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Sports Equipment Management System for SK Bukit Durian

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Abstract

Sekolah Kebangsaan Bukit Durian is a primary school where the current process of managing sports equipment in the storeroom relies on manual records and physical logbooks, leading to inefficiencies and difficulties in tracking equipment usage. The project objectives involve designing the Sports Equipment Management System (SEMS) using an object-oriented approach, developing the system using a mobile-based approach, and testing the system using system and user acceptance testing. The system is developed using Prototyping Model and integrates Quick Response (QR) Code technology to streamline the management of sports equipment. The testing results show all system functions operated correctly and met the users' expectations in terms of functionality, usability, and interface design. Key advantages of the system include real-time inventory monitoring, automated notifications, and efficient report generation. In the future, the system can be expanded by adding features such as equipment expiry tracking and a compensation module for lost or damaged items.

1. Introduction

The management system refers to the ability of the system to store its records and be able to be maintained and manipulated by the management of an organization by complying with their objectives [1]. The system eases the workflow of the organization by organizing its structure and processes to act systematically and ensure smooth processes and achieve planned results.

The Sports Equipment Management System is a systematic approach that enables the admin which is storeroom manager to effectively organize, monitor and control the inventory of sports equipment. This process involves the admin overseeing the use of equipment by teachers at SK Bukit Durian. Effective management is crucial as it ensures that the equipment is always available and in good condition for use in sports activities, thereby supporting the physical and social development of students.

Currently, the management of sports equipment at SK Bukit Durian is conducted manually. The storeroom manager records all equipment using paper documents and stores them in physical files. Teachers wishing to borrow equipment must interact directly with the storeroom manager to ascertain the availability of equipment and all borrowing and returning processes are logged in a physical book. This approach requires considerable time and effort while making data management cumbersome and prone to errors.

However, the use of this current method has led to several issues, including delays in the borrowing and returning process, uncertainty regarding equipment availability and difficulties in monitoring the status of the equipment. The storeroom manager often faces problems with the loss or damage of equipment due to a lack of a

clear system for recording and tracking usage. Additionally, the storeroom manager finds it challenging to generate reports on equipment usage, complicating decision-making.

As a solution to these problems, the proposed Sports Equipment Management System will automate the borrowing and returning processes by using QR code scanning technology. With this system, teachers can easily check the availability of equipment and its location while directly recording the borrowing process in the system. Furthermore, the admin can monitor inventory status and generate useful reports for management decisions. With this systematic approach, the management of sports equipment at SK Bukit Durian is expected to become more efficient, organized, and effective.

The objectives involved in this study are to design the Sports Equipment Management System (SEMS) for SK Bukit Durian using object-oriented approach, develop the system using mobile-based approach and test the system using system testing and user acceptance testing.

This paper is organized into several sections to present the study in a structured manner. Section 2 reviews related works and provides background on the problem domain. Section 3 describes the methodology used in developing the system. It explains the Prototyping Model in detail, including the planning phase, analysis phase, design phase, prototype development, and implementation phase. This section also presents the system's UML diagrams, including the use case diagram and class diagram, the system architecture, the user interface design, and code segments that demonstrate the functionality of each system module. Next. section 4 presents the results and discussion of system testing and User Acceptance Testing (UAT). Finally, Section 5 concludes the paper and outlines future work for system enhancement.

2. Related Work

In this section, the domain background, sports equipment management system, and result of the comparative analysis are discussed.

2.1 Domain Background

SK Bukit Durian is a primary school in a rural area where teachers and students engage actively in sports and extracurricular activities. The school sports room holds various sports equipment used for physical education and school events. This includes equipment for sports like badminton, football, ping pong, athletics and more. Currently, managing and tracking these items are done manually. Teachers need to record borrowed equipment in physical logbooks which are often prone to errors, loss of information and delays in updating the inventory.

To borrow equipment, teachers must visit the storeroom, locate the item and manually record it in the logbook which increases the risk of misplacing or overlooking equipment status. Similarly, damaged items are only reported verbally or through handwritten notes and this cause delays in equipment replacement or repair. Therefore, managing equipment availability and tracking borrow-return status becomes challenging for the storeroom manager.

The lack of an automated tracking and notification system has led to recurring issues like misplaced items, difficulty monitoring equipment conditions and an inefficient borrowing and returning process. The introduction of the mobile-based Sports Equipment Management System (SMES) aims to streamline this process. It includes features such as QR code scanning for real-time borrowing and returning, notifications to remind teachers to return items and a centralized system for updating inventory and tracking damaged items. This system will replace the current manual process which allows for improved inventory control, timely maintenance of equipment and enhanced accessibility for both teachers and storeroom managers. Fig. 1 shows the current process of managing the sports storeroom at SK Bukit Durian.

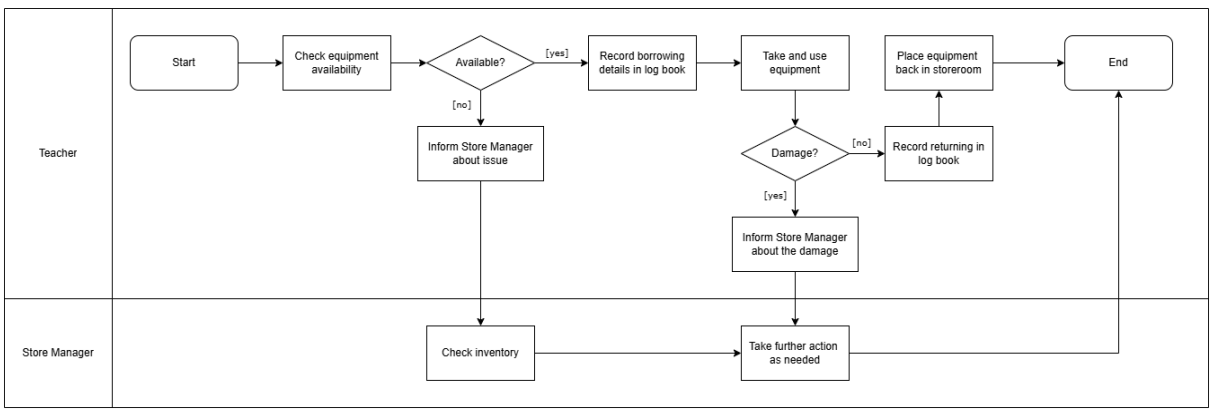

Fig. 1 *Swimlane Diagram (as-is) of the Current Process*

2.2 Sports Equipment Management System

The Sports Equipment Management System (SEMS) is an essential component in the field of sports management. It aims to streamline the processes involved in the storage, circulation, and maintenance of sports equipment. Based on Wang [2], traditional management methods often suffer from inefficiencies and inaccuracies which can hinder the overall effectiveness of sports programs. The SEMS addresses these challenges by providing a digital platform that enables sports administrators to manage equipment more effectively. This system not only enhances the efficiency of operations but also reduces the workload for managers by automating various tasks related to equipment tracking and maintenance.

One of the key features of a robust SEMS is its capability for real-time tracking of sports equipment. This functionality allows users to easily access and update information regarding the availability and condition of equipment, ensuring that data is always current [3]. Such an organized system enhances the management of resources, enabling administrators to respond quickly to the needs of athletes and coaches. Furthermore, the integration of user management functionalities is another critical aspect of SEMS. A paper by Kostova and Tsonkova [4] emphasizes the importance of restricting access to sensitive information based on user roles within the system. This feature enhances security by ensuring that only authorized personnel can manage or access specific equipment data. By implementing role-based access control, SEMS can safeguard against unauthorized usage and potential data breaches, thereby fostering a secure environment for managing sports resources.

In addition to improving operational efficiency, SEMS also contributes to better decision-making through data analytics. By collecting and analysing usage data, administrators can identify trends related to equipment usage and maintenance needs. This capability not only helps in optimizing inventory levels but also in planning future purchases based on actual usage patterns [5]. According to Michael [6], by ensuring that sports equipment remains sufficient and readily accessible, it will directly enhance student performance by providing consistent opportunities for skill development. As educational institutions increasingly recognize the importance of physical education in fostering student well-being, the adoption of sophisticated sports equipment management systems becomes vital. These systems not only support day-to-day operations but also align with broader educational goals by ensuring that students have access to quality sports resources.

