

SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC)

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Abstract

The Skim Pinjaman Buku Teks (SPBT), established in Malaysia in 1975, is a textbook loan program for government-assisted schools, ensuring students receive and maintain textbooks through organized borrowing, returning, and penalty processes. At Sekolah Kebangsaan Pintas Puding (SKPP), this is currently managed manually by a single SPBT teacher using Microsoft Word and Excel, leading to inefficiencies, errors, and increased costs, particularly during peak distribution periods. The SPBT Management System, a web-based application developed using the Waterfall Model with PHP and MySQL, automates textbook registration, tracking, and reporting with barcode technology, enhanced by Role-Based Access Control (RBAC) and password hashing for security. It supports SPBT Teachers, Class Teachers, and Pejabat Pendidikan Daerah (PPD) through modules for login, textbook and student management, and penalties. Functional and User Acceptance Testing (UAT) with these users confirmed all requirements were met, with feedback noting improved efficiency, reduced errors, and high usability. This system streamlines operations, reduces workload, and boosts accuracy and security at SKPP.

1. Introduction

The Textbook Loan Scheme Program in Malaysia, known as Skim Pinjaman Buku Teks (SPBT), was initiated in 1975 exclusively for government-assisted schools [1]. At Sekolah Kebangsaan Pintas Puding (SKPP), this program is responsible for distributing textbooks to students and ensuring each student has access to necessary materials, with replacements provided for damaged books. SPBT oversees the borrowing and returning of books in an organized manner, aligned with subjects and classes typically occurring at the beginning and end of each school year. Students who lose books during this period face fines. Currently, a single SPBT teacher manually records textbook details, checks stock, and prepares reports using Microsoft Word, a process that is time-consuming and prone to errors. The SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) aims to automate record-keeping, track textbook status, and simplify borrowing and returning processes.

The manual management of textbook transactions in Excel by the SPBT teacher, especially during peak times at the start and end of the school year, is inefficient and error prone. The heavy workload of checking stock, generating reports, and handling borrowing processes often leads to teacher burnout and inaccuracies, making it challenging to ensure sufficient textbooks for all students. This ineffective system also increases costs due to mismanagement. Thus, the objectives of this system are to design a web-based SPBT system to enhance efficiency at SKPP using RBAC, develop a smoother and more reliable SPBT process, and test the functionality of the created modules.

In general, the SPBT is like a special club at school that handles all operations related to textbooks every year. It supplies textbooks to students, manages their distribution, and ensures a smooth borrowing and returning process. This includes tracking textbooks, replacing damaged ones, and maintaining stock, which is why borrowing, returning, and penalty processes are essential components. The study domain of the SPBT Management System for SKPP focuses on managing textbooks and retrieval processes within the school. Users include the SPBT Teacher, Class Teacher, and Pejabat Pendidikan Daerah (PPD), who oversee these tasks. The system features eight modules: login, lists of textbooks, lists of class teachers, student information, register textbook, borrowing and returning, penalty, and logout.

Based on interview sessions (attached in the appendix), the current system's manual operations are evident. SPBT teachers use Microsoft Word and Excel for documentation, relying on Telegram and WhatsApp for communication. The SPBT operates year-round, involving tasks like counting textbook stocks early in the year, organizing distribution meetings, conducting spot checks, stamping and labeling new textbooks, collecting and distributing books to students, and running a year-round textbook clinic to repair damaged books. Each student is assigned a serial number to monitor lost or damaged textbooks, highlighting the need for an automated solution.

2. Literature Review

The literature review for the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) into the current manual practices and explores related online platforms, such as the Website SPBT Wilayah Persekutuan Kuala Lumpur, Website Sekolah Kebangsaan Kampung Tunku, and Website Sekolah Kebangsaan Bandar Putra. It emphasizes efficiency, security, and ease of access, spotlighting the integration of Role-Based Access Control (RBAC) and password hashing to overcome limitations in existing systems. This analysis shapes the creation of a customized, secure web-based solution for SKPP.

2.1 Current System

There are no current projects that are in development for SPBT Management System. As for the current SPBT management and textbooks distribution for students, the people in charge of the current system are the SPBT Teacher Madam Zuzilla, which is appointed to do the tasks. The scope of work for SPBT Teachers includes supervising the borrowing and returning of textbooks process with the usage of forms specifically "Borang G", which is a paper printed document. Basically, "Borang G" contains the list of students' names, the title of the textbooks, the date and students' signature for the borrowed and returned textbooks.

Based on the interview sessions as attached in the appendix, it's able to identify the existing system's flow and how it operates. Firstly, they are still doing everything manually using Microsoft Word and Excel for documentation. They used Telegram and WhatsApp for communication. The SPBT operates throughout the whole year which includes counting textbook stocks early in the year, organizing meetings for textbook distribution, doing textbook spot checks for Sekolah Kebangsaan Pintas Puding students, stamping, and labelling new textbook, collecting and distributing textbooks to students as well as opening a textbook clinic which opens the whole year to repair damaged student's textbooks. Each student will be given their own serial number to keep track of if they lost or damaged a book.

2.2 Related System

The comparison between the existing system (Website SPBT Wilayah Persekutuan Kuala Lumpur, Website Sekolah Kebangsaan Kampung Tunku and Website Sekolah Kebangsaan Bandar Putra) and the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) reveal key distinctions in features that significantly impact the efficiency and functionality of the textbook management process.

Website SPBT Wilayah Persekutuan Kuala Lumpur [2], this online system allows everyone to see student's textbook data. It allows teachers to input textbook details, enhancing records' accuracy. This website can automatically generate a report for Admin used. The advantage of this approach lies in its user-friendly interface and accessibility.

Website Sekolah Kebangsaan Kampung Tunku [3], it's also an online system that allows everyone to see textbook data. It facilitates data collection and the ordering of new textbook edition. This web-based system doesn't have limitations when use it but there's no security implement to secure textbook and students' data. This web-based system is like the Website SPBT Wilayah Persekutuan Kuala Lumpur [2].

Website Sekolah Kebangsaan Bandar Putra is an online SPBT Management System that can be conducted by two users which admin and SPBT Teacher. Operating on a web-based platform, it provides efficient book collection organization and supporting features like cataloging, book loan tracking, and member management. This website has user friendly interface, which allows users to see a lot of options that we want to look at textbooks.

Table 1 shows the comparison of the features between the existing system and the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC). The features listed are system type, user scope, security implementation, database and limitation that system faced.

Table 1 *Comparison Between Existing System and Proposed System*

Features/System	System A	System B	System C	Proposed System
Online System	Yes	Yes	Yes	Yes
Security Implement (Password Hashing)	No	No	No	Yes
Role-Based Access Control (RBAC)	No	No	No	Yes
Report Generator	Yes	No	No	Yes
Database	No	No	Yes	Yes
Limitation	No	No	Yes	Yes

System A: Website SPBT Wilayah Persekutuan Kuala Lumpur
 System B: Website Sekolah Kebangsaan Kampung Tunku
 System C: Website Sekolah Kebangsaan Bandar Putra
 Proposed System: SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC)

Following is a comparison of the features of three existing systems, namely System A, System B, and System C, with a proposed SPBT Management System to Sekolah Kebangsaan Pintas Puding in Table 1. These are all online systems. The SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) provides advance security in password hashing and RBAC features for the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) are those which are not provided for the other existing systems under review. Furthermore, the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) has a report generator, as does System A, and it incorporates a database, as does System C, but which Systems A and B lack. Whereas System A does not point out any limitations, the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) identifies and tries to overcome those that were noted in the other systems. The SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) is more secure, functional, and integrated with a database to provide better service to the needs of users.

2.3 System of SPBT Management System for SKPP

In the SPBT Management System at Sekolah Kebangsaan Pintas Puding (SKPP), RoleBased Access Control (RBAC) can effectively manage user access by assigning specific permissions based on user roles [5]. The SPBT Management System for Sekolah Kebangsaan Pintas Puding (SKPP) uses Role-Based Access Control (RBAC) to manage user permissions. SPBT Teachers have full access to manage textbooks, assign and return books, and generate reports. Class Teachers can assign and return books for their own class and update book conditions. *Pejabat Pendidikan Daerah (PPD)* users have limited access to view data and generate reports. This role-based approach ensures secure and appropriate access for each user. Additionally, the system implements password hashing to protect user credentials and enhance security by preventing passwords from being stored in plain text. Password hashing implementation to keep user information secure by hashing sensitive user data, such as passwords, in a one-way manner [6].

