



Development of School Exam Administration Based on LCDP with Scrum Method: An Innovation in Administrative Efficiency in Education

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Abstract.

Purpose: This study aims to explore the potential benefits of integrating innovative technology and agile methodologies, precisely the Scrum method and the AppSheet platform, to enhance the efficiency and effectiveness of school exam administration. The research seeks to address the constraints of manual exam administration and investigate the role of technology in providing practical and efficient solutions.

Methods: The study was conducted at Sekolah Indonesia Kota Kinabalu, Sabah, Malaysia, utilizing the Scrum method with the AppSheet platform. The development of the school exam administration application with AppSheet, the low-code development platform (LCDP), using the Scrum method was carried out with a structured and adaptive approach. User stories and use case diagrams were employed to translate user insights into tangible visualizations, ensuring alignment with the intricate needs of the examination committee.

Result: Implementing the Scrum methodology in the development process has proven effective in creating a tailored and efficient application for school exam administration. The application's design and functionality have been carefully crafted to meet the specific requirements of exam administration, including form-filling, data entry, PDF report generation, and user feedback collection. The user survey conducted as part of the development process has provided valuable insights into user experiences, guiding areas for improvement and ensuring a user-centric approach to application development.

Novelty: This study contributes to the field by demonstrating the successful integration of agile methodologies and user-centric design principles in developing a comprehensive solution for school exam administration. The research highlights the potential of innovative technology to revolutionize exam administration for improved educational outcomes, emphasizing the significance of the Scrum methodology and the AppSheet platform in providing a structured yet adaptive approach to application development in the education sector.

Keywords: Administrative efficiency, Agile development, Exam administration, Technology integration

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INTRODUCTION

Education, as the cornerstone of a nation's development [1], requires sustainability and continuous improvement in quality. It aligns perfectly with the Sustainable Development Goal (SDG4), which recognizes delivering high-quality education as an independent objective [2]. In this context, examinations serve as a vital instrument to measure students' understanding, assess teaching effectiveness, and evaluate the success of educational institutions [3], [4]. However, behind these aspects lies a crucial factor, namely exam administration [5]. Exam administration includes compiling student attendance lists, recording invigilator attendance, and creating exam execution reports. These are not mere administrative formalities but documentation confirming the successful execution of exams and serving as the basis for accountability.

Despite its significance, the paradigm of exam administration is often hindered by conventional manual processes. Manual methods, involving traditional data recording and documentation, are time-consuming, require significant physical storage space, and carry the risk of unavoidable human errors [6]. Therefore, these challenges act as catalysts for considering innovative solutions, particularly leveraging technological advancements, to enhance the efficiency and effectiveness of exam administration [7], ultimately playing a significant role in shaping the education landscape [8].

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Many educational institutions are considering technology-based solutions to modernize exam administration in the digital transformation journey. One compelling solution drawing attention is the development of technology-based applications. React Native, a popular framework for building cross-platform mobile applications [9], offers a robust set of tools and libraries that enable developers to create highly functional and visually appealing apps. However, it requires developers to understand JavaScript and the React framework, which can be challenging for individuals with diverse backgrounds. In this landscape, the AppSheet platform emerges as a viable alternative. AppSheet is an application that provides a low-code development platform (LCDP) for creating application software using data sources like Google Drive, DropBox, and others [10]. Thus, AppSheet allows users from various backgrounds to design and develop applications according to their needs, bringing hope to transform exam administration governance towards a more efficient and practical approach.

Beyond the technological aspect, the development method also plays a crucial role in the success of application development. In this context, Scrum, a software development methodology widely adopted in various sectors [11], known for its flexibility and adaptability, emerges as a suitable solution to address the complexity of developing exam administration applications. This method helps manage potential alterations throughout the development phase, enhancing feasibility and promoting standardization [12]. Scrum enables development teams to work iteratively, ensuring measured development and responsiveness to changing needs that may arise during the development process [13], [14]. These advantages are relevant in the ever-changing educational landscape, demanding quick adaptation to new requirements.

Therefore, this article aims to comprehensively discuss the urgency and necessity of developing exam administration based on AppSheet with the application of the Scrum method. To achieve a deeper understanding, the article will elaborate on the challenges faced by manual exam administration, map the role of technology, specifically AppSheet, in overcoming these challenges, and outline the concepts and benefits of applying the Scrum method in application development. Scrum is an agile software development management methodology that starts with delivering the most valuable features to the client and works from there. Its core values include continuous testing, flexibility, self-management, and creativity [15]. This article will also discuss the user-centric design principles as one of the methods that will be integrated with Scrum. User-centric design focuses on understanding users' needs and behaviours to create intuitive, efficient, and enjoyable solutions. By integrating user-centric design with Scrum, development teams can ensure that the exam administration applications meet the needs and expectations of users, ultimately leading to a more successful implementation.

