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Application of Graph Colouring Algorithm in Course Scheduling Process

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A B S T R A C T

Scheduling is a crucial aspect in every occurrence, ensuring that all processes are orderly. Gema Nusantara Bukittinggi Health Vocational School currently utilizes Microsoft Excel for managing subject scheduling, which often leads to scheduling conflicts. The objective of this research is to develop a web-based subject scheduling system for Gema Nusantara Bukittinggi Health Vocational School. The outcome of this research is a web-based subject scheduling system that is valid, practical, and effective, thereby serving as a useful tool for subject scheduling. This research is classified as research and development (R&D). The system development follows an incremental model with four stages: analysis, design, coding, and testing. The product was evaluated through three types of tests: validity, practicality, and effectiveness. The validity test, conducted with three experts, yielded a value of 0.80, indicating validity. The practicality test, carried out with three practitioners, resulted in a value of 0.97, signifying high practicality. The effectiveness test, involving fifteen teachers, achieved a value of 0.95, demonstrating high effectiveness. Based on the product testing results, it can be concluded that the research product, which is a web-based scheduling system, is suitable for use in the subject scheduling process at Gema Nusantara Bukittinggi Health Vocational School.

1. Introduction

The subject scheduling information system is a system designed to provide information regarding teachers, classrooms, times, and subjects. This scheduling information system is developed as a tool to facilitate teaching schedules in a structured and efficient manner. Furthermore, the implementation of the subject scheduling system ensures that teaching and learning activities proceed smoothly, effectively, and efficiently[1]. Thus, the teaching and learning activities in the school can be conducted to their fullest potential[2].

Based on the observations conducted by the author at SMK Genus Bukittinggi, there are several factors affecting the preparation of subject schedules, notably the frequent occurrence of overlapping teaching hours, which the school is unable to address. Currently, subject scheduling at SMK Genus Bukittinggi is still managed manually by the curriculum department. The process involves the following steps: first, a meeting is held to allocate tasks among subject teachers. Second, the number of classes, the number of teachers at the school, and the number of teaching hours for each teacher are still determined manually. The limitations in the availability of subject teachers and the scheduling process require that the needs of the available classes be adequately met [3]. Conversely, with the large number of teachers available, the scheduling process must meet the teaching

hour requirements for the existing staff. This is particularly important as some teachers may have certification that mandates a minimum of 24 teaching hours.

To address the issues occurring at SMK Kesehatan Bukittinggi, this research employs the graph coloring algorithm approach. This graph is utilized in the scheduling of subjects through the application of graph coloring. Graph coloring is a well-known and intriguing subject within the field of graph theory. This graph technique is implemented in the scheduling system, where each teacher at SMK Kesehatan Gema Nusantara is assigned a different color. The purpose of implementing this graph is to prevent scheduling conflicts. For instance, Informatics teacher Huzar Dani, S.Pd is assigned the color green, while Suci Ramadani, S.Pd is assigned the color red. Both are Informatics teachers, and if they are scheduled to teach in the same class, one of them will be rejected[4]. Thus, the graph coloring technique will create a work schedule that maximizes outcomes in the most efficient manner.

This research designs a subject scheduling system using the PHP programming language. PHP (Hypertext Preprocessor) operates as an interpreter-based system rather than a compiler, utilizing a scripting language format [5]. The difference between a compiler and an interpreter language is as follows: A compiler language converts several program scripts into source code, which is then transformed into object code. In contrast, with an interpreter language, the raw script does not need to be converted into source code. The website template used is responsive, allowing it to adapt to various screen resolutions, while the Database Management System employed is MySQL[6].

2. Method

2.1. Type of research

The research and development method, commonly known as Research and Development (R&D), is the chosen methodology for this research. R&D is a research method used to produce specific products and to test the effectiveness of these methods [7]. This research method is the most relevant approach for this research. The system development example applied in this research represents the System Development Life Cycle (SDLC), also known in Indonesian as the life cycle in system development, which encompasses the stages from identifying problems, through processes, to finding solutions in developing a system.