3. Methodology/Framework

The waterfall model comprises five phases which are Analysis Phase, Design Phase, Implementation Phase, Testing Phase and Maintenance Phase. Analysis Phase involves system and business analysis to define both functional and nonfunctional requirements. Next Design Phase was covered about the process of planning and problem solving for a software solution. For Implementation Phase is where the real code is written and compiled into an operational application, and where the database and text files are created. However, Testing Phase is also known as verification and validation which is a process for checking that a software solution meets the original requirements and specifications and that it accomplishes its intended purpose. Finally is the Maintenance Phase which involves modifying a software solution after delivery and deployment to refine output, correct errors, and improve performance and quality.

3.1 Waterfall Model

The Waterfall Model was chosen for the SPBT Management System for Sekolah Kebangsaan Pintas Puding because it is structured and systematic. Start with Analysis Phase, it outlines the scope, objectives, resources, and time for the project [7].

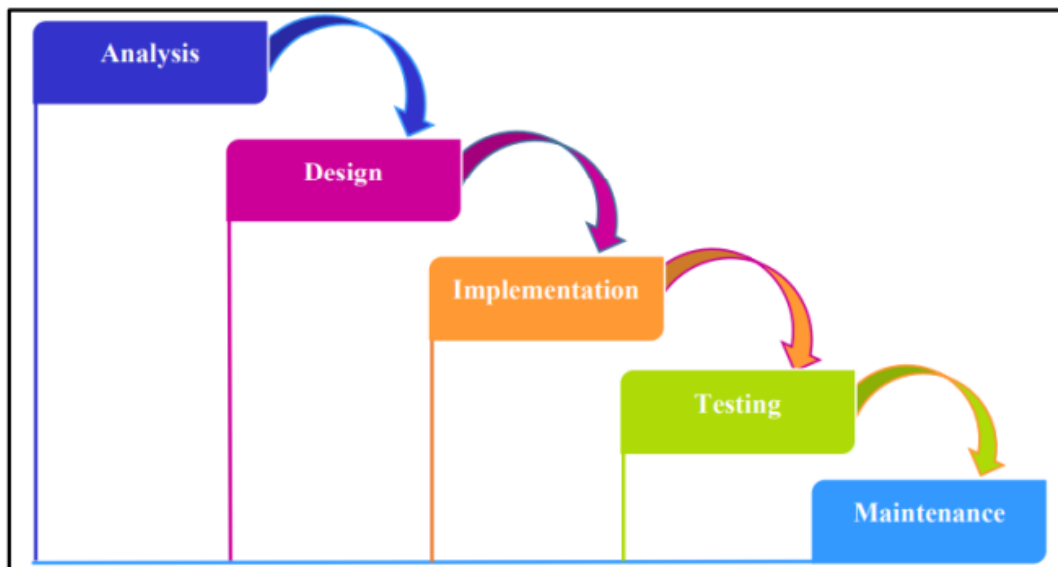


Fig. 1 Waterfall Process Model

The Waterfall Model was chosen for the development of the SPBT Management System at Sekolah Kebangsaan Pintas Puding due to its structured and sequential nature. The process begins with the Analysis Phase, where the project's scope, objectives, timeline, resources, and potential risks are identified. This is followed by the Design Phase, which translates requirements into system designs such as context diagrams, data flow diagrams, ER diagrams, wireframes, and database structures.

Next is the Implementation Phase, where the actual coding of the system is carried out based on the design specifications. Once implemented, the Testing Phase is conducted to identify and fix bugs, ensuring the system meets functional requirements. User testing involving SPBT Teachers, Class Teachers, and PPD representatives is also conducted for validation. Finally, the Maintenance Phase involves ongoing support, including fixing any post-deployment issues, adding features, and ensuring system reliability over time.

4. Analysis and Design

The results and discussion section presents data and analysis. It includes system requirement analysis, flowchart, CD, DFD, ERD, and implementation and testing.

4.1 System Development Workflow

There are six phases in the waterfall model. As shown in Table 2, each phase has its own assignment and output that needs to be produced during the entire project development. Besides that, the output was completed within the specific days that have been given.

The SPBT Management System for Sekolah Kebangsaan Pintas Puding was developed using a structured project life cycle with six phases. The Planning phase identified the project's goals and current system issues through interviews. Requirements Analysis defined system needs and produced a full specification document. Design included wireframes, architecture, diagrams, and a data dictionary. In the Implementation phase, the system and secure database were developed. The Testing phase involved thorough testing by the team and users to ensure functionality and fix bugs. Finally, the Maintenance phase ensures the system remains reliable and fully functional over time.

Table 2 Task and output of each phase

Phase	Task	Output
Planning	- Plan the project. - Identify project's problem, objective, scope and significant. - Interview SPBT teacher - Determine weakness of current system.	Project proposal, Specification of system needed.
Requirements Analysis	Determine the requirement and specification of the system.	Specification of system needed.
System Design	- Design the wireframe of the system. - Design the system architecture, context diagram, data flow diagram and entity relationship diagram.	System architecture, Context diagram, Data flow diagram (DFD), Entity relationship diagram (ERD), Data dictionary
Implementation	- Create data dictionary for the system. - Develop the SPBT system. - Create database - Apply security	System with database, named spbt.
Testing	- Do the testing of the system. - The SPBT teacher tested the functionality of the system. - Identify the issue and bug of the system. - Fix the issues	SPBT teacher test the system
Maintenance	- Fix the problem. - Maintain system availability	Complete system

4.2 System Requirements

The purpose of this section is to explain how the system works and focus on the user's expectations. Non-functional requirements will discuss major requirements. Table 3 and Table 4 show the functional and non-functional requirements of the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC).

Table 3 Functional Requirement

Module	Requirement	User
Login	Able to login using username and password.	SPBT Teacher, Class Teacher, Pejabat Pendidikan Daerah (PPD)
Login	Able to login using username and password.	SPBT Teacher, Class Teacher, Pejabat Pendidikan Daerah (PPD)
List of Textbooks	Able to see all textbooks by level.	SPBT Teacher, Pejabat Pendidikan Daerah (PPD)
List of Class Teacher	Able add, delete, update class teachers who are responsible for the class.	SPBT Teacher
Student Information	Able add, delete and update student textbooks details.	SPBT Teacher, Class Teacher
Register Textbook	Able add, update, delete teachers, reset passwords, and view list usernames	SPBT Teacher
Borrowing and returning	Able update complete or uncomplete textbooks.	SPBT Teacher, Class Teacher
Penalty	Able view total penalty.	SPBT Teacher, Class Teacher, Pejabat Pendidikan Daerah (PPD)
Logout	Able to logout from the system.	SPBT Teacher, Class Teacher, Pejabat Pendidikan Daerah (PPD)

Role-based access and user-specific capabilities are outlined in detail in the SPBT Management System's system requirements. Regarding handling textbooks, class teachers, students, and sanctions, SPBT teachers have the most extensive access. While PPD users have restricted access centred on reading textbooks and penalties, class teachers have access to student textbook information, borrowing and returning, and penalty viewing. This supports effective and safe textbook management at Sekolah Kebangsaan Pintas Puding by guaranteeing that each user type gets access to only pertinent modules.

Table 4 Non-Functional Requirement

Module	Functionalities
Performance of the user interface and system flow	All user able to access the system based on their role.
Operational	Accessible 24/7 with minimal downtime and support concurrent user operations efficiently
Security	The system implements data security by implementing password hashing and Role-Based Access Control (RBAC) for managing user permissions.

Based on the information in Table 4, The SPBT Management System's non-functional criteria place a strong emphasis on security, dependability, and usability. The system makes sure that users can easily access features that are relevant to their roles, runs constantly with few disruptions, and efficiently supports numerous users. Furthermore, it maintains data security by using Role-Based Access Control (RBAC) and password hashing, which guarantee secure and regulated access to system features.

4.3 System Analysis

System design includes Context Diagram (CD), Data Flow Diagram (DFD) and Flowchart. A CD is a visual representation that provides an overview of a system and its interactions with external entities. Fig. 2 illustrates the CD of the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC).