2.3 Comparison with the Existing System

This section provides a comparative analysis of three existing applications which are Courtsite [7], CourtReserve [8], and Sports Booker [9]. Table 1 shows the comparison between the three existing systems and the proposed system. The comparison reveals that while existing systems such as Courtsite, CourtReserve, and Sports Booker focus primarily on court or facility management, the proposed Sports Equipment Management System (SEMS) stands out by offering more comprehensive features tailored specifically for equipment management in school environments. Furthermore, SEMS introduces QR code integration for efficient equipment tracking and allows for custom return time adjustments to suit school schedules. It also offers WhatsApp notifications which may be more accessible and immediate for users compared to email. Additionally, it introduces a damage reporting feature to help maintain equipment quality and accountability. These enhancements demonstrate SEMS's superior functionality and better alignment with the needs of school-based sports equipment management compared to the other applications.

Table 1 *System's Comparison*

Features/System	Courtsite	CourtReserve	Sports Booker	SEMS (Proposed System)
Equipment / Facility Management	Yes (for courts)	Yes (for courts)	Yes (for facilities)	Yes (for equipments)
QR Code Integration	No	No	No	Yes
Real-Time Availability	Yes (for courts)	Yes (for courts)	Yes (for facilities)	Yes (for equipments)
Notifications	Email	Email	Email	WhatsApp
Report Generation	Basic usage report	Custom reports	Custom reports	Custom reports
Custom Return Time Adjustment	No	No	No	Yes
Damage Reporting	No	No	No	Yes

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3. Methodology

This section explained the methodology used to develop the Sports Equipment Management System. The Prototyping Model is a software development approach that focuses on creating an initial prototype of the system to visualize requirements and design early in the development process [10]. Fig. 2 shows the system prototyping model used in the development of the Sports Equipment Management System. This model is chosen because it particularly effective in projects where requirements are not well understood or are expected to change over time, as it allows to gather feedback and make improvements iteratively. The process starts with planning, where initial requirements are gathered, followed by analysis and design, where the basic structure of the prototype is established [11]. A preliminary version of the system known as the "System Prototype" which allows stakeholders to interact with it, providing a tangible representation of the final system. This feedback loop facilitates the identification of any necessary adjustments, which can be incorporated into subsequent versions. The Prototyping Model ensures that the final product aligns closely with the users' needs and expectations, making it particularly suited for user-centred design projects.

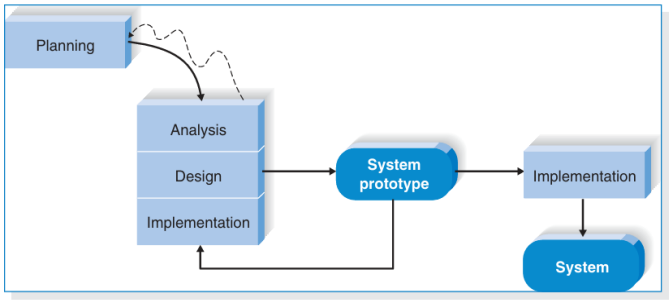

Fig. 2 *System Prototyping Model* [12]

3.1 Planning Phase

In the planning phase of the Prototyping Model, the primary focus is on gathering initial requirements and setting the groundwork for development. This phase involves understanding the project's objectives, identifying key stakeholders and defining the scope of the project and system to be developed.

3.2 Analysis Phase

The analysis phase aims to delve deeper into the initial requirements gathered during planning, focusing on understanding the end users' needs and identifying the system's primary functionalities. In this phase, a more detailed analysis of user requirements is conducted to ensure prioritize essential features and establish a baseline for the first prototype.

3.2.1 System Requirements Analysis

In this section, user, functional, and non-functional requirements will be presented and discussed. The system requirement analysis addresses the specific functionalities to be implemented in the proposed system. Table 2 shows the user requirements of the proposed system. Table 3 shows the functional requirements of the proposed system. Lastly, Table 4 shows the non-functional requirements of the proposed system.

Table 2 *User Requirements of the Proposed System*

User	Requirements
Admin	Enable to login, view the dashboard, manage equipment, view all borrowed and returned record, manage issue item, receive notification, and generate reports.
Teacher	Enable to register an account, login, view the dashboard, borrow and return equipment, report issue item, and receive notification.

Table 3 *Functional Requirements of the Proposed System*

User	Requirements	User
User Registration	• The system shall be able to allow teachers to register an account. • The system shall allow teachers to submit registration details. • The system shall be able to verify the user registration details. • The system shall be able to store the user details in the database.	• Teachers

Table 3: *(cont)*

Login	• The system shall allow users to log in with credentials. • The system shall provide a form for users to input login details. • The system shall verify the login details against the database to ensure accuracy. • The system shall display an appropriate error message if the login details are incorrect. • The system shall allow users to reset their password through an email verification process.	• Admin • Teachers
Dashboard	• The system shall be able to allow teachers to view the available quantity of sports equipment in the storeroom. • The system shall allow the admin to view a summary of equipment status and track late returns.	• Admin • Teachers
Equipment Management	• The system shall be able to allow the admin to perform CRUD operations on sports equipment details.	• Admin
Equipment Borrowing	• The system shall allow teachers to borrow equipment by scanning the QR code on the equipment. • The system shall allow teachers to borrow multiple equipment items as a bundle in a single transaction. • The system shall automatically record the borrowing time when the teacher makes the borrowing. • The system shall allow teachers to adjust the return time, with a default return time set to 1 hour. • The system shall allow teachers and admin to view the list of borrowed equipment.	• Admin • Teachers
Equipment Returning	• The system shall allow teachers to return equipment by marking it as returned. • The system shall update equipment status to "available" once returned. • The system shall allow users to view the list of returned equipment.	• Admin • Teachers
Issue Item Management	• The system shall be able to allow teachers to mark items as damaged or missing. • The system shall notify the admin about issue equipment for further action. • The system shall allow admin to view the list of issue equipment.	• Admin • Teachers
Notification	• The system shall be able to send notifications to teachers via WhatsApp when borrowing time exceeds the set period. • The system shall notify the admin about the issue items reported by teachers.	• Admin • Teachers
Report Generation	• The system shall be able to allow admin to generate reports when needed.	• Admin
User Management	• The system shall be able to allow the admin to view and delete teacher accounts as needed.	• Admin

Table 4 *Non-Functional Requirements of the Proposed System*

Requirements	Functionalities
Operational	• The system should be easy to use. • The system should be able to work with any web browser, such as Google Chrome, Mozilla Firefox, or Microsoft Edge. • The system should have a responsive design and be compatible with both desktop and mobile devices.
Performance	• The system should be always accessible. • The system shall respond to user actions within 2 seconds.

Table 4: *(cont)*

Security	• The system requires user passwords to have a minimum length of 6 characters and include a combination of letters, numbers, and special characters. • The system shall deny access to any user if the username and password input are incorrect.
Usability	• The system shall provide a user-friendly interface that is easy to navigate. • The system should have a consistent layout across all pages.
Integrity	• The system shall store user passwords in an encrypted format in the database.

3.3 Design Phase

In the design phase, the focus shifts to creating the system's initial architecture, including UML diagrams and user interface design, based on the requirements identified in the analysis phase. This phase involves developing a preliminary layout, including user interface components and the underlying structural framework to form the basis of the prototype.

3.3.1 General System Architecture

The system architecture used in the Sports Equipment Management System is based on the Model-View-Controller (MVC) design pattern as shown in Fig. 3. It separates the application into three interconnected components to ensure scalability and maintainability. The View represents the user interface, enabling users to interact with the system. The Controller acts as an intermediary, processing user requests from View and communicating with the Model to retrieve or update data. The system includes specialized controllers, such as User, Equipment, Transaction, Issue Item and Report Controller, each handling specific functional areas. The Model encapsulates business logic and interacts directly with the database, managing data retrieval, updates, and storage through components like User Model, Equipment Model, Transaction Model, and Report Model.