2.2. Development Mod

The system development model used in this research follows the System Development Life Cycle (SDLC) with an incremental model, as illustrated in the stages shown in the image below. ***[8] :***

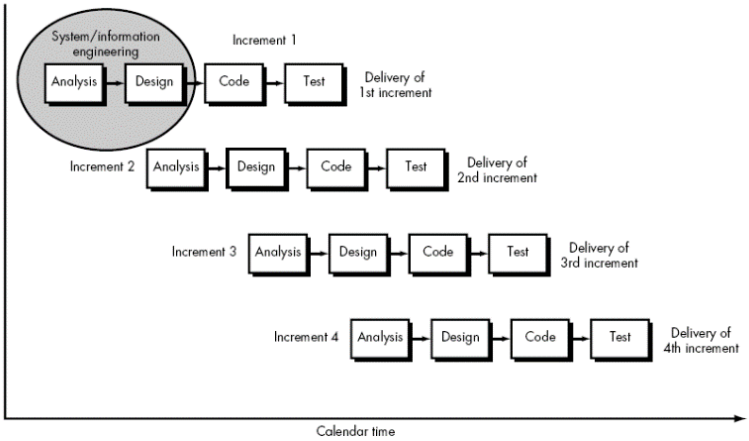

Figure 1. System Development Model

The stages of the Incremental SDLC model are as follows:

1. Analysis: This stage involves assessing the requirements for the system to be developed. It includes the evaluation of data needs, conducting interviews to understand the current processes, and identifying the necessary data. This analysis helps in evaluating both the existing system and the system to be developed.

2. Design: The design phase begins after the analysis of the new system has been completed. This stage involves designing the interface for the system.

3. Code: During this stage, the system is developed through coding, encompassing the system's requirements.

4. Test:This stage follows the coding phase, where the system is tested to ensure that it meets the desired specifications and requirements.

2.3. Research stage

The following are the stages in this research:

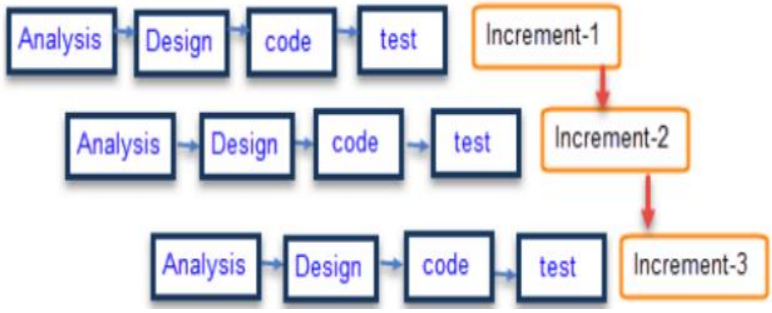

Figure 2. Research Stage Scheme

The explanation of the research stages is as follows:

1. Analysis: This stage involves assessing the requirements for the system to be developed. It includes evaluating data needs, conducting interviews to understand the ongoing processes, and identifying the necessary data. This analysis facilitates the evaluation of both the existing system and the system to be developed.

2. Design: The design stage follows the completion of the system analysis. At this stage, the interface design for the new system begins.

3. Code: In this stage, the system is developed through coding, incorporating the system's requirements.

4. Test: This stage occurs after the coding phase. The system is tested to ensure that it meets the desired specifications and requirements.

2.4. Product Test

This research involves product testing, which includes validity testing, practicality testing, and effectiveness testing. The instruments used in this testing process include questionnaires designed to assess validity, practicality, and effectiveness. [9].

The validity testing of the product was conducted by evaluating the product's validity through three experts who are competent in their respective fields. The validity testing utilized a questionnaire instrument that covered several assessment aspects: content validity, instructional design, appearance, and programming. The validated questionnaires were then processed using a validation formula based on Aiken's V formula, where the product is considered valid if it falls within the range of 0.60-1.00, and invalid if it scores below 0.60. For the product's practicality testing, a similar questionnaire instrument was employed, which was also validated by the three validators [10]. The practicality testing will determine whether the developed system provides ease of use for its users and is suitable for practical application. The analysis of practicality utilizes the kappa moment as follows [11] :

$$k = \frac{p - pe}{1 - pe}$$

Information:

k : Kappa moment that shows the practicality of the product

p : The proportion realized, calculated by dividing the number of marks given by the examiner by the maximum number.

pe : The proportion that is not realized, is calculated by subtracting the maximum value from the total value given by the examiner and dividing it by the maximum value.