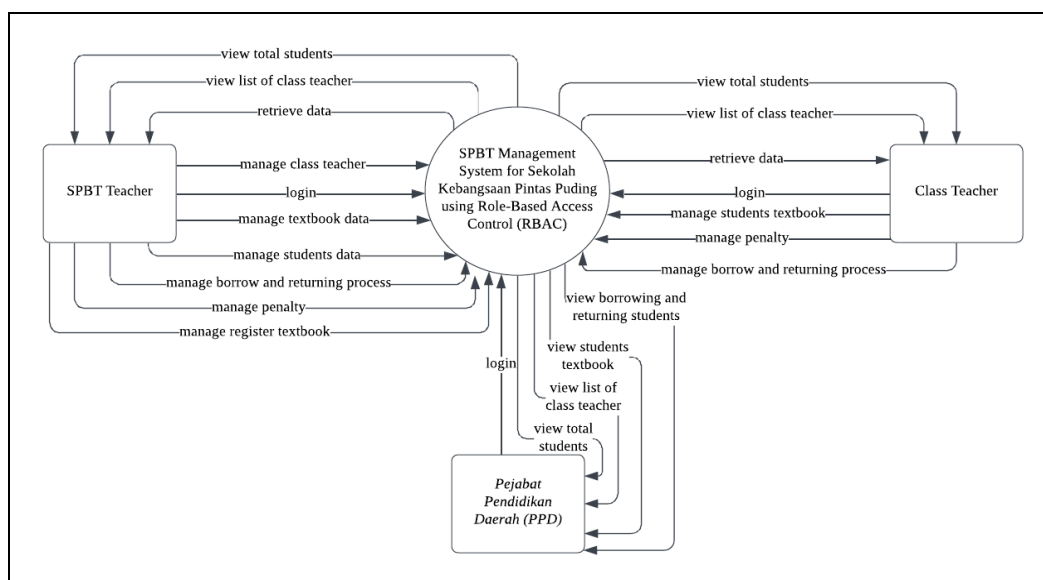


Fig. 2 CD for proposed system

The context diagram represents the SPBT Management System for Sekolah Kebangsaan Pintas Puding (SKPP), employing Role-Based Access Control (RBAC) to oversee interactions among three primary user roles which are SPBT Teacher, Class Teacher, and *Pejabat Pendidikan Daerah (PPD)*. In the middle of the diagram is the system itself, serving as the core through which all user interactions take place. SPBT Teachers enjoy extensive access, which includes logging in, overseeing class teachers, managing textbook information, maintaining student records, handling borrowing and returning activities, applying penalties, and registering textbooks. They are also able to obtain essential information like the total number of students and the names of class teachers. Class Teachers, conversely, have restricted access concentrating on student textbook information, the borrowing and returning procedure, fines, and accessing data regarding students and class teachers. PPD users have the most limited access, possessing view-only rights that enable them to log in, see data on student

borrowing and returns, textbook records for students, overall student counts, and the list of class teachers. Through the implementation of RBAC, the system guarantees that each user only accesses functionalities pertinent to their duties, thereby improving both security and system efficiency.

While DFD shows the flow of data within that SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) and between its external entities and shows the inputs, outputs, processes, and data storage. Fig. 3 depicts the DFD level 0 of the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC).

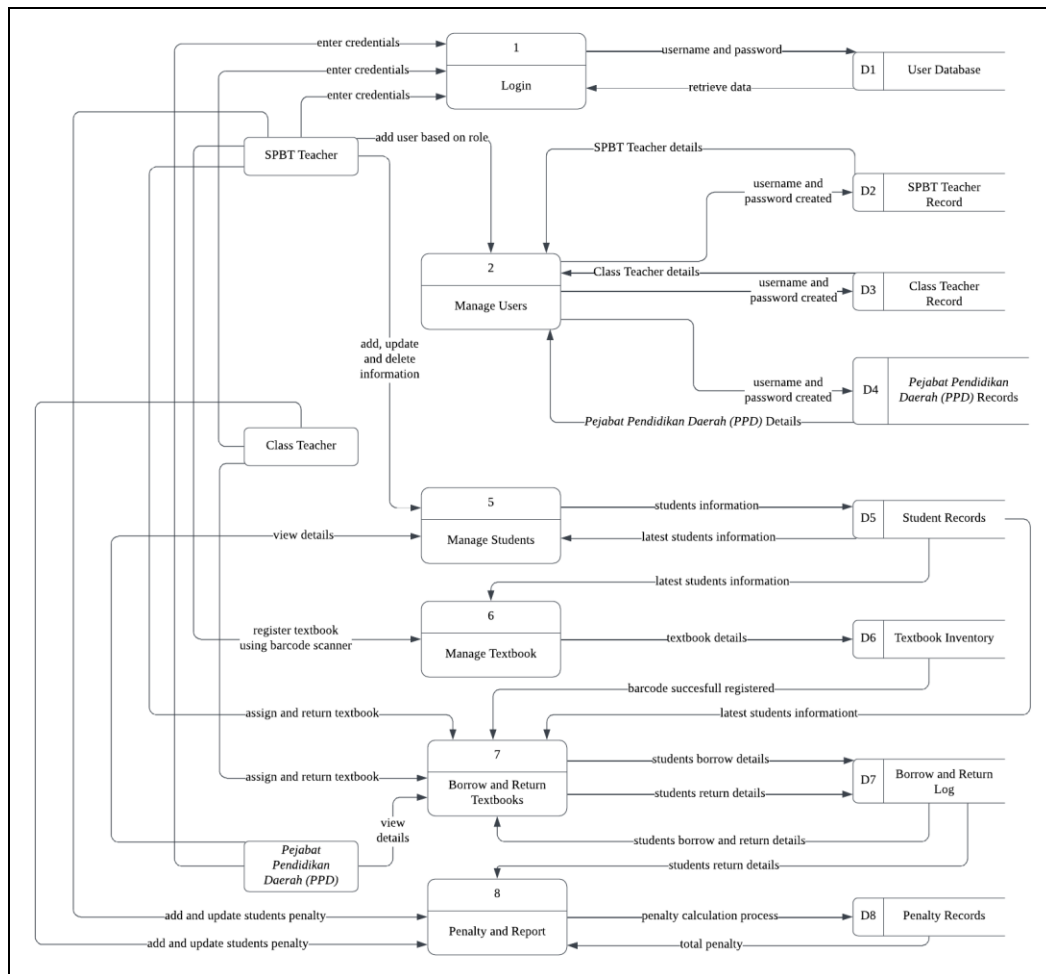


Fig. 3 DFD for proposed system

The Data Flow Diagram (DFD) of SPBT Management System, details the flow of data through the system to enhance textbook management at Sekolah Kebangsaan Pintas Puding. External actors like the SPBT Teacher, Class Teacher, and *Pejabat Pendidikan Daerah (PPD)*, communicate with the system by providing inputs such as credentials and retrieving outputs such as updated records. The process begins with the Login function (Process 1), where the stakeholders enter their username and password, which are verified against the User Database (D1) to provide access or deny it, retrieving user information accordingly. The SPBT Teacher then serves users (Process 2), creating and updating information for SPBT Teachers (D2), Class Teachers (D3), and PPD (D4) as well as textbooks (Process 4) by registering barcodes, with the information being inserted into the Textbook Inventory (D6). The Class Teacher manages student administration (Process 3), making a record of Student Records (D5), and borrowing and returning (Process 5), making notes in the Borrow and Return Log (D7), while helping update penalties (Process 6) maintained in Penalty Records (D8). Similarly, the PPD reads information and makes penalty reports (Process 6), since records from D8, for an exchange of information overall across all positions. This structured data flow mirrors the system's Role-Based Access Control (RBAC) model for secure and efficient operations projected onto individual tasks of every user.

The Flowchart is a system process diagram illustrating the steps or activities involved in a system or process. Fig. 4 shows the flowchart of the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) for the SPBT Teacher. Fig. 5 shows the flowchart of the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) for Class

Teacher. Fig. 4 shows the flowchart of the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) for *Pejabat Pendidikan Daerah (PPD)*.