Firstly, it will address the constraints in manual exam administration. Manual processes are slow and require substantial resources, such as labor and paper. Additionally, the risk of human errors in data recording and documentation increases. In line with this, it will investigate the role of technology, especially AppSheet, as a solution to these constraints. AppSheet allows the creation of applications without coding skills, making it adaptable to exam administration needs and providing a practical and efficient solution [16].

It is, furthermore, entering the realm of development methods by discussing the Scrum method. Scrum is relevant because it enables teams to work collaboratively [17], aligning well with the dynamic nature of the education world. Scrum furnishes an organized framework for the development team to operate in brief sprints, ensuring the delivery of functional software every few weeks [18]. The introduction of the Scrum concept will be complemented by examples of its application in the development of exam administration applications. Through the application of Scrum, it is expected that application development is rapid and capable of effectively responding to changing needs. Scrum has emerged as a preferred development model due to its effectiveness in facilitating frequent communication with the product owner during the continuous iterations of evolving software [19], [20].

METHODS

The research was conducted at Sekolah Indonesia Kota Kinabalu, Sabah, Malaysia, utilizing the Scrum method with the AppSheet platform. The school exam administration application with the AppSheet platform using the Scrum method was developed with a structured and adaptive approach. The Scrum methodology is a pivotal and widely embraced component in agile methods, renowned for its effectiveness in creating new products and services [21], [22]. This agile development methodology has gained approval

for streamlining the development process, focusing on effectively handling emerging user requirements and prioritizing them efficiently [23], [24].

The Scrum team consisted of four members: a scrum master, a product owner from the school, and two appsheet developers from Sekolah Indonesia Kota Kinabalu. The Scrum Master facilitated the Scrum process, ensuring the team adhered to Scrum principles and practices. The Product owner was responsible for defining the features and priorities of the application, representing the school's interests, and ensuring that the application met its needs. The two AppSheet developers were responsible for the actual development of the application.

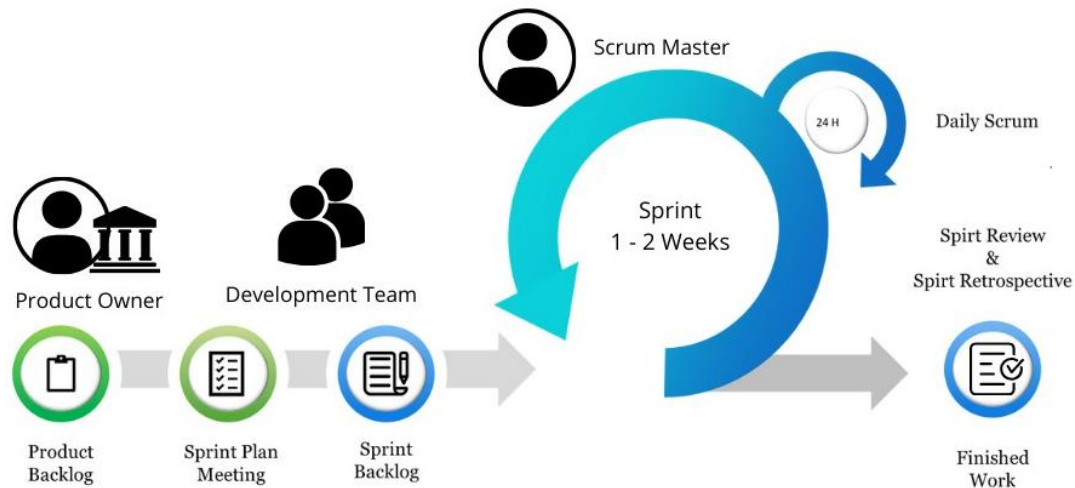


Figure 1. The Scrum methodology

The development process began with creating the Product Backlog, which included user stories gathered from observations and interviews with the seven examination committees. The product backlog, organized as a prioritized sequence of user stories, serves as a roadmap for the project [25]. These user stories were prioritized based on the school's requirements and the Sprint Backlog was formed. Sprint planning involves breaking down tasks into manageable units [26]. The team selected crucial user stories, creating a sprint backlog for the current sprint. The school provided the app's vision while the Scrum team developed the application. The actual execution of tasks, including development, testing, and documentation, occurred during the sprint. Daily Scrums, or stand-up meetings, facilitated communication among the team, ensuring collaboration and progress tracking. Regular touch bases allow the team to discuss progress daily plans and address any obstacles faced [27], [28]. The Sprint Review and Retrospective evaluated the team's work and processes [29], adapting the product backlog if necessary and devising improvement plans. This practice served as the main approach for the team to concentrate on continuous enhancements within the process [30]. The development process continued iteratively, with new user stories added to the Product Backlog based on the school's evolving needs. The total development duration until the application's completion was two weeks, divided into multiple sprints. User-centric design principles were implemented throughout the development process to ensure the application effectively met users' needs and preferences. This approach involves understanding user perspectives, engaging them in the design process, and refining solutions based on feedback. A survey with 15 users was conducted to identify areas for improvement, ensuring that the application aligned with the school's requirements and expectations.