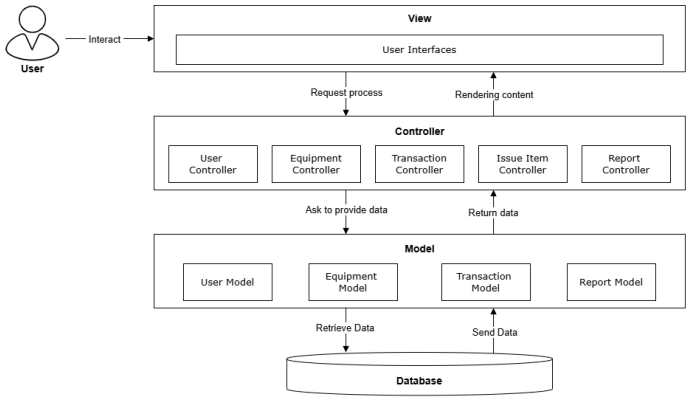

Fig. 3 *Architecture Diagram for SEMS*

3.3.2 Use Case Diagram

The use case diagram of the proposed system is presented in Fig. 4. There are two types of users who are involved in the system and each of the users interacts with the system through specific use cases designed to meet their responsibilities. Admin has comprehensive access to the system and is responsible for managing the overall functionality of the sports equipment inventory. For example, admin can login, generate reports, manage user accounts, manage equipment, manage issue items, view borrowed and returned records. On the other hand, teachers interact with the system in a more limited capacity which only includes register, login, view equipment, report issue item, borrow and return equipment.

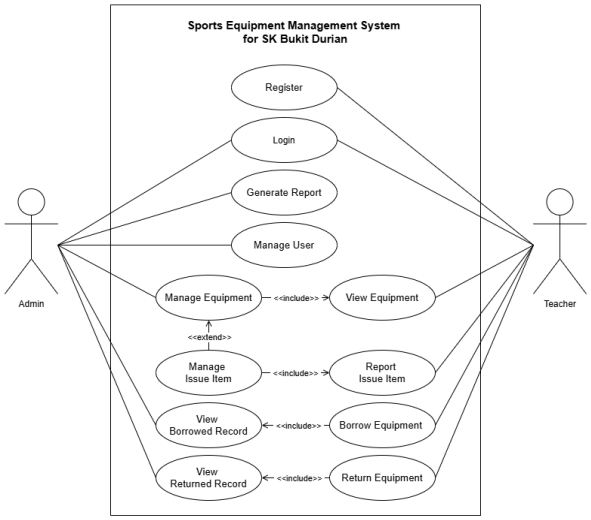

Fig. 4 *Use Case Diagram for SEMS*

3.3.3 Class Diagram

The class diagram illustrates the conceptual model in database modeling as shown in Fig. 5. The diagram represents the core components of the system, including the `Admin`, `Teacher`, `EquipmentCategory`, `EquipmentItem`, `Transaction`, and `IssueItem` classes. The `Admin` class manages the system and oversees equipment categories and items. A single admin is responsible for managing multiple equipment categories and their associated items, as indicated by a one-to-many relationship with both the `EquipmentCategory` and `EquipmentItem` classes. The `Teacher` class represents the users who interact with the system by borrowing, returning, and reporting issue equipment. Teachers are connected to the `Transaction` class, where each teacher can perform multiple transactions related to borrowing and returning equipment. The `EquipmentCategory` class categorizes equipment into groups. Each category can contain one or more equipment items, as depicted by a one-to-many relationship with the `EquipmentItem` class. The `EquipmentItem` class represents individual pieces of equipment that belong to a specific category. Each item can be involved in multiple transactions and may be reported as damaged multiple times. These interactions are modelled through their relationships with the `Transaction` and `IssueItem` classes. The `Transaction` class manages borrowing and returning activities. It connects teachers and equipment items, allowing for multiple transactions to occur between these entities. The `IssueItem` class tracks reports of issue equipment. Each damage or missing report is linked to a specific equipment item and may involve multiple reports over time.

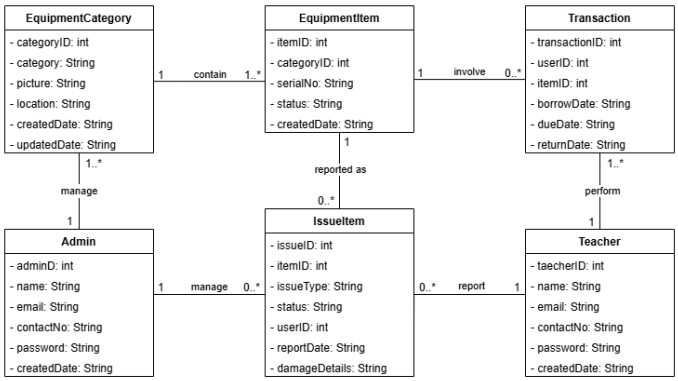

Fig. 5 *Class Diagram for SEMS*

3.4 System Prototype Phase

This system prototype phase involves developing an initial, functional version of the system that captures essential features and provides a working model for stakeholders to evaluate. In this phase, the prototype is built based on the design created in the previous phase, incorporating core functionalities that allow users to interact with the system and provide feedback. Then, every prototype was tested and implemented. The prototype was developed using HTML, CSS, JavaScript and PHP, leveraging MySQL as the database for data storage and retrieval.

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3.5 Implementation Phase

This implementation phase marks the transition from a prototype to a fully functional and finalized system. Based on the feedback and adjustments made in the previous phase, this phase focuses on enhancing the prototype to include all necessary features and refine its performance and stability. Here, the system is developed to meet all specified requirements and any placeholder components or temporary solutions in the prototype are replaced with optimized, production-ready code. Additionally, functionality testing is conducted to ensure that the system operates reliably and meets quality standards. Besides that, this system also be tested by the end user. The test cases were executed, and the actual results were compared with the expected result.

3.5.1 User Registration Module

Fig. 6(a) shows the interface for the registration which allows teachers to register for the system. Teachers are required to fill in information such as full name, email address, phone number, password, and confirm password. The form includes input validation to ensure that all fields are completed correctly before submission. The data entered by the user is then securely stored in the database with password encryption to protect user credentials. After successfully registering a new account, the teacher will be directed to the login page, where they can view and interact with the available modules based on their assigned role. Fig. 6(b) shows the JavaScript code segment responsible for validating the email and phone number fields during registration in real-time. While Fig. 6(c) presents the backend PHP code that handles the registration process.

Fig. 6(a) *Interface for registration*

Fig. 6(b) *JavaScript code segment for user registration*

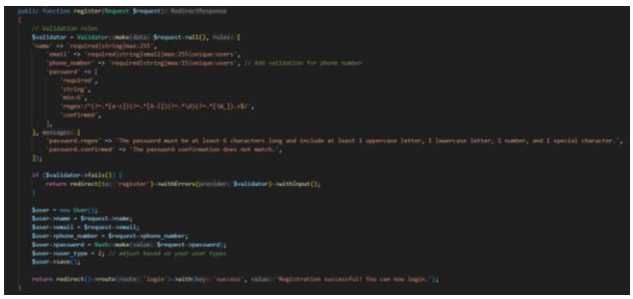


Fig. 6(c) *Backend code segment for user registration*

3.5.2 Login Module

Fig. 7(a) shows the login interface for registered users. The interface prompts users to enter their email and password to access the system. Upon submission, the system verifies the format of the email and checks the entered credentials against the records stored in the database. If the email or password is incorrect or does not match any existing user, an error message is displayed, preventing access. When the credentials are valid, the user is successfully authenticated and redirected to the dashboard page according to their role. Fig. 7(b) displays the code segment that handles the login authentication process.