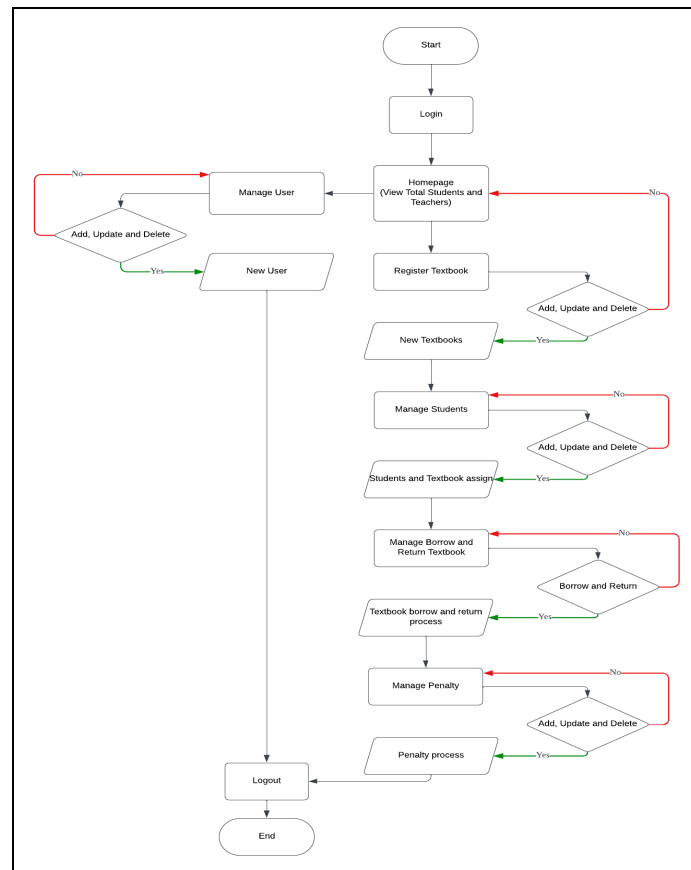


Fig. 4 Flowchart for SPBT Teacher

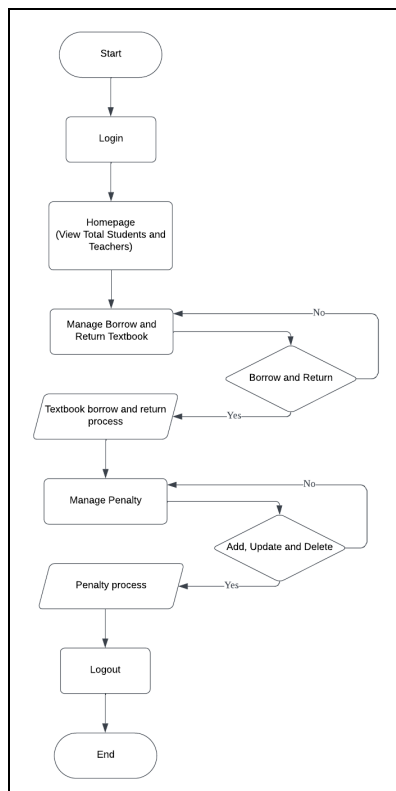


Fig. 5 Flowchart for Class Teacher

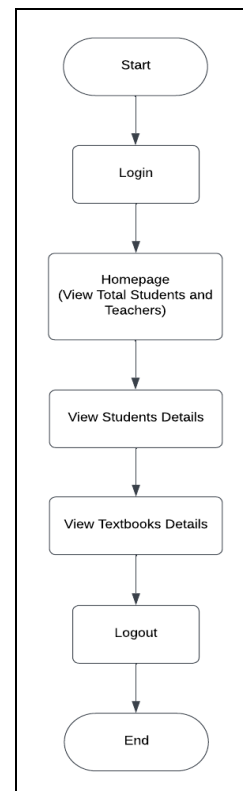


Fig. 6 Flowchart for Pejabat Pendidikan Daerah (PPD)

Database design defines the structure to facilitate and store data in a database system. It involves defining the database schema, which includes specifying the tables, columns, data types, relationships, and constraints that will be used to store and retrieve data efficiently. The database design components in this section include an Entity Relationship Diagram (ERD). Fig. 7 depicts the ERD of the SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC).

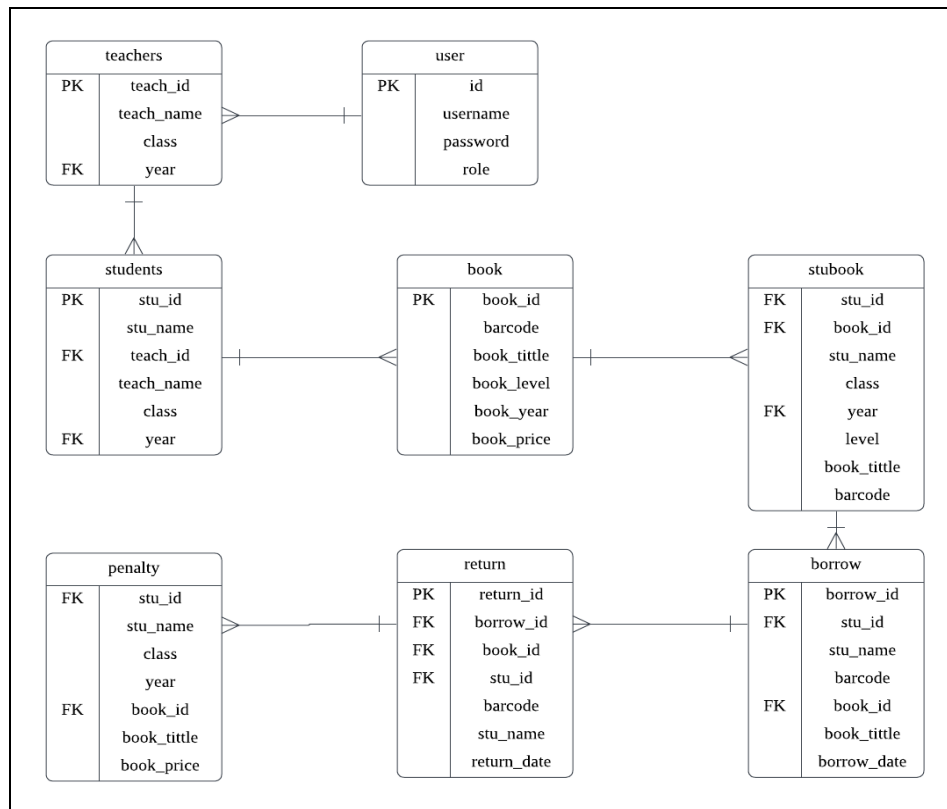


Fig. 7 ERD for proposed system

The database structure for textbook management at Sekolah Kebangsaan Pintas Puding is summarised in the Entity-Relationship Diagram (ERD) for the SPBT Management System. It consists of seven entities: enabling role, student management, links to instructors (teacher_id, name, class, year), and students (stu_id, name, teacher_id, class, year). To support textbook and transaction tracking, the book entity (book_id, barcode, title, book_level, book_year, book_price) links to the following: penalty (stu_id, class, year, book_id, title, book_price), return (return_id, book_id, stu_id, barcode, return_date), and borrow (borrow_id, stu_id, name, class, year, level, book_title, borrow_date). Although the approach makes administration more efficient, the absence of book_id in borrow raises the possibility of a flaw that needs to be fixed.

4.4 System Design

Fig. 8 Login Interface

id	username	password
2003	Admin	skppspbt2024#
2006	aida	\$2y\$10\$hw0undRJl5l6ptEi0YTX3.jey22qy9jMR0OtrCRVyKj...
2007	ali	\$2y\$10\$olLMq11aQStye1xslTnZO8eCzgymoStzp1QcizBf6...
2008	zatie	\$2y\$10\$F5TnQQF0QHdhiGhlosX12eUr6BEXLroK4Ud2YSLtqPE...

Fig. 9 Database Table for Login

During the login process, users must enter their username and password in the box provided in Fig. 8 to access the system. Username and password will be stored in the database shown on Fig. 9. After the user login and success to access the system, the user will be directly onto the homepage.

Add Teacher

Teacher Name:

Select Class:

Select a class
▼

Select Year:

Select Year
▼

Add Teacher

Back

Fig. 10 Login Interface

teach_id	teach_name	class	year
103	CIKGU NUR ADILAH BINTI ABD JALIL	1 AL GHAZALI	2024
104	CIKGU SUZANA BINTI ABD GHANI	1 AL KINDI	2024
105	CIKGU WAHIDAH BINTI HAMIDON	2 AL BIRUNI	2024
106	CIKGU RASHIDAH BINTI BACHOK	2 AL FARABI	2024
107	CIKGU ZURIANI BINTI ZULKARNAINI	2 AL GHAZALI	2024
108	CIKGU RAFIDAH BINTI YATIM @ MOHD YATIM	2 AL KINDI	2024
109	CIKGU ESAH BINTI SALIP	3 AL BIRUNI	2024
110	CIKGU NUR DHABITAH BINTI RAHMAT	3 AL FARABI	2024
111	CIKGU NUR ILYANI BINTI YAACOB	3 AL GHAZALI	2024
112	CIKGU MOHD RAZIF BIN MOHD SAIDI	3 AL KINDI	2024
113	CIKGU NURUL HASANAH BINTI ZAINUDDIN	4 AL BIRUNI	2024
114	CIKGU WAN RUSNIZA BINTI MEGAT ABDUL RAZAK	4 AL FARABI	2024
115	MUHAMMAD SHAFIQ BIN ZAZALI	4 AL GHAZALI	2024
116	MUHAMMAD NUR FARIS BIN AZMAN	4 AL KINDI	2024
117	CIKGU HARYTAH BINTI HARUN	5 AL BIRUNI	2024
118	CIKGU SAPINAS BINTI CHE MAT	5 AL FARABI	2024
119	CIKGU HASNITA BINTI HASSAN	5 AL GHAZALI	2024
120	CIKGU NORHAYATI BINTI SAMIRAN	5 AL KINDI	2024
121	CIKGU RUHIL HAYATI BINTI ABDUL KASSIM	6 AL BIRUNI	2024
122	CIKGU NOR MISLINA BINTI MOKHTAR	2 AL KINDI	2024
129	MAIMUNAH	1 AL BIRUNI	2024

Fig. 11 Database Add Teacher

SPBT teacher is accessible to add and edit teachers' name when class teacher changes so SPBT teacher will change it by herself. On this page, SPBT Teacher can add a new class teacher as shown in Fig. 10. All teacher names added will be stored in the database as shown on Fig. 11.