RESULTS AND DISCUSSIONS

Development process

User Stories in pursuing comprehensive user stories, we conducted in-depth interviews with a diverse panel of examination organizers, through these interactions with seven experienced school exam organizers, a rich tapestry of insights emerged, shaping the foundation of our application development process, as shown in Table 1.

Table 1. Table of user stories

No	Users Stories
1	We desire a simple and adaptive application in the form of a school exam administration form.
2	We want the application to be accessible to teachers or invigilators.
3	We want the application to be usable on mobile phones.
4	We want an application that can be utilized for electronic signatures.
5	We want an application that can be used to generate PDF reports.
6	We want an application that can upload images.

These user stories served as the foundation for developing concise use case diagrams, as shown in Figure 2. These visual representations map out user-system interactions, clearly understanding intended functionality. The collaborative effort of translating user insights into tangible visualizations through use case diagrams signifies a pivotal step in ensuring the proposed application aligns seamlessly with the intricate needs of the examination committee. These visualizations will guide feature refinement, enhance usability, and shape a robust, user-centric school exam administration application as we develop. Within the Use Case Diagram, users initiate the application login process based on a predefined code provided by the school exam committee.

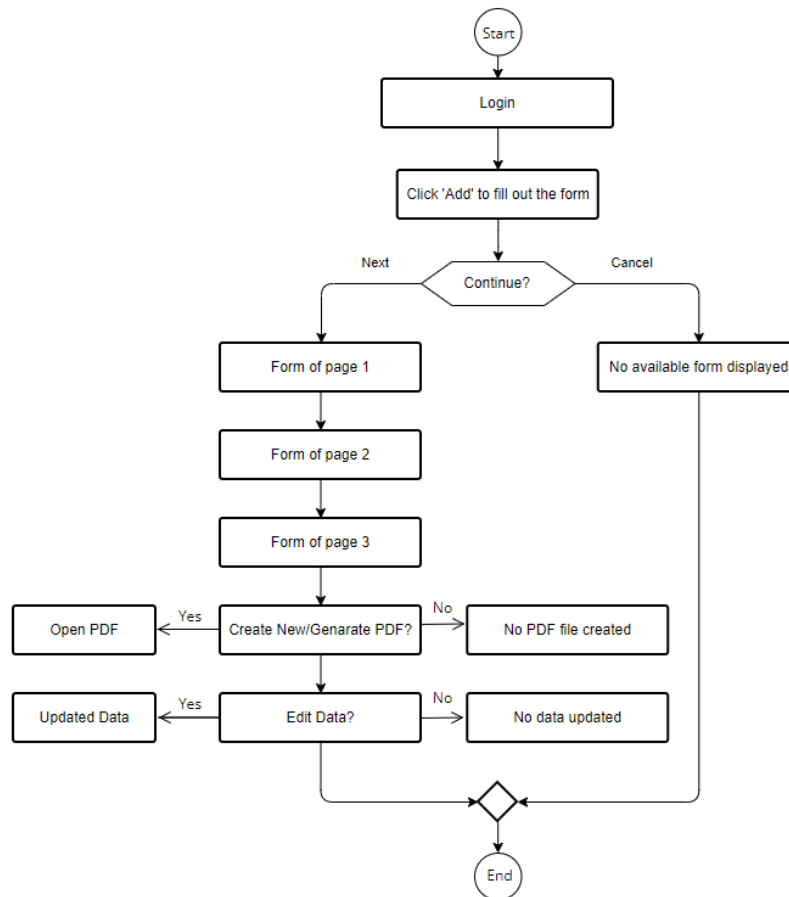


Figure 2. Use case diagram

System architecture

The application's front end is created using the AppSheet platform, a low-code application development environment for user interface creation. The domain model involves creating a UI for exam invigilators and teachers, through which they can interact with the system and perform exam administration tasks and invigilation, among other functions. The AppSheet platform is used for user-friendly and efficient user interface design tools.

The application's back-end processes user requests, specifically managing data and executing business logic. It was implemented using cloud services, namely, Google Drive and Google Sheets, which served as the database. This component was built with an emphasis on scalability and security, meaning that it can support a high number of users while handling a vast amount of data securely. The front-end and back-end components of the system are interconnected and function as a single and well-balanced exam administration system outlined in Figure 3. The system architecture is visualized in Figure 3 below:

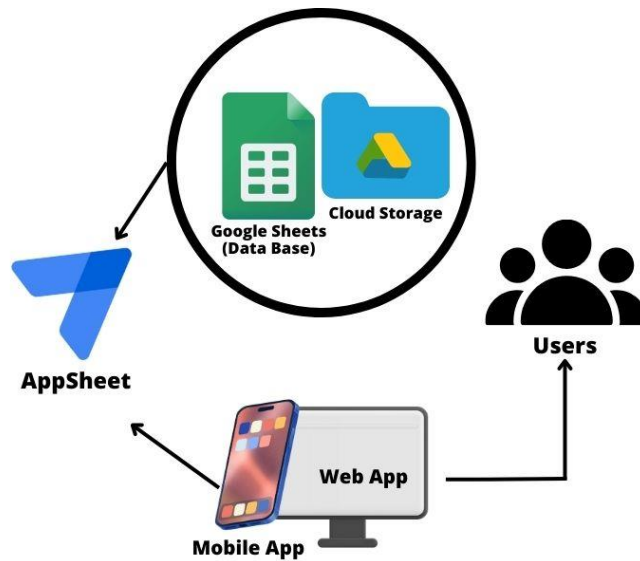


Figure 3. System architecture

Database setup and customization

After acquiring the user stories data, the subsequent step in developing the school exam administration application involved setting up and customizing the database, a crucial step aligned with the Scrum methodology. This initial process aimed to store and manage exam-related data efficiently. Initially, a database schema was meticulously designed to define the database structure, outlining tables, columns, and their relationships. Subsequently, the database was created using Google Sheets, a cloud-based application. This choice was made for its seamless integration with the AppSheet platform, ensuring smooth data entry and management. The Google Sheets document is stored in Google Drive, and the exam report results are in the PDF folder, as shown in Figure 4.

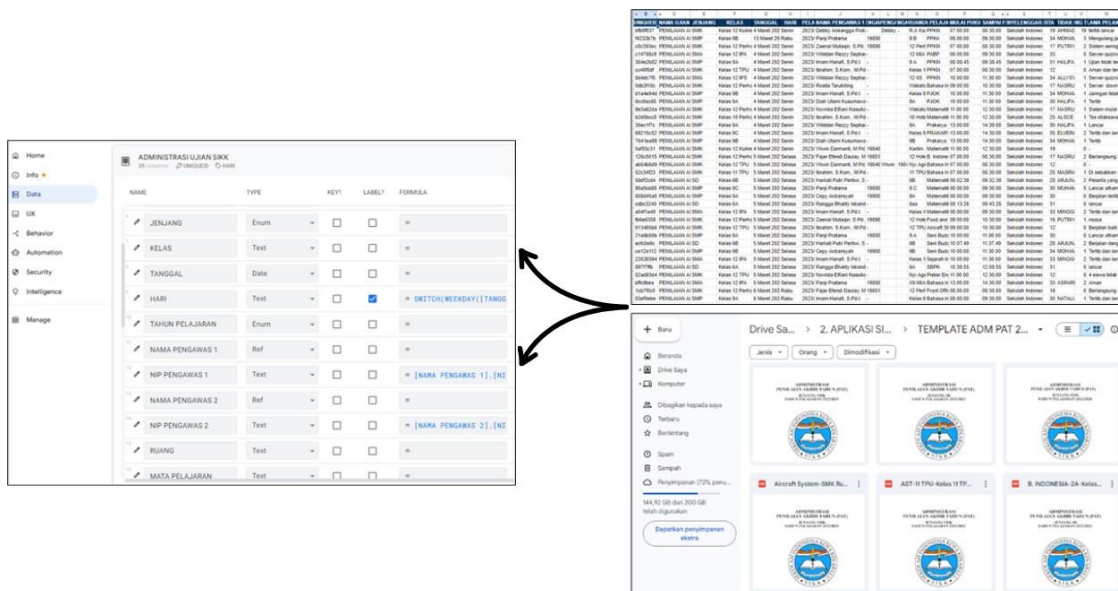


Figure 4. Integrating database with AppSheet

Furthermore, the data in Google Sheets was processed and adjusted in the "Data" menu of the AppSheet editor, tailored to user needs based on the Product Backlog. The team carried out this process during the first week of development. Additionally, the customization process involved daily scrum meetings to adjust the database to the specific needs of the school exam administration process. These meetings ensured that the database was continuously improved based on user feedback and evolving needs, which was in line with the iterative nature of the Scrum methodology.

The next step was for the team to conduct daily scrum meetings and focus on designing the application's user interface using the "UX" and "Automation" menus. The UX menu was utilized to create user-friendly, intuitive, and responsive interfaces, enhancing the overall user experience. However, it should be noted that AppSheet has limitations in customizing the user experience to a more modern look, although it can still meet the requirements of exam administration applications. Simultaneously, the Automation menu was used to automate the creation of PDF reports from the data filled out in the exam administration form, as shown in Figure 5. This design process was guided by user-centric design principles emphasising understanding user needs, tasks, and workflows.