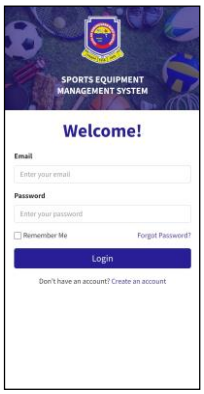
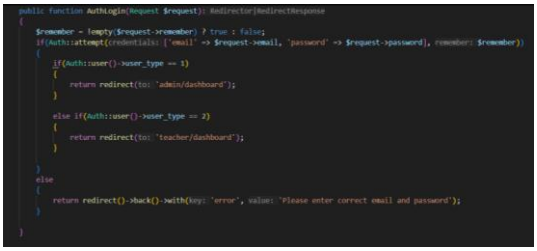


Fig. 7(a) *Interface for login*

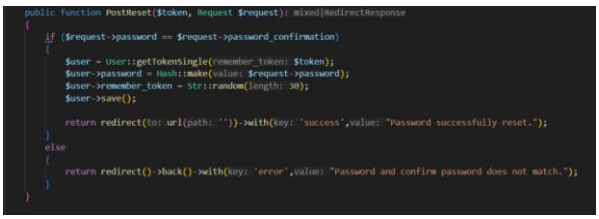


```
public function AuthLogin(Request $request): RedirectorRedirectResponse
{
    $remember = !empty($request->remember) ? true : false;
    if(Auth::attempt(credentials: ['email' => $request->email, 'password' => $request->password], remember: $remember))
    {
        if(Auth::user()->user_type == 1)
        {
            return redirect(to: 'admin/dashboard');
        }

        else if(Auth::user()->user_type == 2)
        {
            return redirect(to: 'teacher/dashboard');
        }

    }
    else
    {
        return redirect()->back()->with(key: 'error', value: 'Please enter correct email and password');
    }
}
```

Fig. 7(b) *Code segment for login authentication*

Fig. 8(a) shows the interface for the "Forgot Password" feature, which allows users to recover access to their account in case they forget their login credentials. In this interface, the user is required to input their registered email address into the provided field. Upon submission, the system checks whether the email exists in the database. If the email is found, a password reset link will be sent to the user's email, allowing them to create a new password. If the email is not registered, an error message is displayed. Fig. 8(b) presents the backend code responsible for handling the forgot password request.

Fig. 8(a) *Interface for forgot password*



```
public function PostReset($token, Request $request): mixed|RedirectResponse
{
    if ($request->password == $request->password_confirmation)
    {
        $user = User::getTokenSingle(remember_token: $token);
        $user->password = Hash::make(value: $request->password);
        $user->remember_token = Str::random(length: 30);
        $user->save();

        return redirect(to: url(path: ''))->with(key: 'success',value: "Password successfully reset.");
    }
    else
    {
        return redirect()->back()->with(key: 'error',value: "Password and confirm password does not match.");
    }
}
```

Fig. 8(b) *Code segment for forgetting password*

3.5.3 Dashboard Module

Fig. 9(a) shows the dashboard interface for admin while Fig. 9(b) shows the dashboard interface for teacher. The admin dashboard displays a comprehensive summary including the total number of equipment categories, items, registered teachers, and issue items. It also features graphical representations and tables illustrating the status of equipment by category, giving an overview of available, borrowed, and damaged items. Additionally, the admin can view a list of items that have been returned late, allowing timely follow-up. On the other hand, the teacher's dashboard presents a summary focused on their borrowed and returned items. Additionally, a dedicated section on the right displays a list of borrowed items, showing the item's category, serial number, and the time remaining. Teachers can also access graphs and tables detailing the equipment status by category, which helps them monitor the availability of sports equipment for their classes. Figure 9(c) and 9(d) illustrates the process behind how the dashboard displays relevant information for both admin and teacher users.

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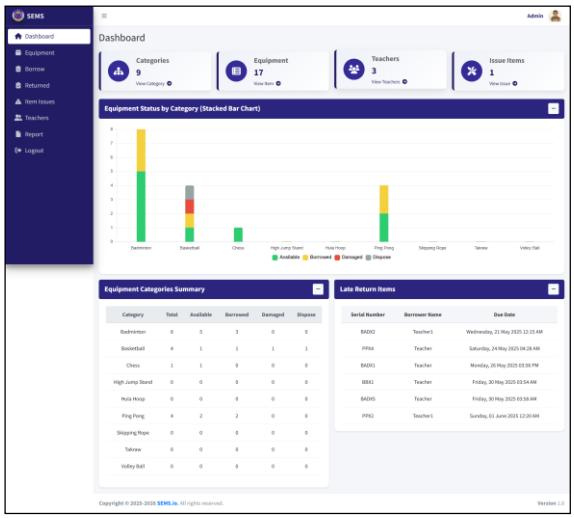


Fig. 9(a) *Interface for admin dashboard*

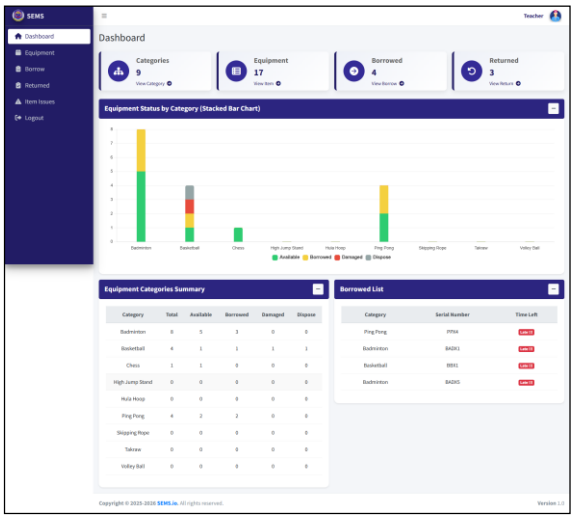
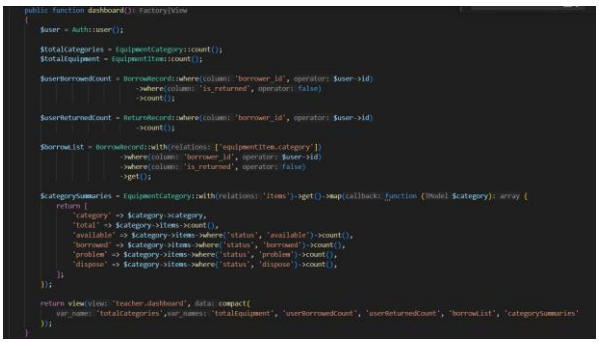


Fig. 9(b) *Interface for teacher dashboard*



```
public function dashboard(): Factory|View
{
    $user = Auth::user();

    $totalCategories = EquipmentCategory::count();
    $totalEquipment = EquipmentItem::count();

    $userBorrowedCount = BorrowRecord::where(column: 'borrower_id', operator: $user->id)
                        ->where(column: 'is_returned', operator: false)
                        ->count();

    $userReturnedCount = ReturnRecord::where(column: 'borrower_id', operator: $user->id)
                        ->count();

    $borrowList = BorrowRecord::with(relations: ['equipmentItem.category'])
                        ->where(column: 'borrower_id', operator: $user->id)
                        ->where(column: 'is_returned', operator: false)
                        ->get();

    $categorySummaries = EquipmentCategory::with(relations: 'items')->get()->map(callback: function ($model $category): array {
        return [
            'category' => $category->category,
            'total' => $category->items->count(),
            'available' => $category->items->where('status', 'available')->count(),
            'borrowed' => $category->items->where('status', 'borrowed')->count(),
            'problem' => $category->items->where('status', 'problem')->count(),
            'dispose' => $category->items->where('status', 'dispose')->count(),
        ];
    });

    return view(view: 'teacher.dashboard', data: compact(
        var_name: 'totalCategories',var_names: 'totalEquipment', 'userBorrowedCount', 'userReturnedCount', 'borrowList', 'categorySummaries'
    ));
}
```

Fig. 9(c) *Code segment for admin dashboard*

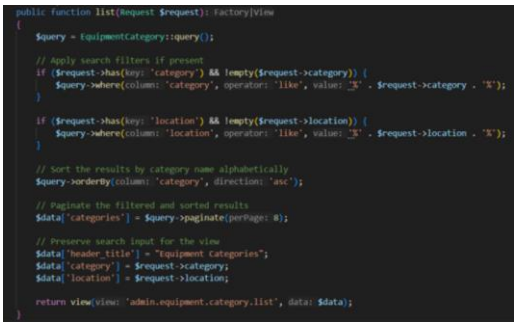
```
public function dashboard(): Factory|View
{
    $totalCategories = EquipmentCategory::count();
    $totalEquipment = EquipmentItem::count();
    $totalUsers = User::count();

    $categorySummaries = EquipmentCategory::with(relations: 'items')->get()->map(callback: function ($model $category): array {
        return [
            'category' => $category->category,
            'total' => $category->items->count(),
            'available' => $category->items->where('status', 'available')->count(),
            'borrowed' => $category->items->where('status', 'borrowed')->count(),
            'problem' => $category->items->where('status', 'problem')->count(),
            'dispose' => $category->items->where('status', 'dispose')->count(),
        ];
    });

    // Fetch late return records
    $today = Carbon::now()->startOfDay();
    $lateReturns = BorrowRecord::where(column: 'is_returned', operator: false)
        ->where(column: 'return_date', operator: '<', value: $today)
        ->with(relations: 'user')
        ->get();

    return view(view: 'admin.dashboard', data: compact(
        var_name: 'totalCategories', var_names: 'totalEquipment', 'totalUsers', 'categorySummaries', 'lateReturns'
    ));
}
```