Table 1. Practical References

Interval	Category
0,81-1,00	Very High
0,61-0,80	High
0,41-0,60	Medium
0,21-0,40	Low
0,01-0,20	Very Low
≤0,20	Not Practical

The effectiveness testing of the product will measure the alignment between the intended objectives and the actual outcomes of the product. A product that meets all the predetermined objectives can be deemed effective. Operationally, the design of this information system delivers results as expected. The effectiveness testing of the product is conducted using Richard R. Hake's statistical formula, with the following provisions: [12] :

$$< \text{g} >= \frac{(\% < Sf > - \% < Si >)}{(100 - \% < Si >)}$$

Explanation of the formula <g> : G-Score, <Sf> : final Score, <Si> : initial score. The conditions are as follows: high effectiveness if the value is >=0.7, medium effectiveness if the value is 0.7> (g)>0.3 and low effectiveness if the value is (g) <=0.3.

3. Results and Discussion

3.1. Analysis

In order to design a system, it is essential to go through an analysis phase. This phase involves identifying and examining the problems encountered during the design process of the subject scheduling system. Below is the class schedule board for Gema Nusantara Health Vocational School, which is currently managed using Microsoft Excel.

JADWAL PELAJARAN SEMESTER GANJIL

SMK GEMA NUSANTARA BUKITTINGGI TAHUN PELAJARAN 2023/2024

HARI	NO	JAM	FARMASI																							
			TEKNOLOGI FARMASI															FARMASI KLINIS								
			KELAS X						KELAS XI									KELAS XII								
			X FARMASI 1	KD	X FARMASI 2	KD	X FARMASI 3	KD	XI FARMASI 1	KD	XI FARMASI 2	KD	XI FARMASI 3	KD	XI FARMASI 4	KD		XII FARMASI 1	KD	XII FARMASI 2	KD	XII FARMASI 3	KD			
SENIN	1	07.30 - 08.15	FARMAKOLOGI	RV	B. INDONESIA		PAI	YN	KIMIA FARMASI	FT	SEJARAH	DR	BK		F. KOGNOSI	AU		PRAK. RESEP	LZ FL	RESPONSI	YN	B. INDONESIA	PT			
	2	08.15 - 09.00	II		II		II		II		II		II		II			II		II		II				
	3	09.00 - 09.45	SEJARAH		II	DS	II		BK		KFA		F. KOGNOSI		MTK			II		F. KOGNOSI		RESPONSI				
	4	09.54 - 10.30	II	DR	II		FARMAKOLOGI	RV	II		II	FT	II	AU	II	LL		B. INDONESIA	PT	II	YL	II	YN			
	5		I S T I R A H A T																							
	6	10.45 - 11.30	PAI	YN	SEJARAH	DR	II	RV	F. KOGNOSI	AU	B. INDO	RR	KFA	FT	II			II	PT	PRAK. RESEP	LZ FL	B. JEPANG	CA			
	7	11.30 - 12.15	II		II		B. INDONESIA	DS	II		II		II		RESPONSI	YN		BK		II		II				
	8		I S T I R A H A T																							
	9	12.45 - 13.30	II	YN	BK		II	DS	MTK		II	RR	SEJARAH	DR	II	YN		II		II		PRAK. RESEP	LZ FL			
