (2012). *Object-oriented analysis and design (OOAD): High-impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors*. Emereo Publishing.

17.Samoylov, A., Tselykh, A., Sergeev, N., & Kucherova, M. (2017). Review and analysis of means and methods for automatic data extraction from heterogeneous sources. *Proceedings of the IV International Research Conference "Information Technologies in Science, Management, Social Sphere and Medicine" (ITSMSSM 2017)*. IV International research conference "Information technologies in Science, Management, Social sphere and Medicine" (ITSMSSM 2017), Tomsk, Russia. https://doi.org/10.2991/itsmssm-17.2017.43

18.Seidl, M., Scholz, M., Huemer, C., & Kappel, G. (2015). The Activity Diagram. In M. Seidl, M. Scholz, C. Huemer, & G. Kappel, *UML @ Classroom* (pp. 141–166). Springer International Publishing. https://doi.org/10.1007/978-3-319-12742-2_7

19.Singhal, C., Mahto, R. V., & Kraus, S. (2022). Technological Innovation, Firm Performance, and Institutional Context: A Meta-Analysis. *IEEE Transactions on Engineering Management*, *69*(6), 2976–2986. https://doi.org/10.1109/TEM.2020.3021378

20.Yassine, A., Chenouni, D., Berrada, M., & Tahiri, A. (2017). A Serious Game for Learning C Programming Language Concepts Using Solo Taxonomy. *International Journal of Emerging Technologies in Learning (iJET)*, *12*(03), 110. https://doi.org/10.3991/ijet.v12i03.6476