Penalty Management

User ID:

Penalty Description:

Add Penalty

List of Penalties

ID	User ID	Penalty Description	Penalty Date	Status
1	12	TEXTBOOK DAMAGE	2024-12-30 18:48:17	Unresolved

Back

Fig. 12 Textbook List Interface

id	user_id	penalty_description	penalty_date	status
1	12	TEXTBOOK DAMAGE	2024-12-30 18:48:17	Unresolved

Fig. 13 Class Teacher Database

Penalty interface can display all student's penalty based on their textbook record. Penalty can be done when student's textbook gone, damage and unwrap. As shown in Fig. 12 the penalty displayed. Penalty will be stored in penalty database as shown in Fig. 13.

5. Implementation and Testing Phase

This section discusses the development and testing of the SPBT Management System developed for Sekolah Kebangsaan Pintas Puding. It explains the implementation of the key modules such as textbook registration, textbook borrow and return, and the role-based access control (RBAC) mechanism with security measures including password hashing, input validation, and user-level access controls. Functional testing and user acceptance phase (UAT) to ensure system performance, usability, and data security across different user roles.

5.1 Implementation of Security Module

This segment will discuss the security features that are implemented in this system. The security features that applied cover the aspects of confidentiality, integrity and availability of SPBT Management System. There are two features that are implemented which are Role Based Access Control (RBAC) and password hashing.

5.1.1 Role-Based Access Control (RBAC)

RBAC is one of the key security aspects that will be included in the SPBT management system, as was indicated in the previous chapter. The user role is separated into three categories based on Fig. 14 which are SPBT Teacher, Class Teacher, and *Pejabat Pendidikan Daerah (PPD)*. The user will be directed to the designated homepage according to their role after successfully completing the security layer of strong password validation in Fig. 15. Fig. 14 and Fig. 15 show the Role Based Access Control (RBAC) implementation on SPBT Management System that must assign role for declaration.

10	Ali	\$2y\$10\$GuCti9qxDTT9VSN3vAu0KeMbjdl06780thJntOve.c3...	SPBT Teacher
11	Aida	\$2y\$10\$3mdpj6lGjGndYgi8d3pvOkIsVAY0UqQnHT5D84fWeA...	Class Teacher
12	Ainoor	\$2y\$10\$GawHLoyadKga0SMIEh9h3uK14pwR/O34yA49XN8N.BS...	Stakeholder

Fig. 14 Role that applies as user in database

```

if ($SERVER["REQUEST_METHOD"] == "POST") {
    $username = trim($_POST['username']);
    $password = $_POST['password'];
    $role = $_POST['role'];

    if (empty($username) || empty($password) || empty($role)) {
        $loginError = "All fields are required.";
    } else {
        $sql = "SELECT id, username, password, role FROM users WHERE username = ?";
        $stmt = $conn->prepare($sql);
        $stmt->bind_param("s", $username);
        $stmt->execute();
        $result = $stmt->get_result();

        if ($result->num_rows == 1) {
            $user = $result->fetch_assoc();
            if (password_verify($password, $user['password'])) {
                if ($role == $user['role']) {
                    $_SESSION['user_id'] = $user['id'];
                    $_SESSION['username'] = $user['username'];
                    $_SESSION['role'] = $user['role'];

                    switch ($user['role']) {
                        case 'SPBT Teacher': header("Location: a_homepage.php"); break;
                        case 'Class Teacher': header("Location: c_homepage.php"); break;
                        case 'Stakeholder': header("Location: s_homepage.php"); break;
                        default: $loginError = "Unknown role."; break;
                    }
                    exit();
                } else {
                    $loginError = "Incorrect role selected.";
                }
            }
        }
    }
}

```

Fig. 15 RBAC feature applied in SPBT Management System

5.1.2 Password Hashing

During the user registration procedure that conduct by SPBT Teacher, the SPBT Management System uses a password hashing method. The system does not save the user's password in plain text in the database when they enter it. Rather, it stores the data after applying a secure hashing technique. A hashing function is used to transform the password into an irreversible hash value, as shown in Fig. 16. As seen in Fig. 17, the system makes use of PHP's hashed password function.

username	password	role
spbt	\$2y\$10\$exatj2CjNkBCfclQ6yS5meg2vET9igiDtc6V1U8x.pJ...	SPBT Teacher
skpp	\$2y\$10\$BmKP3xKpGTb15mYyUlozG.7KKY4FawFID.UbUedldKz...	Stakeholder
teacher	\$2y\$10\$GYpKPeTVmN6xtUuLKVA9i.wV..EG8QYW0SQOA8H1ikM...	Class Teacher

Fig. 16 Hash password store in user's database

```

$hashed_password = password_hash($password, PASSWORD_BCRYPT);
$sql = "INSERT INTO users (username, password, role) VALUES (?, ?, ?)";
$stmt = $conn->prepare($sql);
$stmt->bind_param("sss", $username, $hashed_password, $role);

```

Fig. 17 Hashed password function applied in the SPBT Management System

This built-in feature automatically applies a salt and a powerful one-way hashing algorithm (like Bcrypt) to guarantee the hashed password's security and uniqueness. Using this method, user data is shielded from common dangers like rainbow table exploits and brute-force attacks.

5.2 Implementation of Module

SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) having different user access to different modules within the system. In this system, each role has specific permissions and action they can perform.

5.2.1 Login Module

As seen in Fig. 18, every user uses the identical login page and must finish it to gain access to the system. The user will be taken to their personal homepage according to their role once they have successfully completed the login process.

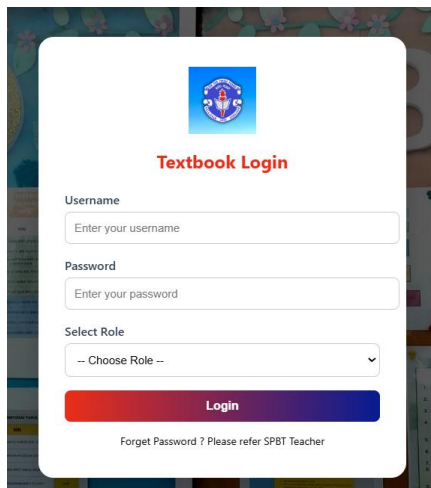


Fig. 18 Login Interface

```
if ($_SERVER["REQUEST_METHOD"] == "POST") {
    $username = trim($_POST['username']);
    $password = $_POST['password'];
    $role = $_POST['role'];

    if (empty($username) || empty($password) || empty($role)) {
        $loginError = "All fields are required.";
    } else {
        $sql = "SELECT user_id, username, password, role FROM users WHERE username = ?";
        $stmt = $conn->prepare($sql);
        $stmt->bind_param("s", $username);
        $stmt->execute();
        $result = $stmt->get_result();

        if ($result->num_rows == 1) {
            $user = $result->fetch_assoc();
            if (password_verify($password, $user['password'])) {
                if ($role == $user['role']) {
                    $_SESSION['user_id'] = $user['user_id'];
                    $_SESSION['username'] = $user['username'];
                    $_SESSION['role'] = $user['role'];
                }
            }
        }
    }
}
```

Fig. 19 Code Segment for Login Process

The primary method of authentication for all SPBT Management System users is the login interface. By using a role-based redirection mechanism, it makes sure that every user may access just the features that are pertinent to their position, be it *Pejabat Pendidikan Daerah (PPD)*, Class Teacher, or SPBT Teacher. By displaying customised dashboards and restricting access to just authorised functions, this design improves system security and usability.