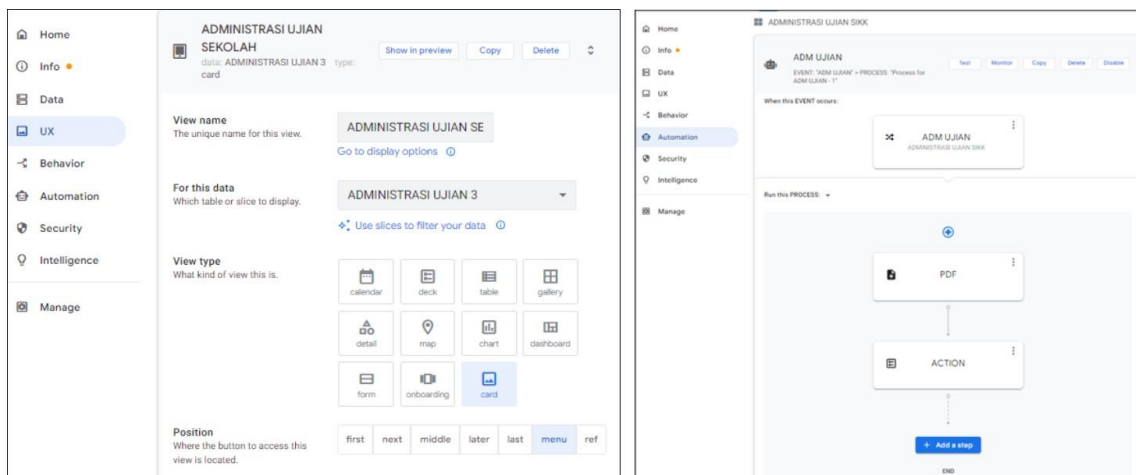


Figure 5. Determining user experience (UX) and automation for PDF report generation

The next step involves configuring security settings and sharing the application link, as illustrated in Figure 6. It enables installation on users' smartphones for testing and feedback purposes. This process was conducted in the second week of development.

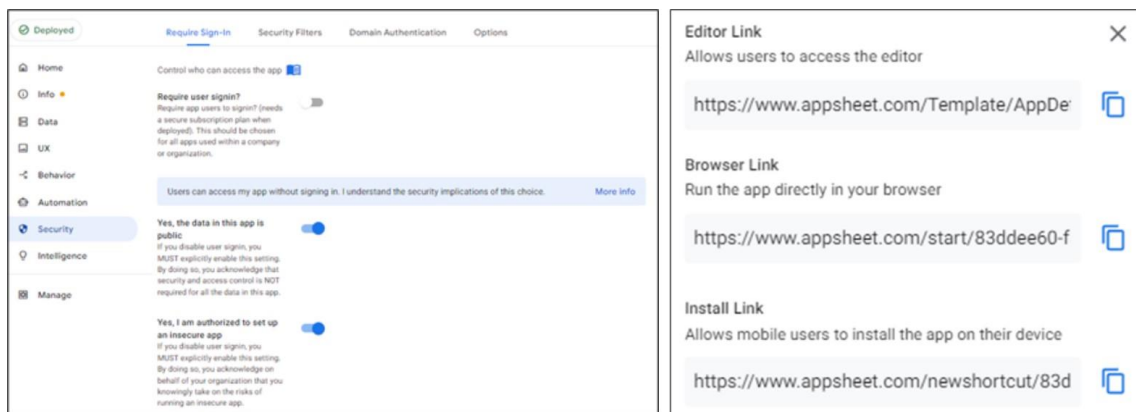


Figure 6. Security settings and sharing app links process

Testing

During the Sprint Review phase, the application was tested by users, including teachers and invigilators, to gather direct input and feedback on functionality and user experience. This testing is done through the "Add" button, as seen in Figure 7, to initiate form filling. Users then select "Next" to navigate smoothly

through the form-filling process. After the testing, a Sprint Retrospective meeting is held, where the Scrum team evaluates the development process. In this meeting, the team identifies what has been done well and what needs improvement to enhance the quality and efficiency of application development.

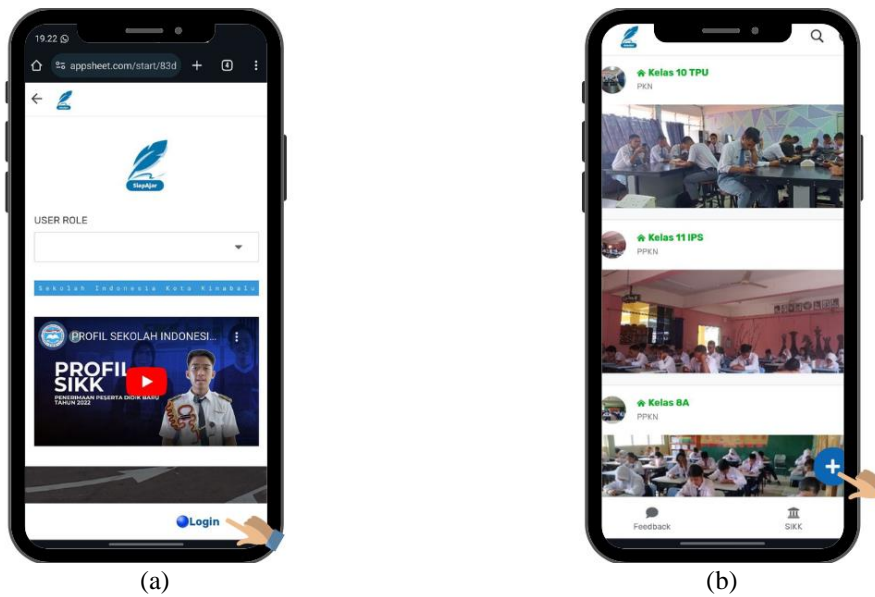


Figure 7. Initiating and navigating form-filling

Three form pages in the application can be filled out, namely, Form Page 1, illustrated in Figure 8, which meticulously captures critical details such as Exam Name, Educational Level, Date, Day, Academic Year, Supervisor 1's Name, Supervisor 2's Name, Exam Room, Subject, and Exam Duration. This information ensures a comprehensive understanding of the exam logistics.