	10	13.30 - 14.15	BK		FARMAKOLOGI	RV	II		II		PENJAS		II		KFA	FT		RESPONSI	YN	B. INDONESIA	PT	II				
	11	14.15 - 15.00	II		II		II		II		II		PENJAS		II			II		II		II				
SELASA	1	07.30 - 08.15	PKn	YL	PRAK. RESEP	WD YN	MULOK	RT	FARMAKOLOGI	RV	TEORI RESEP	FL	PAI	YN	PKK	DV		UU. FARMASI	LZ	MTK	AD	KFA	FT			
	2	08.15 - 09.00	II		II		II		II		II		II		II			II		II		II				
	3	09.00 - 09.45	PRAK. RESEP	WD YN	PKn	YL	INFORMATIKA	DN	TEORI RESEP	FL	FARMAKOLOGI	RV	II		II			KFA	FT	II		UU. FARMASI	LZ			
	4	09.54 - 10.30	II		II		II		II		II		B. INGGRIS	NV	BK			II		II		II				
	5		I S T I R A H A T																							
	6	10.45 - 11.30	INFORMATIKA	DN	PAI	YN	PKN	YL	PENJAS	JL	PKK	DV	II	NV	II			B. INGGRIS	NV	UU. FARMASI	LZ	BK				
	7	11.30 - 12.15	II		II		II		II		II		FARMAKOLOGI	RV	TEORI RESEP	FL		II		II		II				
	8		I S T I R A H A T																							
	9	12.45 - 13.30	B. INGGRIS	MR	II		PRAK. RESEP	WD YN	B. INDONESIA	RR	II		II	RV	II	FL		II	NV	KFA	FT	F. KOGNOSI	YL			
	10	13.30 - 14.15	II		INFORMATIKA	DN	II		II				TEORI RESEP	FL	PKn	YL		II		II		II				
	11	14.15 - 15.00	II		II		BK		II				II		II											
RABU	1	07.30 - 08.15	MULOK	RT	INFORMATIKA	DN	B. INGGRIS	MR	PRAK. RESEP	YN FL	MF	AL	B. INGGRIS	NV	FARMAKOLOGI	RV		F. KOGNOSI	YL	PAI	YN	MTK	AD			
	2	08.15 - 09.00	II		II		II		II		II		II		II			II		II		II				
	3	09.00 - 09.45	INFORMATIKA	DN	SINONIM	HF	II		SEJARAH	DR	PRAK. RESEP	YN FL	MF	AL	B. INDONESIA	PT		FARMAKOLOGI	RV	II		II				
	4	09.54 - 10.30	II		II		II		II		II		II		II			II		BK		II				
	5		I S T I R A H A T																							
	6	10.45 - 11.30	SINONIM	HF	MULOK	RT	INFORMATIKA	DN	MF	AL	PAI	YN FL	PRAK. RESEP	YN FL	II			MTK	AD	II						
	7	11.30 - 12.15	II		II		II		II		II		II		SEJARAH	DR		II		FARMAKOLOGI	RV	K3LH		SJ		
	8		I S T I R A H A T																							

Figure 3. Subject Schedule Board of Gema Nusantara Health Vocational School, Bukittinggi

3.2. Design

In the design phase, the author will develop a system tailored to the school's needs, aimed at facilitating the vice principal of curriculum and the administrative staff in the process of scheduling subjects, ensuring that the outcomes align with expectations.

3.2.1. General System Design

The general system design is as follows [13] : Use case diagram: The design of the use case diagram for the subject scheduling system provides a global overview of the subject scheduling system. The use case diagram is utilized to represent the interaction between all users and the system's components. Below is the use case diagram for the subject scheduling process.