Fig. 9(d) *Code segment for teacher dashboard*

3.5.4 Equipment Management Module

Fig. 10(a) displays the interface of the list of equipment categories. This page allows administrators to view a list of all existing equipment categories along with their respective locations and total quantity. Each category is visually represented with an image, name, and location label to make identification easier. Users can perform key actions such as viewing details, editing category information, or deleting a category using the corresponding buttons provided for each item. Additionally, the interface includes search and filter functionality by category or location to streamline the management process, as well as pagination for navigating through multiple entries. A button to add new equipment categories is also available at the top right corner of the page. Fig. 10(b) shows the code segment that handles the process of displaying the list of equipment categories.

Fig. 10(a) *Interface for listing equipment categories*

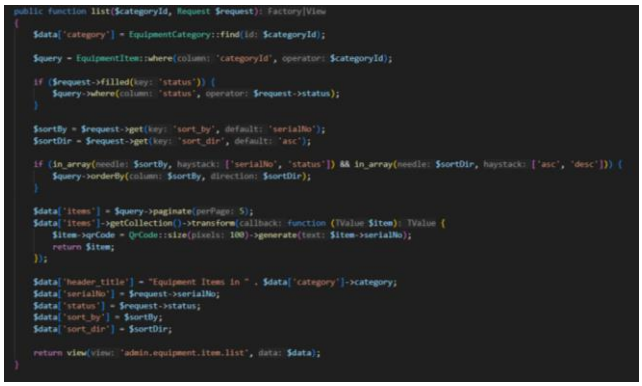


```
public function list(Request $request): Factory|View
{
    $query = EquipmentCategory::query();

    // Apply search filters if present
    if ($request->has(key: 'category') && !empty($request->category)) {
        $query->where(column: 'category', operator: 'like', value: '%' . $request->category . '%');
    }

    if ($request->has(key: 'location') && !empty($request->location)) {
        $query->where(column: 'location', operator: 'like', value: '%' . $request->location . '%');
    }

    // Sort the results by category name alphabetically
    $query->orderBy(column: 'category', direction: 'asc');

    // Paginate the filtered and sorted results
    $data['categories'] = $query->paginate(perPage: 8);

    // Preserve search input for the view
    $data['header_title'] = "Equipment Categories";
    $data['category'] = $request->category;
    $data['location'] = $request->location;

    return view(view: 'admin.equipment.category.list', data: $data);
}
```

Fig. 10(b) *Code segment for listing equipment categories*

Fig. 11(a) shows the interface for managing equipment items within a specific category. The interface displays a table that includes the item ID, serial number, status, a scannable QR code, and action buttons for each item. The status labels are color-coded to indicate different conditions such as "Available," "Borrowed," "Problem," and "Dispose," allowing for quick identification. Users can filter the items by status using a dropdown menu and perform actions such as deleting an item or reporting an issue, ensuring efficient item tracking and management. Additionally, there is a button at the top right that allows administrators to add new items. Fig. 11(b) describes the code segment used to display the list of equipment items within a selected category.

Fig. 11(a) *Interface for listing equipment item*



```
public function list($categoryId, Request $request): Factory|View
{
    $data['category'] = EquipmentCategory::find(id: $categoryId);

    $query = EquipmentItem::where(column: 'categoryId', operator: $categoryId);

    if ($request->filled(key: 'status')) {
        $query->where(column: 'status', operator: $request->status);
    }

    $sortBy = $request->get(key: 'sort_by', default: 'serialNo');
    $sortDir = $request->get(key: 'sort_dir', default: 'asc');

    if (in_array(needle: $sortBy, haystack: ['serialNo', 'status']) && in_array(needle: $sortDir, haystack: ['asc', 'desc'])) {
        $query->orderBy(column: $sortBy, direction: $sortDir);
    }

    $data['items'] = $query->paginate(perPage: 5);
    $data['items']->getCollection()->transform(callback: function (TValue $item): TValue {
        $item->qrCode = QrCode::size(pixels: 100)->generate(text: $item->serialNo);
        return $item;
    });

    $data['header_title'] = "Equipment Items in " . $data['category']->category;
    $data['serialNo'] = $request->serialNo;
    $data['status'] = $request->status;
    $data['sort_by'] = $sortBy;
    $data['sort_dir'] = $sortDir;

    return view(view: 'admin.equipment.item.list', data: $data);
}
```

Fig. 11(b) *Code segment for listing equipment item*

3.5.5 Equipment Borrowing Module

Fig. 12(a) displays the interface of the Borrowed List page under the Equipment Management Module. This page allows administrators to monitor all borrowed equipment items by displaying a structured table containing key information such as the serial number of each item, the name of the borrower, the borrow date, and the due date. Each row in the table represents a borrowed item, with action buttons for quick actions like returning the item or reporting it as issued. To improve usability, the table supports sorting by each column, enabling users to easily organize the data as needed. At the top right corner of the page, there are buttons for scanning items and managing group borrowing through the “Borrow in Bundle” feature, which enhances the efficiency of borrowing multiple items at once. Fig. 12(b) describes the code segment used to display the list of currently borrowed equipment that has not yet been returned.

Fig. 12(a) *Interface for listing borrowed items*

```
public function list(Request $request): Factory|View
{
    $sortBy = $request->get(key: 'sort_by', default: 'borrow_date');
    $sortDir = $request->get(key: 'sort_dir', default: 'desc');

    $items = BorrowRecord::with(relations: 'equipmentItem', 'user')
        ->where(column: 'is_returned', operator: false)
        ->orderBy(column: $sortBy, direction: $sortDir)
        ->paginate(perPage: 5)
        ->appends(key: ['sort_by' => $sortBy, 'sort_dir' => $sortDir]);

    return view(view: 'admin.borrow.list', data: compact(var_name: 'items', var_names: 'sortBy', 'sortDir'));
}
```

Fig. 12(b) *Code segment for listing borrowed items*

Fig. 12(c) displays a scanning screen used to borrow an individual item by scanning its QR code. Once the scanning is successful, the system automatically redirects to a borrow form that shows the scanned serial number, along with fields to input the return date and time, as well as the purpose of borrowing, show in Fig. 12(d). This makes the process of borrowing an item quick and efficient, minimizing manual input. Fig. 12(e) displays a form for borrowing multiple items at once, called as "Borrow in Bundle." In this form, users select a category, specify the quantity of items to borrow, and the system will list the items to be borrowed. Similar to the individual borrowing form, users must enter the return date and time as well as describe the purpose of the borrowing. Fig. 12(f) and 12(g) show the code segment that involved in the process of borrowing an item by scanning its QR code. While Fig. 12(h) and 12(i) present the code segments for the bundle borrowing feature, which allows users to borrow multiple items of the same category at once.