5.2.2 List of Textbook Module

User able to choose which textbook they want to see. As seen in Fig. 20, the system presents the list of textbooks for that grade once the user selects. SPBT Teacher able to manage the textbook inventory for every level contain of buttons for adding and deleting entries as shown in Fig. 21.

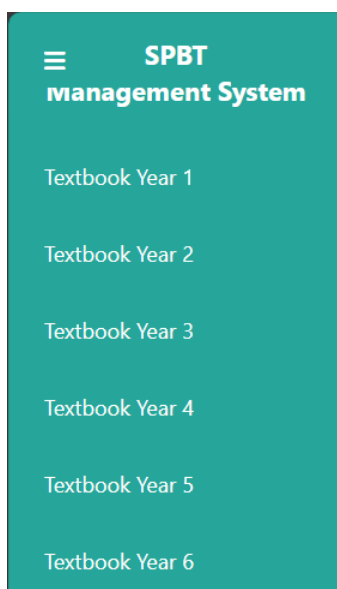


Fig. 20 Textbooks list based on each student's level

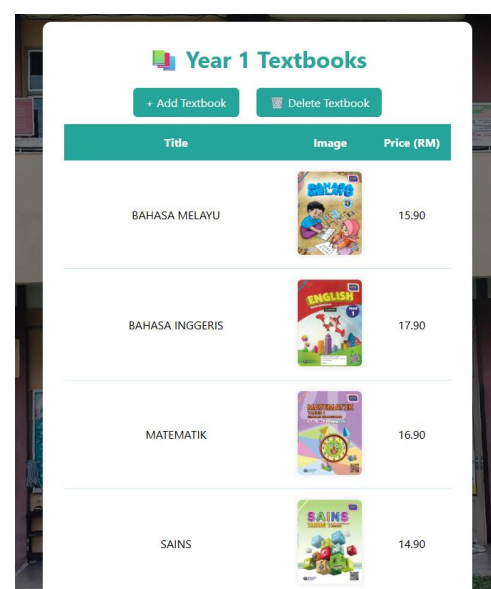


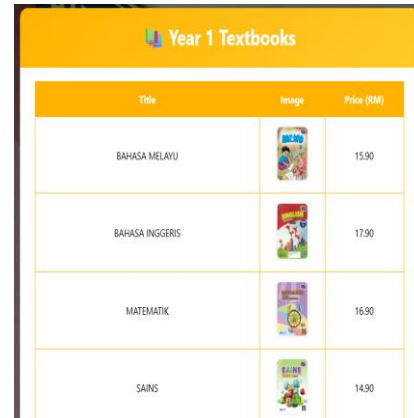
Fig. 21 List of textbooks for that grade Interface

Class Teacher and PPD interface was not the same as SPBT Teacher. As shown in Fig. 22 as Class Teacher role interface and Fig. 23 *Pejabat Pendidikan Daerah (PPD)* role interface only can view all the textbooks were selected. This role cannot add and delete textbooks. This module ensures a structured and organized view of all textbooks distributed to students, helping streamline textbook management and retrieval.



Title	Image	Price (RM)
BAHASA MELAYU		15.90
BAHASA INGGERIS		17.90
MATEMATIK		16.90
SAINS		14.90

Fig. 22 Class Teacher interface

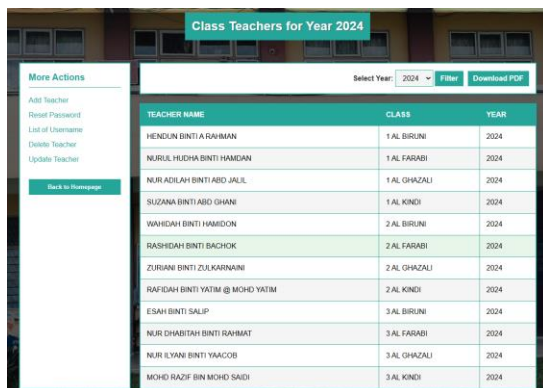


Title	Image	Price (RM)
BAHASA MELAYU		15.90
BAHASA INGGERIS		17.90
MATEMATIK		16.90
SAINS		14.90

Fig. 23 Pejabat Pendidikan Daerah (PPD) interface

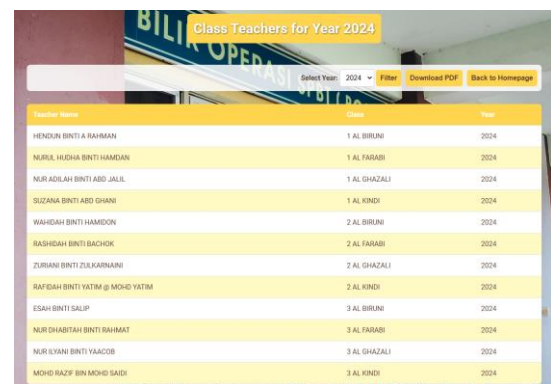
5.2.3 List of Class Teacher Module

SPBT Teachers can manage class teacher details for a chosen year using the List of Class Teachers module, which is displayed in Fig. 24. Using the "More Actions" panel, the SPBT Teacher can add, update, delete teachers, reset passwords, or list usernames, all secured by RBAC. As shown in Fig. 25 that is *Pejabat Pendidikan Dearah (PPD)* interface, this role just able to view list of class teacher on selected year and download PDF. The Class Teacher table contains the data, which is dynamically presented. The module was evaluated to make sure SPBT Teachers could efficiently manage teacher records.



TEACHER NAME	CLASS	YEAR
HENDUN BINTI A RAHMAN	1 AL BIRUNI	2024
NURUL HUDA BINTI HAMDAN	1 AL FARABI	2024
NURI ADILAH BINTI ABD JALIL	1 AL GHAZALI	2024
SUZANA BINTI ABD GHANI	1 AL KINDI	2024
WAHDAH BINTI HAMDON	2 AL BIRUNI	2024
RASHDAH BINTI BACHOK	2 AL FARABI	2024
ZURRANI BINTI ZULKARNAINI	2 AL GHAZALI	2024
RAFIDAH BINTI YATIM @ MOHD YATIM	2 AL KINDI	2024
ESAH BINTI SALIP	3 AL BIRUNI	2024
NUR DHABITAH BINTI RAHMAT	3 AL FARABI	2024
NURI ILYANI BINTI YAACOB	3 AL GHAZALI	2024
MOHD RAZIF BIN MOHD SAIDI	3 AL KINDI	2024

Fig. 24 Class Teacher Interface

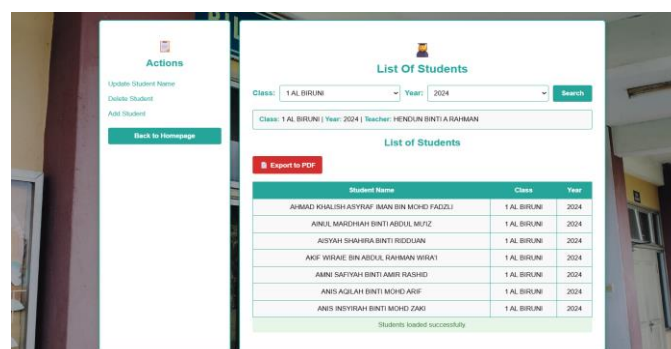


Teacher Name	Class	Year
HENDUN BINTI A RAHMAN	1 AL BIRUNI	2024
NURUL HUDA BINTI HAMDAN	1 AL FARABI	2024
NURI ADILAH BINTI ABD JALIL	1 AL GHAZALI	2024
SUZANA BINTI ABD GHANI	1 AL KINDI	2024
WAHDAH BINTI HAMDON	2 AL BIRUNI	2024
RASHDAH BINTI BACHOK	2 AL FARABI	2024
ZURRANI BINTI ZULKARNAINI	2 AL GHAZALI	2024
RAFIDAH BINTI YATIM @ MOHD YATIM	2 AL KINDI	2024
ESAH BINTI SALIP	3 AL BIRUNI	2024
NUR DHABITAH BINTI RAHMAT	3 AL FARABI	2024
NURI ILYANI BINTI YAACOB	3 AL GHAZALI	2024
MOHD RAZIF BIN MOHD SAIDI	3 AL KINDI	2024

Fig. 25 Pejabat Pendidikan Daerah (PPD) interface

5.2.4 Student Information Module

This page serves as a centralized interface for managing and monitoring student-related data at Sekolah Kebangsaan Pintas Puding, tailored to the roles of SPBT Teacher, Class Teacher, and *Pejabat Pendidikan Daerah (PPD)*. Its primary functions include displaying student details for a selected class and year, enabling the SPBT Teacher to update, delete, or add student records via the "Actions" panel as shown in Fig. 26, and allowing all users to filter, search, and export data to PDF for reporting as shown in Fig. 27 as Class Teacher and Fig. 28 as *Pejabat Pendidikan Daerah (PPD)*.