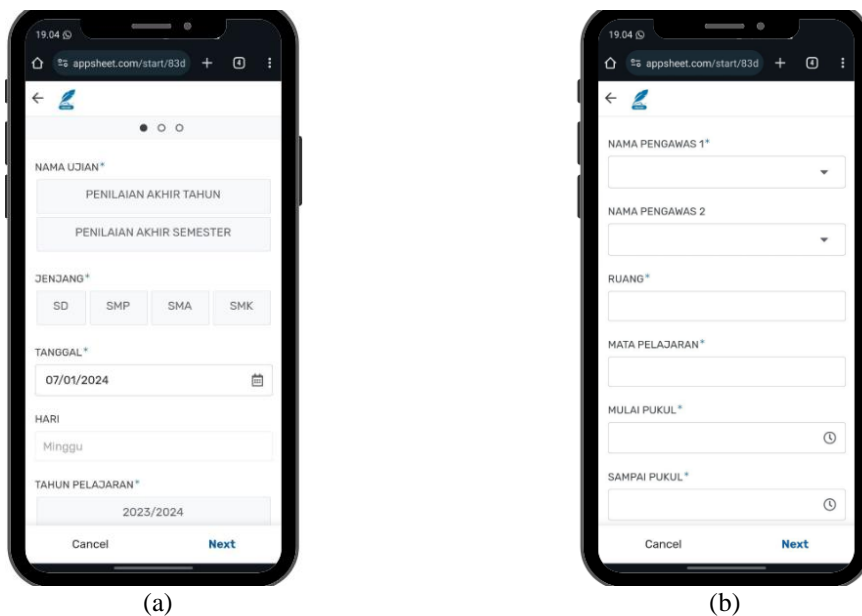


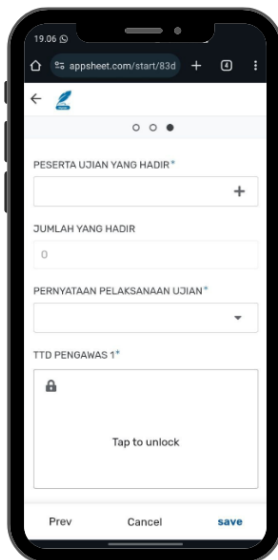
Figure 8. Form page 1 details

Form Page 2, as seen in Figure 9, extends the scope to include Exam Venue, Total Participants, Absent Participants, Number of Absent Students, and Notes on Exam Execution. These details provide valuable insights into overall exam attendance and proceedings.

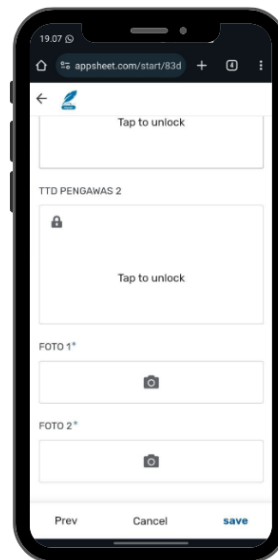


Figure 9. Form page 2 details

Number of Present Participants, Statements, Supervisor 1's Signature, Supervisor 2's Signature, Upload Photo 1, and Upload Photo 2. This section emphasizes documentation and verification aspects of the exam, as seen in Figure 10.



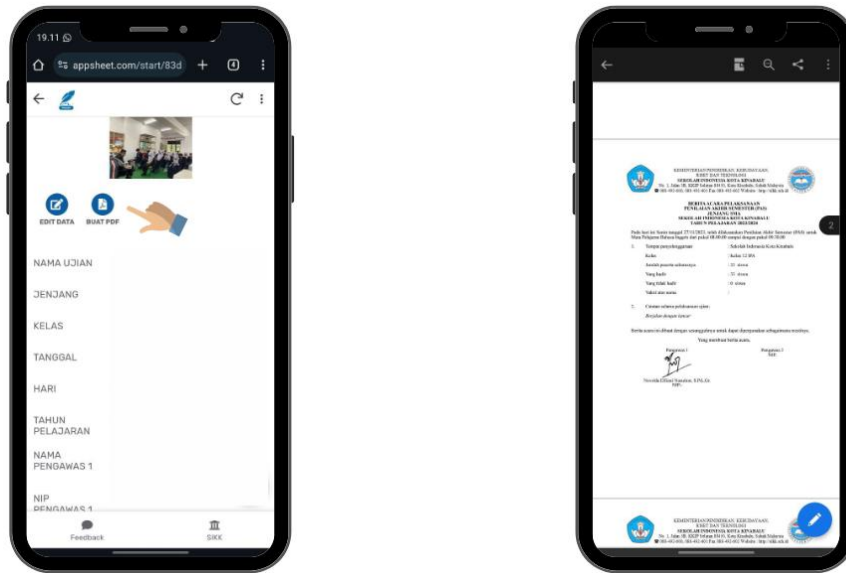
(a)



(b)

Figure 10. (a) Signature form and (b) image upload form

Upon completing the data entry, users are prompted to click "Save" to secure the information. Notably, users have the flexibility to edit data, generate PDF reports (Figure 11a), and open the PDF (Figure 11b).