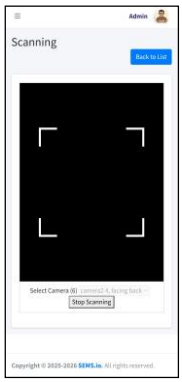


Fig. 12(c) *Scanning Interface*

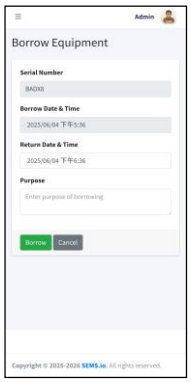


Fig. 12(d) *Form for single item borrowing*

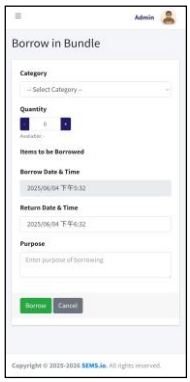


Fig. 12(e) *Form for multiple item borrowing*

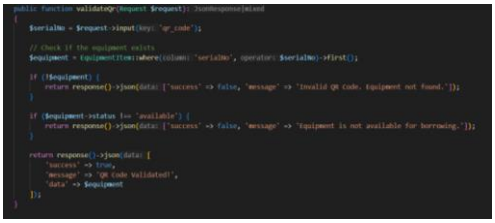


Fig. 12(f) *Code segment for QR code validation*

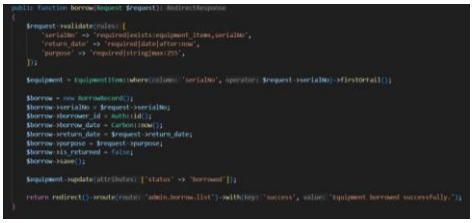


Fig. 12(g) *Code segment for single item borrowing*

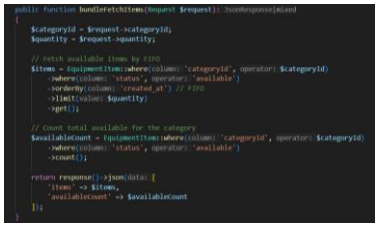


Fig. 12(h) *Code segment for bundle item fetching*

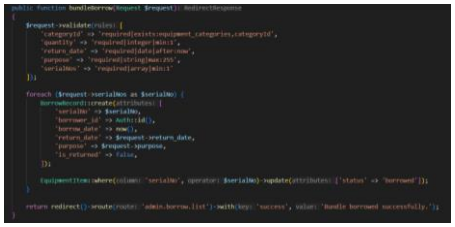


Fig. 12(i) *Code segment for multiple item borrowing*

3.5.6 Equipment Returning Module

Fig. 13(a) shows the return list interface, which displays a record of all equipment items that have been successfully returned to the storeroom. This table includes key information such as the serial number of the equipment, the name of the borrower, the date the item was borrowed, and the date it was returned. The list helps administrators track the complete borrowing cycle of each item and verify that the equipment has been returned on time. Sorting options are available for each column, allowing the manager to organize the data based on specific needs, such as reviewing recent returns or identifying frequent borrowers. Fig. 13(b) displays the code segment used for the equipment return functionality.

Fig. 13(a) *Interface for listing returned items*

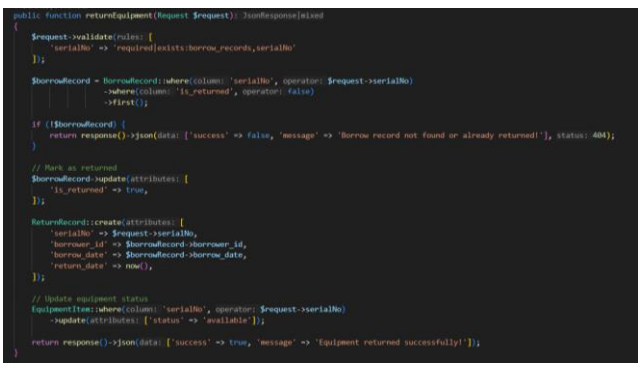


Fig. 13(b) *Code segment for listing returned items*

3.5.7 Issue Item Management Module

Fig. 14(a) shows the interface of the report item issue in the Item Issue Management Module. This page allows users to report any equipment that is either damaged or missing. Users must first select the type of issue by choosing either the "Damage" or "Missing" radio button. A description text box is provided for users to enter details about the issue encountered. To support the report, users can also upload a photo of the damaged item by using the "Choose File" button. Once all necessary information is filled in, users can submit the report by clicking the "Submit Report" button or cancel the process by clicking "Cancel". Fig. 14(b) illustrates the logic behind the process of reporting an issue with a borrowed item.

Fig. 14(a) *Form for reporting an issue*

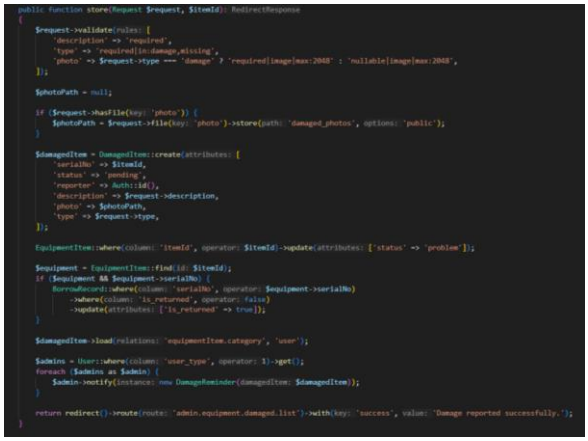


Fig. 14(b) *Code segment for handling reported issues*

3.5.8 Notification Module

Fig. 15(a) illustrates the notification sent to teachers when they have not returned one or more borrowed items by the due date, while Fig. 15(b) shows the code segment used to generate and send this notification. The system automatically compiles the serial numbers of all overdue items and calculates the total count. A personalized message is then generated, informing the teacher of the number of overdue items and listing each one. This notification is sent directly through WhatsApp, ensuring that teachers are promptly reminded to return the equipment, helping to improve accountability and timely equipment tracking.

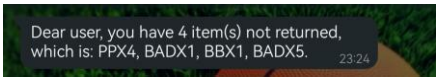


Fig. 15(a) *Late Return Notification to Teacher*

Fig. 15(b) *Code Segment for Late Return Notification to Teacher*

Fig. 15(c) displays the notification received by admin summarizing all users who have overdue equipment. While Fig. 15(d) shows the code segment responsible for checking all borrow records, identifying late returns, and compiling a summary for admin notification. The system first identifies which users have not returned their borrowed items on time by checking the borrow records. It then groups the overdue items by each user and compiles a summary that includes the teacher's name, phone number, and the list of unreturned item serial numbers. This summary is sent via WhatsApp to the administrators, allowing them to monitor overdue returns in real time and follow up if necessary.

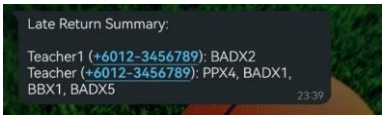


Fig. 15(c) *Late Return Notification to Admin*

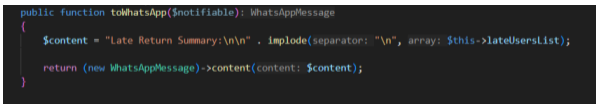


Fig. 15(d) *Code Segment for Late Return Notification to Admin*

Fig. 16(a) presents the WhatsApp notification that is sent to administrators when a damaged or missing item is reported, while Fig. 16(b) shows the corresponding code segment that prepares this notification. The system retrieves key information including the category of the item, its serial number, the type of issue, and the name of the person who reported it. A message is then generated and sent to the admin via WhatsApp, providing

immediate awareness of the issue. This quick notification ensures that the administration can take timely action to repair, replace, or investigate the condition of the reported equipment.

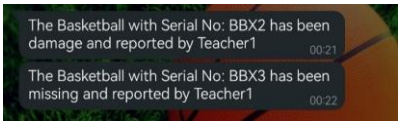


Fig. 16(a) *Issue Item Notification to Admin*

Fig. 16(b) *Code Segment for Issue Item Notification to Admin*

3.5.9 Report Generation Module

Fig. 17(a) shows the interface of the Report Generation Form, which enables administrators to generate various types of reports based on selected criteria. The form features a dropdown menu that allows users to choose the specific type of report they want to generate, including options such as QR Code (PDF), Equipment Item, Borrow, Return, Damaged Item, and Teacher. In addition to the report type selection, the interface provides date range filtering with "Start Date" and "End Date" input fields, allowing users to generate reports for a specific period. Fig. 17(b) illustrates the logic behind generating various types of reports within the system.