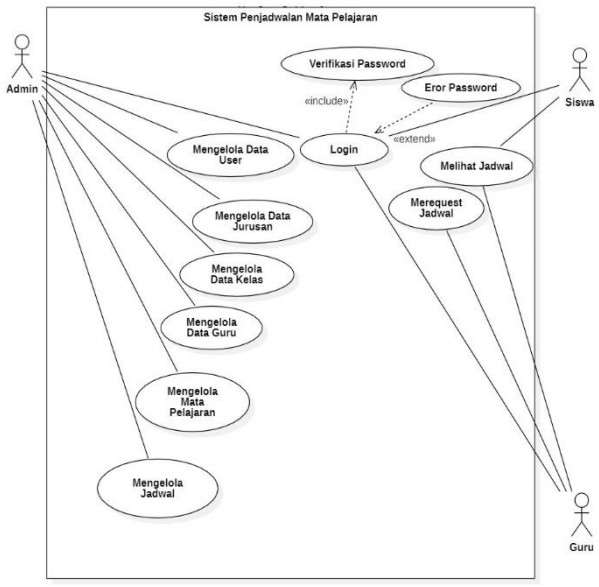

Figure 4. Use Case Diagram of Subject Scheduling System

Based on the use case diagram above, it can be observed that there are three actors: the admin, the teacher, and the student. There are eleven actions depicted, starting with logging in, followed by password verification. If an error occurs, the user will be prompted to log in again. The diagram shows that the admin can manage user data, department data, class data, teacher data, subject data, and schedules. Teachers have the ability to perform two actions: requesting schedules and viewing schedules, while students can only view schedules.

Activity Diagram: The activity diagram describes the activities that occur within the system [14]. The activity diagram illustrates the initiation of an activity, the conditions or decisions that may occur within the system, and how an activity concludes.

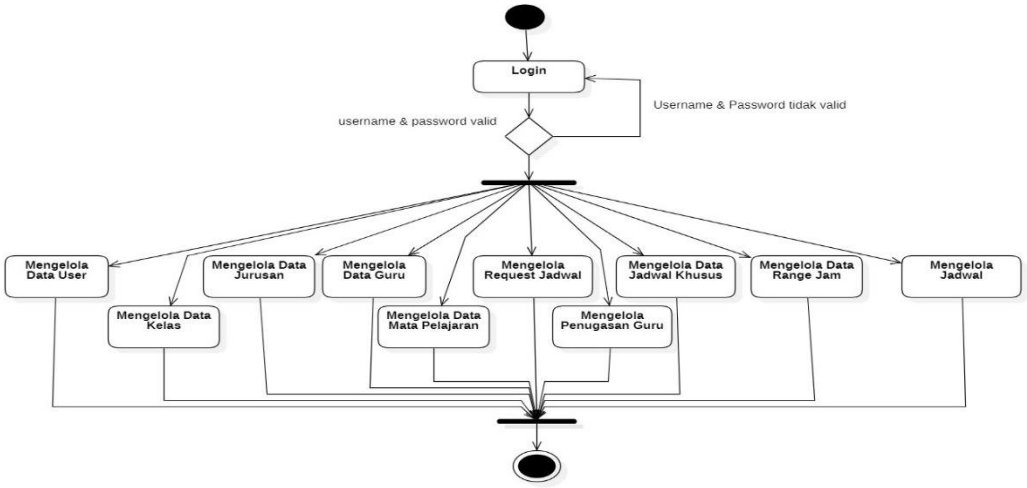

Figure 5. Admin Activity Diagram

The activity diagram for the admin, as depicted in the diagram, shows the activities performed by the admin. These activities include managing user data, managing class data, managing department data, managing teacher data, managing subject data, managing schedule requests, managing teacher assignments, managing special schedule data, managing time range data, and managing the schedule.

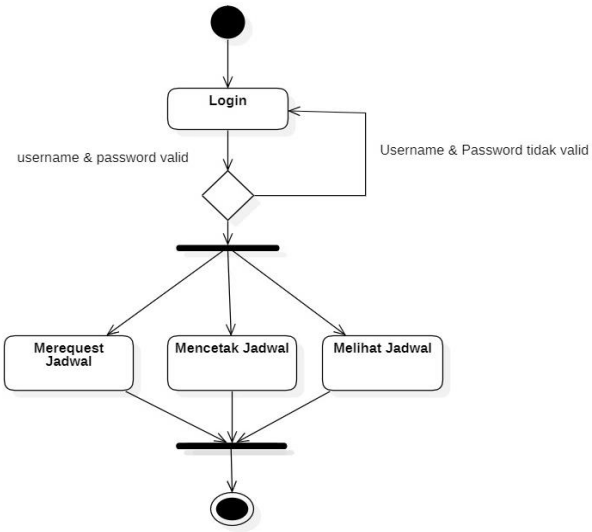

Figure 6. Teacher Activity Diagram

In the activity diagram above, the teacher can see that the activities carried out by the teacher are: the teacher requests the schedule and views the schedule.