(a) (b)
Figure 11. (a) PDF generation and (b) PDF view

This meticulous design of form pages collectively aims to capture indispensable information for exam administration, providing organisers with a comprehensive and adaptable solution. Incorporating the user story related to PDF report generation significantly enhances the application's utility, delivering a streamlined and efficient reporting mechanism to elevate the examination management process.

The development phase spanned fourteen days and was divided into two sprints with a dedicated team of two individuals. The initial seven days were focused on preparing user stories, setting data, and designing based on user-centric principles. The following seven days were dedicated to searching for formulas used in the application and creating a prototype. However, users encountered an obstacle when they could not generate PDF reports. The team then focused on overcoming this challenge, and finally, the application was successfully deployed.

Users survey

We meticulously gathered and stored user data in the comprehensive survey for insightful analysis. Employing a Likert scale ranging from 1 to 5, users expressed their opinions through categories: Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), and Strongly Agree (SA). The survey strategically delved into three pivotal dimensions: Design, Functionality, and Performance, each carefully identified and seamlessly incorporated into our assessment framework.

The survey was distributed using Google Forms, featuring a structured set of questions outlined in Table 2 to ensure a wide-reaching and user-friendly data collection process. This table comprises 15 thoughtfully formulated questions, aligning with the specified dimensions. Users, the key contributors to this endeavor, provided valuable feedback across these dimensions, shedding light on their experiences.

Table 2. User survey findings

Dimension	Questions	SD	D	N	A	SA
Design	1. The application features a straightforward and easily comprehensible interface design.	0%	0%	6.7%	20%	73.3%
	2. The navigation bar is well-suited to the app	0%	0%	6.7%	26.7%	66.7%
	3. The app is tailored for use by teachers/invigilators	0%	0%	0%	26.7%	73.3%
	4. The colors and visuals in the app look nice and go well together	0%	0%	6.7%	26.7%	66.7%
	5. The font style and size enhance the overall user experience positively	0%	0%	13.3%	33.3%	53.3%
Functionality	6. There aren't any errors encountered when accessing the app	0%	0%	13.3%	33.3%	53.3%
	7. The image upload feature works well and smoothly	0%	0%	6.7%	26.7%	66.7%

Performance	8.	The signature feature functions well and operates smoothly	0%	0%	6.7%	26.7%	66.7%
	9.	The app can be easily used to fill out forms	0%	0%	0%	40%	60%
	10.	The app facilitates the creation of PDF reports	0%	0%	13.3%	26.7%	60%
	11.	The app performs efficiently with prompt responsiveness during the operation	0%	0%	6.7%	26.7%	66.7%
	12.	The app doesn't slow down your phone	0%	0%	6.7%	26.7%	66.7%
	13.	The app doesn't significantly drain your device's battery	0%	0%	6.7%	26.7%	66.7%
	14.	The app effectively manages multiple users interacting simultaneously or during heavy usage	0%	0%	6.7%	33.3%	60%
	15.	No delays are observed when filling out the form	0%	0%	6.7%	33.3%	60%

The recent comprehensive user survey has highlighted areas for improvement in the application. Although 73.3% of users strongly agree that the interface is straightforward, suggesting positive design elements, there is room for enhancement. Notably, 20% of users express a neutral stance on the clarity of the interface, indicating the need for further refinement to ensure widespread user understanding. In terms of functionality, while smooth image uploads (66.7%) and ease in form filling (60%) receive positive feedback, the 53.3% reporting minimal errors suggests an improvement in error prevention. Additionally, 60% of users find the app conducive to generating PDF reports, which signifies functionality strengths and signals areas that can be refined for a more seamless experience. The performance dimension, while generally well-received, with 66.7% strongly agreeing on efficient operation, suggests potential areas of optimization, given that 6.7% of users noted delays when filling out forms. These insights will be pivotal in guiding targeted improvements to elevate the overall user experience.

Overall, the user satisfaction survey results indicate a high level of satisfaction, signifying the successful implementation of the application. It reinforces the understanding that the Scrum methodology and the use of the AppSheet platform contribute positively to the application development process, especially in the context of exam administration. In situations characterized by uncertainty, the primary benefit of the Scrum methodology becomes more evident, aligning with the findings that emphasise the improvement of the software development process in such situations research [31].