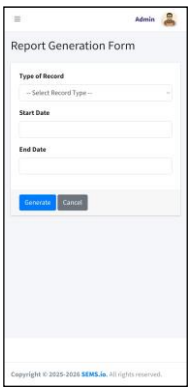


Fig. 17(a) *Form for generating reports*

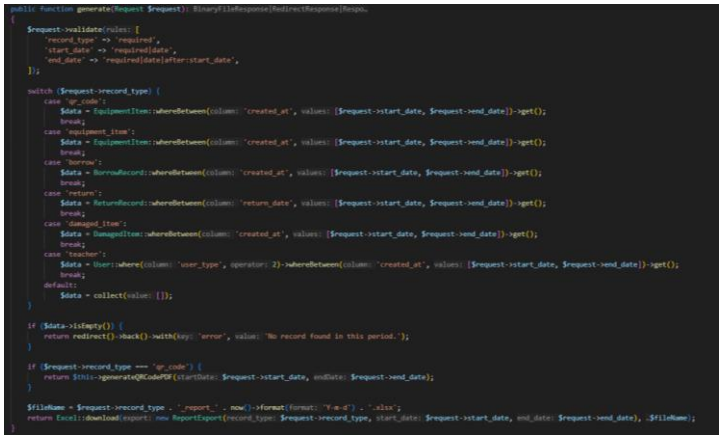
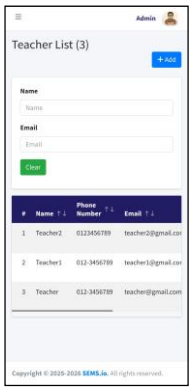


Fig. 17(b) *Code segment for generating report*

3.5.10 User Management Module

Fig. 18(a) displays the interface for the Teacher List, where administrators can view, manage, and update information about teachers registered in the system. The interface provides a searchable and sortable table that includes key details such as the teacher's name, phone number, email address, and registration date. At the top of the table, there are input fields for filtering the list by name or email, along with buttons to search or clear the filters. Each row in the list represents a teacher, with options to edit or delete their information via the action buttons on the right-hand side. A blue “Add” button is also available at the top-right corner, allowing admins to register new teachers into the system. Fig. 18(b) illustrates the backend process responsible for displaying a paginated list of teachers.



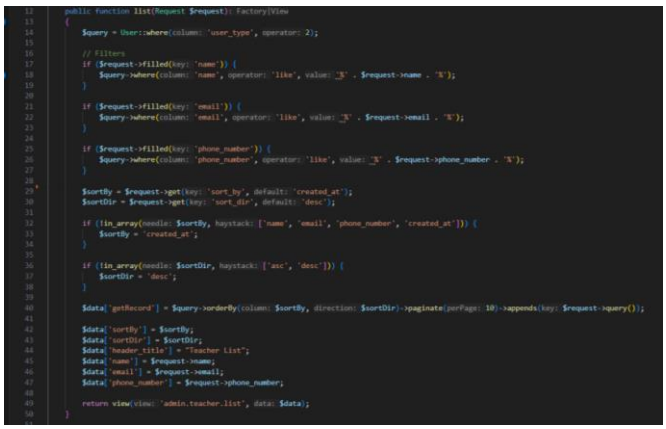


Fig. 18(a) *Interface for listing teachers*

Fig. 18(b) *Code Segment for listing teachers*

4. Results and Discussion

This section presents the results of system testing using predefined test cases. Additionally, user acceptance testing was conducted involving the target users, which included the storeroom manager and teachers from SK Bukit Durian.

4.1 System Testing

Table 5 shows the overall results of the test cases, indicating that a total of 58 test cases were developed based on eight use cases. All of these test cases passed the tests conducted to assess the SEMS.

Table 5 *Overall Test Case Result*

Test Case ID	Use Case	Total Test Cases	Total Success	Total Fail
TC_100	Register	9	9	0
TC_200	Login	7	7	0
TC_300	Generate Report	5	5	0
TC_400	Manage user	5	5	0
TC_500	Manage equipment	8	8	0
TC_600	Manage issue item	6	6	0
TC_700	Borrow equipment	13	13	0
TC_800	Return equipment	5	5	0
	Total	**58**	**58**	**0**

4.2 User Acceptance Testing

User Acceptance Testing (UAT) was conducted to evaluate whether the Sports Equipment Management System (SEMS) meets the expectations and requirements of the end users. A total of 10 respondents participated, consisting of the storeroom manager and selected teachers from SK Bukit Durian, who interacted with the system and completed tasks related to their roles. Their feedback was collected through a Google Forms questionnaire consisting of 15 questions, which assessed aspects such as system functionality, usability, and overall satisfaction with the user interface design. A 5-point Likert scale was used for each question, where 1 represented "Strongly Disagree" and 5 represented "Strongly Agree."

4.2.1 Satisfaction with System Functionality

Fig. 19 shows the graph illustrating user satisfaction with the system's functionality, while Table 6 presents the summary of responses. Most users agreed that the dashboard clearly displays equipment status, and that the system helps manage categories, borrowing, returning, and tracking damaged or missing equipment efficiently. Users also found that the system effectively alerts them about overdue returns and reported items, while also generating useful reports covering various aspects of the system. These findings indicate that the system's core functionalities successfully meet the users' operational needs.

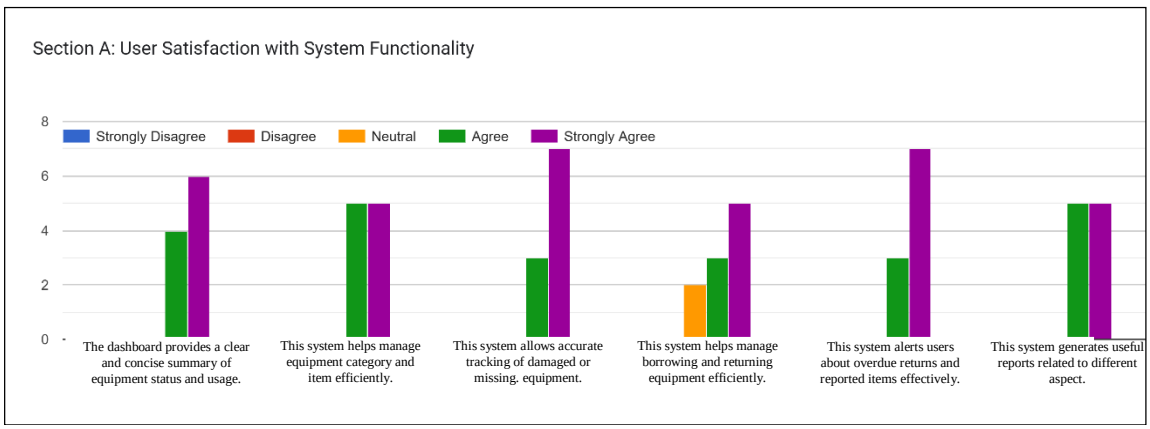


Fig. 19 *Graph of User Satisfaction with System Functionality*

Table 6 *Results of User Responses on System Functionality Satisfaction*

No.	Question	Scale					Total
		1	2	3	4	5	
1.	The dashboard provides a clear and concise summary of equipment status and usage.	0	0	0	4	6	10
2.	This system helps manage equipment category and items efficiently.	0	0	0	5	5	10
3.	This system allows accurate tracking of damaged or missing equipment.	0	0	0	3	7	10
4.	This system helps manage borrowing and returning equipment efficiently.	0	0	2	3	5	10
5.	This system alerts users about overdue returns and reported items effectively.	0	0	0	3	7	10
6.	This system generates useful reports related to different aspect.	0	0	0	5	5	10

4.2.2 Satisfaction with System Usability

Fig. 20 shows the graph illustrating user satisfaction with the system's usability, while Table 7 displays the detailed results of the responses collected. User feedback showed a high level of satisfaction with the system's usability. Respondents found the system easy to understand and use, with smooth navigation between features and quick loading times. The menus and options were considered logically organized, and users appreciated that the system functioned well across different devices. These results reflect that the system is user-friendly and accessible for both admin and teachers.