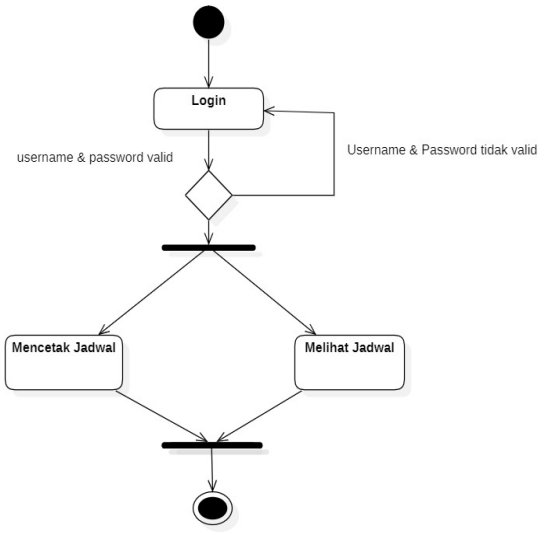

Figure 7. Student Activity Diagram

The activity diagram for students, as depicted in the above diagram, shows that students perform the following activities: logging into the system, and then carrying out two actions: printing and viewing the schedule.

The sequence diagram illustrates the interactions between objects within the system [15]. The sequence diagram is used to depict a series of steps performed in response to an event to produce a specific output. Below is the sequence diagram for the subject scheduling system.

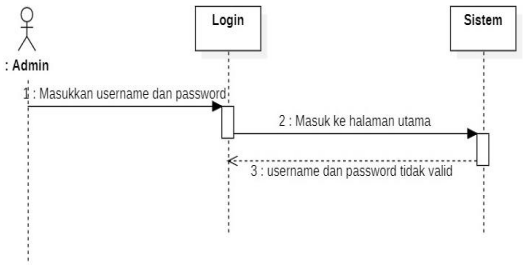

Figure 8. Login Sequence Diagram

From the image above, it is clear that the login form can be used by three users, namely admin, teacher and student, to enter the system.

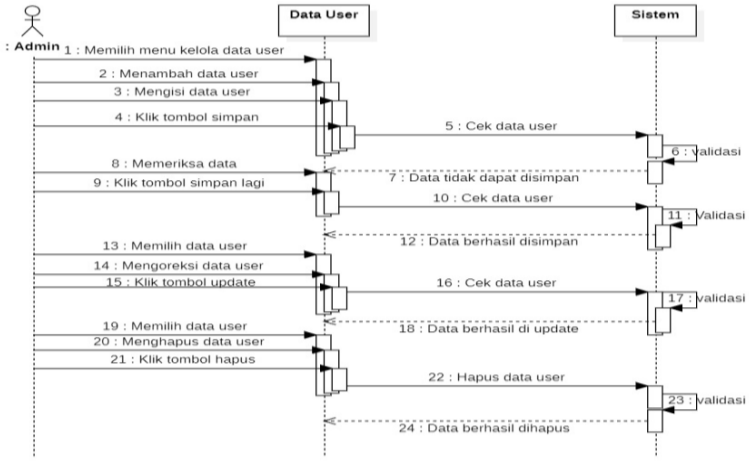

Figure 9. Sequence Diagram of User Data

The sequence diagram for managing user data involves one actor: the admin. In this system, only the admin can manage users by adding user data, entering user information, and saving it. The system will then verify the entered data. If an error message is displayed indicating that the data cannot be saved, the admin will review the user data again and click the save button. The system will recheck the corrected user data, and if the data is successfully saved, the admin can select user data to update or delete as needed.