Student Name	Class	Year
AHMAD KHALISH ASYRAF IMAN BIN MOHD FAZLI	1 AL BIRUNI	2024
AINUL MAEDHAH BINTI ABDUL MUZ	1 AL BIRUNI	2024
ASIAH SHAHARA BINTI REDUAN	1 AL BIRUNI	2024
AKIF WIRAJE BIN ABUL RAHMAN WIRAY	1 AL BIRUNI	2024
AMIN SAFIYAH BINTI AMIR RASHID	1 AL BIRUNI	2024
ANIS AGILAH BINTI MOHD ARIF	1 AL BIRUNI	2024
ANIS NERYAH BINTI MOHD ZAKI	1 AL BIRUNI	2024

Fig. 26 SPBT Teacher interface for List of Students

As shown in Fig. 26, the Class Teacher interface for the "List of Students" enables Class Teachers to efficiently monitor their students' textbook activities for a selected class. This interface displays a table listing student names, total books borrowed, and total penalties, allowing Class Teachers to track textbook borrowing and identify any penalties owed. Features like class and year filters, a search bar, and a "Download PDF" option facilitate easy data access and reporting.

No	Student Name	Total Book Borrow	Total Penalty (RM)
1	AHMAD KHALID AHYAF IMAN BIN MOHD FADZLI	4	0.00
2	AINA, MARSHAH BINTI ABDUL MUZ	1	0.00
3	AIDYAH SHAHRA BINTI RIDWAN	4	0.00
4	AKIF WIRAE BIN ABDUL RAHMAN WIRAI	1	0.00
5	AMNI SAFYAH BINTI AMIR BASHID	1	0.00
6	ANIS ADILAH BINTI MOHD ARIE	1	0.00
7	ANIS INSYIRAH BINTI MOHD ZAKI	3	0.00

Fig. 27 Class Teacher interface for List of Students

Student Name	Class	Year
AHMAD KHALID AHYAF IMAN BIN MOHD FADZLI	1 AL BIRUNI	2024
AINA, MARSHAH BINTI ABDUL MUZ	1 AL BIRUNI	2024
AIDYAH SHAHRA BINTI RIDWAN	1 AL BIRUNI	2024
AKIF WIRAE BIN ABDUL RAHMAN WIRAI	1 AL BIRUNI	2024
AMNI SAFYAH BINTI AMIR BASHID	1 AL BIRUNI	2024
ANIS ADILAH BINTI MOHD ARIE	1 AL BIRUNI	2024
ANIS INSYIRAH BINTI MOHD ZAKI	1 AL BIRUNI	2024

Fig. 28 Pejabat Pendidikan Daerah (PPD) for List of Students

This module in the SPBT Management System provides distinct interfaces for SPBT Teacher, Class Teacher, and Pejabat Pendidikan Daerah (PPD), each designed with unique functions and access rights. All roles benefit from class/year filters, search functionality, and PDF export options, ensuring streamlined data management, while Role-Based Access Control (RBAC) secures each interface, improving textbook oversight and administrative efficiency at Sekolah Kebangsaan Pintas Puding.

5.2.5 Textbook Registration Module

The Textbook Registration module, as depicted in Fig. 29 enables the SPBT Teacher to register textbooks efficiently using a barcode scanner, ensuring accurate data entry. This innovative implementation of the Textbook Registration module significantly reduces the time burden on the SPBT Teacher by enabling barcode scanning instead of manual entry of individual numbers, thereby minimizing time-consuming tasks and enhancing efficiency at Sekolah Kebangsaan Pintas Puding.

Fig. 29 Textbook Registration interface

```
if ($SERVER["request_method"] == "post") {
    $book_title = $_POST['book_title'];
    $book_year = $_POST['book_year'];
    $barcode = $_POST['barcode'];
    $book_price = $_POST['book_price'];

    if (empty($book_title) && empty($book_year) && empty($barcode) && empty($book_price)) {
        // Check for duplicate barcode
        $check = $conn->prepare("SELECT book_id FROM textbooks WHERE barcode = ?");
        $check->bind_param("s", $barcode);
        $check->execute();
        $check->store_result();

        if ($check->num_rows > 0) {
            $message = "<div class='error'>This barcode has already been registered. Please scan a different one.</div>";
        } else {
            $stmt = $conn->prepare("INSERT INTO textbooks (book_title, book_year, barcode, book_price) VALUES (?, ?, ?, ?)");
            $stmt->bind_param("sssd", $book_title, $book_year, $barcode, $book_price);

            if ($stmt->execute()) {
                $message = "<div class='success'>Textbook registered successfully</div>";
            } else {
                $message = "<div class='error'>Error: " . $stmt->error . "</div>";
            }
        }

        $stmt->close();
    }
}
```

Fig. 30 Textbook Registration code segment

5.2.6 Borrow and Returning Module

The Borrowing and Returning Textbook module allow SPBT Teachers to efficiently assign and return textbooks using a barcode scanner. Fig.31 and Fig. 32 show how the system streamlines tracking, auto-fills student details, and enables quick penalty recording.

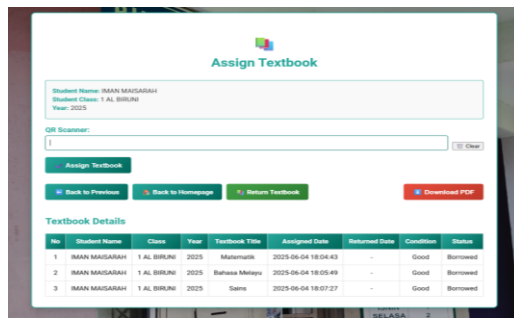


Fig. 31 Assign Textbook for student interface as SPBT Teacher

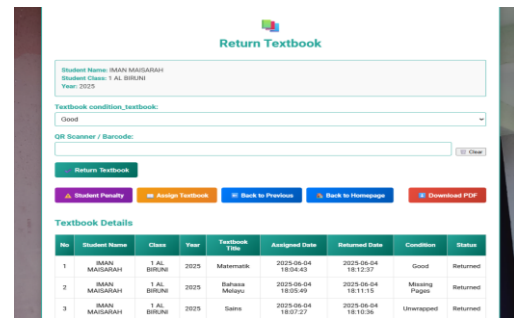


Fig. 32 Return Textbook for student interface SPBT Teacher

Fig. 33 and Fig. 34 show the Class Teacher's interface for assigning and returning textbooks using a barcode scanner. This streamlines the process by saving time, reducing manual effort, and enabling accurate tracking and penalty recording.

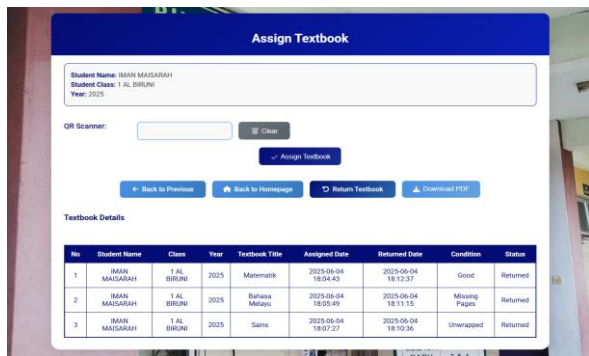


Fig. 33 Assign Textbook for student interface as Class Teacher

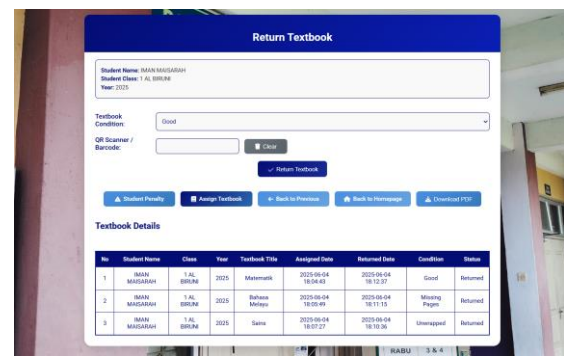


Fig. 34 Return Textbook for student interface as Class Teacher

As depicted in Fig. 35, the Assign and Return Textbook List for Student interface for the *Pejabat Pendidikan Daerah (PPD)* role enables PPD users to view and download detailed textbook. Features such as a Download PDF option ensure easy access to data for administrative purposes, supporting effective oversight within the SPBT Management System.