The study's comparative analysis between modernized and manual exam administration reveals significant advantages of the modernized approach. Developed using Scrum with AppSheet, the modernized exam took two weeks with a team of four, while the manual method lacked specific parameters. The modernized approach showed high task efficiency and user satisfaction, suggesting substantial time and resource savings compared to the manual method, as evident in Table 3. However, it should be noted that the cost comparison in this table is high for the manual method because Sekolah Indonesia Kota Kinabalu has 43 classes from elementary to high school levels. Therefore, if exams were conducted manually, the cost of exam administration would also be high due to expenses such as paper and ink purchases.

Table 3. Comparative analysis of modernized exam vs. manual exam administration

Aspect	Modernized Exam	Manual Exam
Time Needed	2 weeks	N/A
Resources Required	4 team members	More than 4 team members
Efficiency in Task Handling	High	Low
User Satisfaction	High	Low
Paper Usage	None	High
Storage Space	None (cloud-based)	Large physical storage
Data Search	Easy (digital-based)	Difficult (manual-based)
Cost	Free (using promo code)	High
Form Filling Time (time-consuming)	2 minutes average	5 minutes average
Flexibility	Reusable for future exams	Single use during exam
Customization	Flexible	Limited

Creating an application using the Scrum methodology is faster due to teamwork and alignment with user stories [32]. As a development method, it is easily controllable, flexible, and embraces a comprehensive development strategy where the entire team collaborates as a cohesive unit to achieve common goals [33]. The adaptability, responsiveness, and collaborative nature of Scrum empower the team to navigate changes seamlessly and promote a culture of continuous learning and improvement. The AppSheet platform, which employs a low-code development approach, further accelerates the development process, especially during

sprints, with the flexibility to adapt to user needs. This approach is also highly relevant in developing exam administration applications, enabling them to be adaptive to the evolving educational landscape.

However, it is important to acknowledge that there are other practical methods for creating applications using the AppSheet platform besides the Scrum method, each with its strengths and weaknesses. These include the Waterfall method, which is known for its sequential approach and thorough documentation but can be rigid and less adaptable to changes [34], [35] and the Rapid Application Development (RAD) Method, which emphasizes rapid prototyping [36] and user feedback but may lead to scope creep and increased complexity. Another method is Extreme Programming (XP), which focuses on frequent releases and customer involvement but lacks explicit project management practices [37]. Each of these methods offers unique advantages and challenges, and the choice of methodology should be based on the specific requirements and constraints of the project.

The effectiveness of the development can be attributed to several factors. Firstly, the Scrum methodology's iterative nature allowed for continuous application improvement and refinement. Daily Scrums facilitated communication and collaboration among team members [38], ensuring alignment with the project's goals. Using the low-code AppSheet platform also accelerated the development process, enabling quick iterations based on user feedback. However, implementing the Scrum methodology faced challenges, particularly in adapting to changing requirements and priorities. It required the team to be flexible and agile, often necessitating quick decisions and adjustments to the development process. One limitation of Scrum was its reliance on user stories as the main requirement source, which could sometimes be ambiguous or incomplete, leading to delays as the team clarified and refined the requirements. Moreover, the methodology's efficiency diminished in large-scale project development, reducing its effectiveness for such endeavors [39]. Nevertheless, the Scrum methodology proved instrumental in successfully developing the application, emphasizing collaboration, flexibility, and continuous improvement. The iterative nature of Scrum facilitated quick feedback loops [40], ensuring prompt resolution of issues or changes. Overall, the combination of Scrum and AppSheet provided a robust framework for developing the school exam administration application, highlighting their effectiveness in agile methodologies [41].

The development of the school exam administration application was a blend of technical expertise and user-centric design principles. These principles guided the entire development process, ensuring that the application fulfilled the school's administrative needs and offered a seamless and intuitive user experience. The team ensured that the application aligned with end users' preferences and expectations through user engagement, feedback collection, and iterative design. This user-centric approach is vital in educational settings, where usability and accessibility are paramount. Prioritizing user needs streamlined exam administration processes, enhancing efficiency and user-friendliness. Integration of user feedback emphasized the iterative nature of development, underscoring the significance of continuous improvement to meet evolving user needs. Ultimately, the application's success was attributed to incorporating user-centric design principles, ensuring it met functional requirements and delivered a superior user experience.

CONCLUSION

The successful implementation of the Scrum methodology, using user stories and developing use case diagrams, has proven to be a highly effective approach in crafting a tailored and efficient school exam administration application. The careful consideration given to the application's design and functionality, addressing specific requirements such as form-filling, data entry, PDF report generation, and user feedback collection, reflects a meticulous process aimed at meeting the intricate needs of the examination committee. Moreover, the user survey conducted throughout the development process has played a crucial role in gathering valuable insights, illuminating areas for improvement, and ensuring a user-centric approach to application development. This collective methodology has resulted in a comprehensive and adaptable solution for school exam administration, showcasing the success of agile methodologies and iterative development in delivering a robust and user-focused application.

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