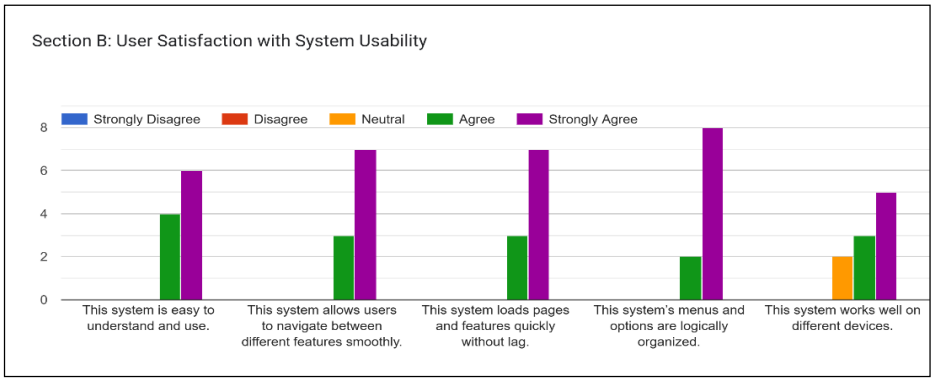


Fig. 20 *Graph of User Satisfaction with System Usability*

Table 7 *Results of User Responses on System Usability Satisfaction*

No.	Question	Scale					Total
		1	2	3	4	5	
1.	This system is easy to understand and use.	0	0	0	4	6	10
2.	This system allows users to navigate between different features smoothly.	0	0	0	3	7	10
3.	This system loads pages and features quickly without lag.	0	0	0	3	7	10
4.	This system's menus and options are logically organized.	0	0	0	2	8	10
5.	This system works well on different devices.	0	0	2	3	5	10

4.2.3 Satisfaction with System User Interface Design

Fig. 21 shows the graph illustrating user satisfaction with the system's user interface design, while Table 8 displays the detailed results of the responses collected. Feedback on the system's user interface design was also

favourable. Users appreciated the clean layout, readable fonts, and well-organized screens that helped them quickly understand how to use each feature. The interface design was considered visually appealing and appropriate for a school setting. This positive response reflects the effectiveness of the design in enhancing the overall user experience.

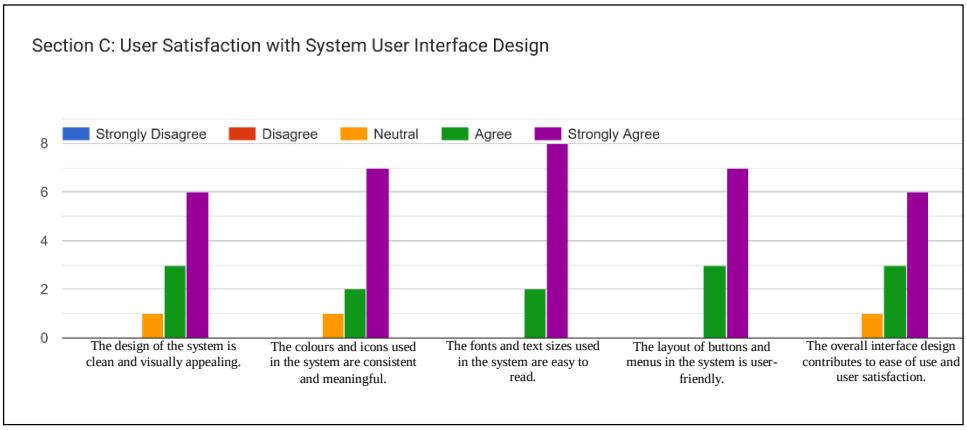


Fig. 21 *Graph of User Satisfaction with System User Interface Design*

Table 8 *Results of User Responses on System User Interface Design*

No.	Question	Scale					Total
		1	2	3	4	5	
1.	The design of the system is clean and visually appealing.	0	0	1	3	6	10
2.	The colours and icons used in the system are consistent and meaningful.	0	0	1	2	7	10
3.	The fonts and text sizes used in the system are easy to read.	0	0	0	2	8	10
4.	The layout of buttons and menus in the system is user-friendly.	0	0	0	3	7	10
5.	The overall interface design contributes to ease of use and user satisfaction.	0	0	1	3	6	10

5. Conclusion

In conclusion, the Sports Equipment Management System developed for SK Bukit Durian successfully meets the objectives by providing a mobile-based, user-friendly platform that streamlines the management of sports equipment through QR code integration. The system offers significant advantages such as real-time inventory tracking, reduced paperwork, faster borrowing and returning processes, and improved accountability through notification features. However, the system has limitations as it does not support equipment expiration tracking or automatic reminders for replacements, and it lacks a compensation process for missing or damaged equipment since the equipment value is not recorded for accountability. Future enhancements could address these gaps by introducing lifecycle monitoring with timely notifications and integrating item valuation to support accountability and recovery processes.

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Conflict of Interest

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

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Vivian Kuik Huoi Thin, Rabatul Aduni Sulaiman; **data collection:** Vivian Kuik Huoi Thin, Rabatul Aduni Sulaiman; **analysis and interpretation of results:** Vivian Kuik Huoi Thin, Rabatul Aduni Sulaiman; **draft manuscript preparation:**

Vivian Kuik Huoi Thin, Rabatul Aduni Sulaiman. All authors reviewed the results and approved the final version of the manuscript.

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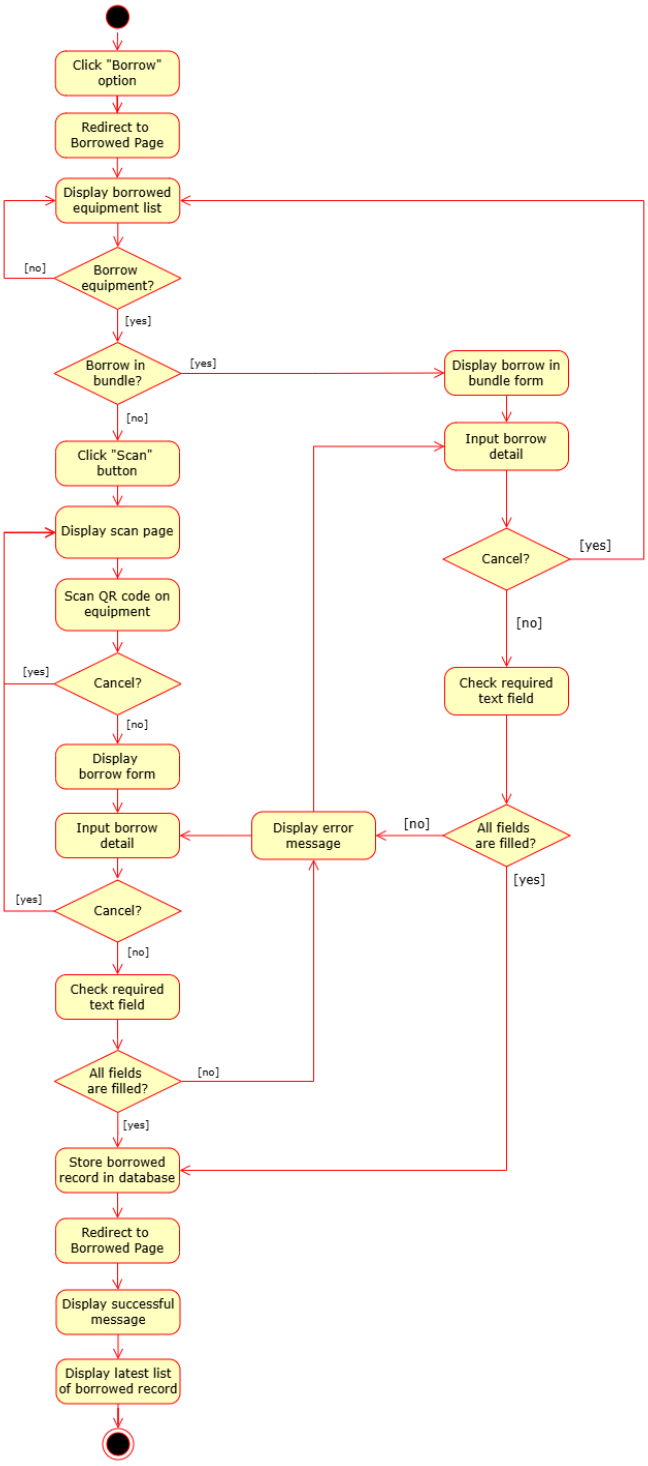
Appendix A: Activity Diagram

Borrow Equipment



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Appendix B: Sequence Diagram

Borrow Equipment