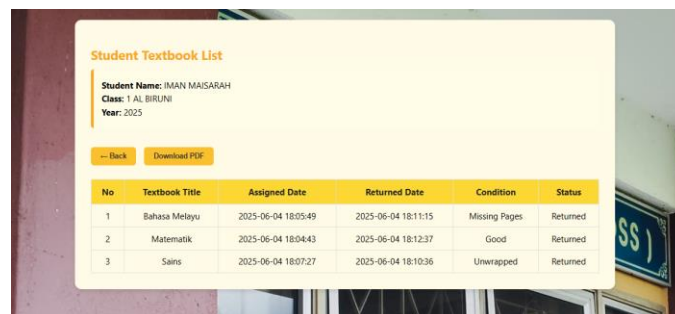


Fig. 35 Assign and Return Textbook List for student interface as Pejabat Pendidikan Daerah (PPD)

The Borrowing and Returning Textbook module benefit all user roles SPBT Teacher, Class Teacher, and PPD by providing tailored functions. SPBT and Class Teachers can assign, return, and track textbooks using barcode scanners, while PPD users can view and download student records. This module streamlines processes, ensures accuracy, and improves administrative efficiency.

5.2.7 Penalty Module

The Penalty Module records student fines for lost, damaged, or incomplete textbooks at Sekolah Kebangsaan Pintas Puding. As shown in Fig. 36 and Fig. 37, SPBT Teacher and Class Teachers can assign penalties by specifying reasons and amounts. This feature simplifies penalty tracking, supports accountability, and ensures efficient fine management. This module enables the SPBT Teacher to efficiently record and save student

penalties for textbook issues, ensuring all data is easily stored, accessible, and manageable at Sekolah Kebangsaan Pintas Puding.

No	Textbook Title	Price (RM)	Condition	Status	Date
1	Sains	0.00	Unworn	Unpaid	2025/06/04 10:10:17
2	Rafesa Melayu	0.00	Missing Pages	Unpaid	2025/06/04 10:22:24
3	Sains	0.00	Unworn	Paid	2025/06/04 10:22:44

Fig. 36 Student Penalty interface as SPBT Teacher

No	Textbook Title	Price (RM)	Condition	Status	Date
1	Sains	0.00	Unworn	Unpaid	2025/06/04 10:10:17
2	Rafesa Melayu	0.00	Missing Pages	Unpaid	2025/06/04 10:22:24
3	Sains	0.00	Unworn	Paid	2025/06/04 10:22:44

Fig. 37 Student Penalty interface as Class Teacher

5.2.8 Logout Module

The Logout Module in the SPBT Management System ensures secure session termination for all users, integrated across every page through the navigation bar, as illustrated in Fig. 38. The logout functionality is implemented using PHP to end the user's session upon clicking the Logout button, redirecting them to the login page. The layout of the logout button, as shown in Fig. 39, is seamlessly embedded within the navigation bar, providing a consistent and accessible user experience across all interfaces. This implementation enhances user navigation, supports efficient session management, and aligns with the system's goal of delivering a secure and user-friendly experience.

```

1 <?php
2 session_start();
3 session_unset();
4 session_destroy();
5 header("Location: login.php");
6 exit;

```

Fig. 38 Logout PHP code

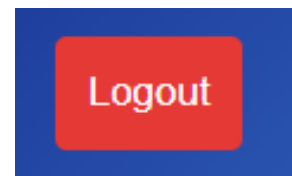


Fig. 39 Logout button

5.3 System Testing

System testing was carried out by the developer to ensure the SPBT Management System met client requirements and functioned smoothly. All modules were tested for proper operation and user experience. Security testing, including password hashing and role-based access control, was also performed to protect the system from potential threats.

5.3.1 Functional Testing

Functional testing was conducted with SPBT Teachers, Class Teachers, and PPD at Sekolah Kebangsaan Pintas Puding to evaluate the SPBT Management System's usability and performance. Users tested key features like Login, List of Textbook, List of Class Teacher, Students Information, Textbook Registration, Borrowing and Returning, Penalty, and Logout then provided feedback through a questionnaire. Table 5.1 shows the results, confirming the system functions well and meets user needs.

Table 5 Test category of the system

Test Category	Description
1	The functionality of the system that is tested by SPBT Teacher
2	The functionality of the system that tests by Class Teacher
3	The functionality of the system that tests Pejabat Pendidikan Daerah (PPD)

Based on the user testing results in Table 6, the SPBT Management System meets all functional requirements across SPBT Teacher, Class Teacher, and PPD roles. All modules passed testing, confirming the system is stable, user-friendly, and effective in managing textbooks at Sekolah Kebangsaan Pintas Puding.

Table 6 *Test plan of the system*

Module	Test Category	Description	Expected Result	Actual Result
Login	1,2,3	Login on the system based on role assigned.	User can login to someone who was already registered by SPBT Teacher	Pass
List of Textbooks	1,2,3	SPBT Teacher able to add, delete and update all textbooks by level.	Class Teacher and PPD able to view the list of textbooks	Pass
List of Class Teacher	1,3	SPBT Teacher able to add, delete, update and reset passwords for class teachers who are responsible for the class.	Class Teacher get their own username and password to the class that assigned and PPD able to view the Class Teacher that assign with the class	Pass
Textbook Register	1	SPBT Teacher must register textbook using barcode scanner.	The textbook who was registered only can proceed to borrow by students.	Pass
Student Information	1,2,3	SPBT Teacher is able add, delete and update student details.	All roles can view students from any class, except the Class Teacher, who can only view the list of students in the class they are assigned to.	Pass
Borrowing and returning	1,2,3	SPBT Teacher and Class Teacher able assign and return textbooks for students and download PDF.	All role able to download the borrow and return details to put it in report.	Pass
Penalty	1,2,3	SPBT Teacher and Class Teacher able to add total penalty and download PDF.	All role able to download to make it as report	Pass
Logout	1,2,3	Able to logout from the system.	Users can logout from their account when they want	Pass

6. Results and Discussion

The SPBT Management System for Sekolah Kebangsaan Pintas Puding using Role-Based Access Control (RBAC) has successfully achieved its main objectives, offering a structured, role-based platform that improves textbook management efficiency across SPBT Teachers, Class Teachers, and Pejabat Pendidikan Daerah (PPD) users. Key modules such as Login, List of Textbook, List of Class Teacher, Students Information, Textbook Registration, Borrowing and Returning, Penalty, and Logout were implemented with features like barcode scanning, PDF export, and Role-Based Access Control (RBAC), enabling seamless task delegation and secure data handling. User testing results confirmed the system's functionality and reliability, with successful execution of all test cases. This demonstrates that the system effectively supports textbook assignments, return tracking, and penalty management while improving administrative workflows.

Despite these achievements, certain limitations remain, including readability issues for older users, slow loading times for large datasets, and the absence of advanced features like penalty notifications and multi-language support. To enhance the system's effectiveness, future improvements are proposed, such as optimizing accessibility with better font and contrast options, improving system performance, and integrating advanced tools like real-time analytics and automated alerts. These enhancements aim to increase user satisfaction, ensure system sustainability, and expand its functionality, positioning the SPBT Management System as a scalable and user-friendly solution for school-level educational administration.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: **study conception and design:** S. A. Mohd Shukur, N. Rahim; **data collection:** S. A. Mohd Shukur, N. Rahim; **analysis and interpretation of results:** S. A. Mohd Shukur, N. Rahim; **draft manuscript preparation:** S. A. Mohd Shukur, N. Rahim. All authors reviewed the results and approved the final version of the manuscript.

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Appendix

Fig. 40 Google Form testing

Fig. 41 Google Form testing

Borrowing and Returning Textbook Module

Does the QR/barcode scanner save time when assigning or returning textbooks? *

1 2 3 4 5

★ ★ ★ ★ ★

Is the return process (including penalty recording) straightforward? *

1 2 3 4 5

★ ★ ★ ★ ★

Penalty Module

Can you easily record and view penalty details for students? *

1 2 3 4 5

★ ★ ★ ★ ★

Is the "Penalty History" section helpful for tracking payments? *

1 2 3 4 5

★ ★ ★ ★ ★

Fig. 42 Google Form testing

Accessibility and Overall Experience

Are the text and buttons large enough to read comfortably? *

1 2 3 4 5

★ ★ ★ ★ ★

Does the system meet your role's needs effectively? *

1 2 3 4 5

★ ★ ★ ★ ★

Additional Comments

Please provide any suggestions or issues you encountered:

.....

Fig. 43 Google Form testing