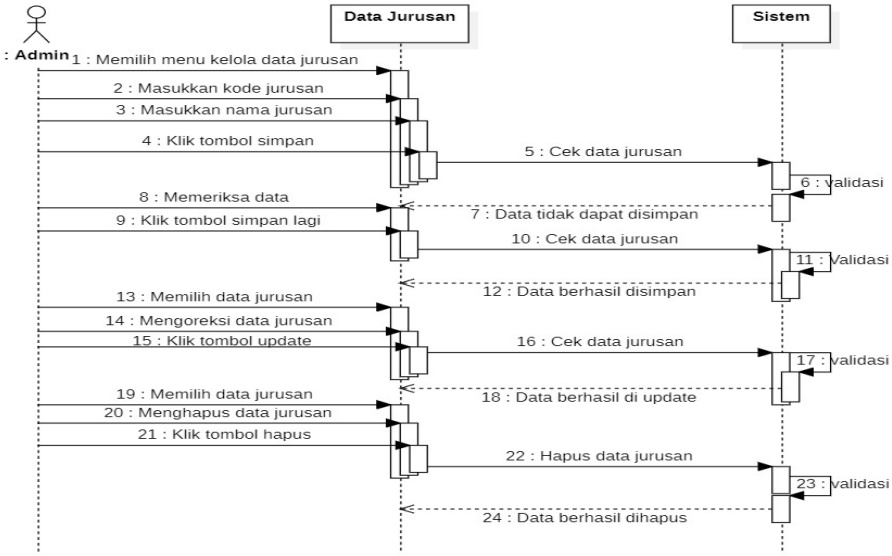

Figure 10. Sequence Diagram of Department Data

The sequence diagram for managing departments involves one actor: the admin. In this system, only the admin can manage department data by adding department information, entering the data, and saving it. The system will then verify the entered data. If an error message appears indicating that the data cannot be saved, the admin will review the data again and click the save button. The system will recheck the corrected department data, and if the data is successfully saved, the admin can select department data to update or delete as necessary..

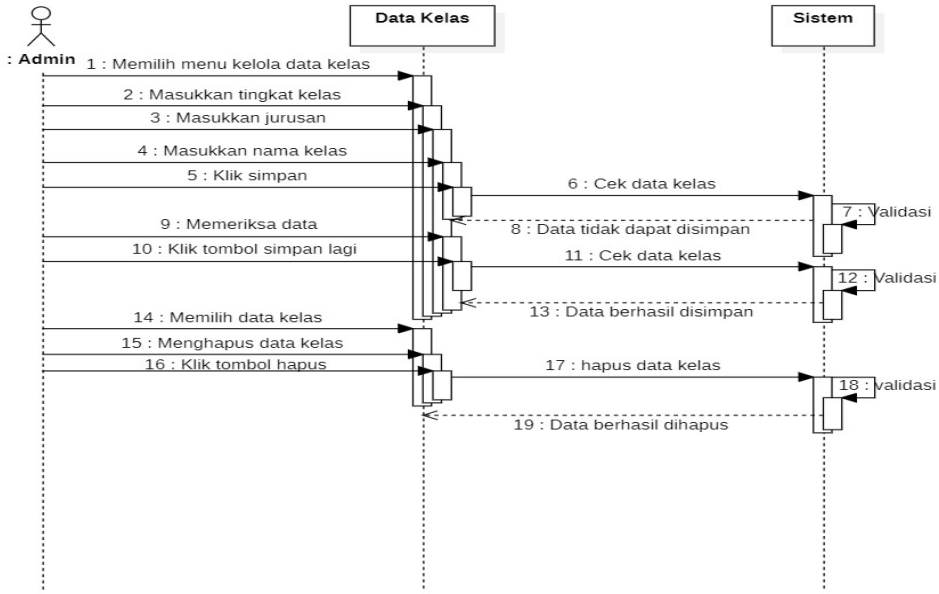

Figure 11. Class Data Sequence Diagram

The sequence diagram for managing class data involves one actor: the admin. In this system, only the admin can manage class data by adding class information, entering the data, and saving it. The system will then verify the entered data. If an error message appears indicating that the data cannot be saved, the

admin will review the data again and click the save button. If there are incorrect or unnecessary class data, the admin can delete the data as needed..

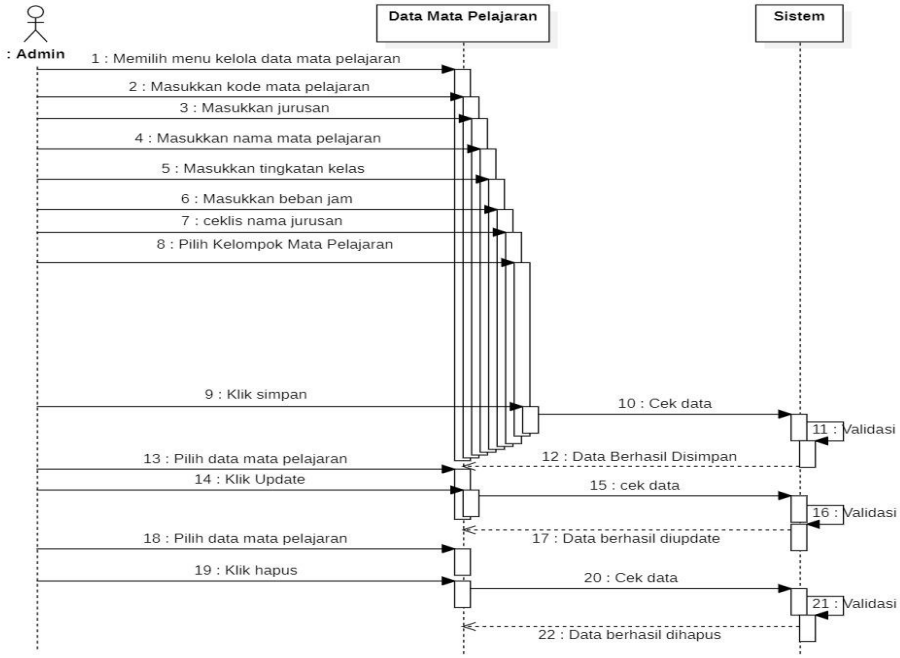

Figure 12. Sequence Diagram of Subject Data

The sequence diagram for managing subject data involves one actor: the admin. In this system, only the admin can manage subject data by inputting the subject code, subject name, class level, credit hours, department, and subject group, and then saving the information. The system will verify the entered data, and if the data is successfully saved, the input data will be displayed. To modify the data, the admin selects the data to be updated and clicks the update button. The system will validate the data according to the input. Data that is no longer needed will be deleted by the system through the delete button.

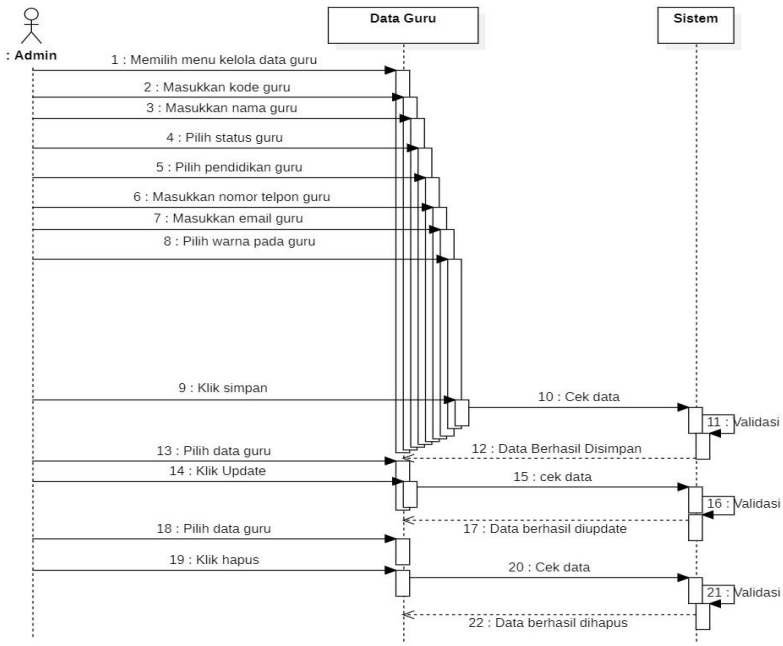

Figure 13. Teacher Data Sequence Diagram

The sequence diagram for managing teacher data involves one actor: the admin. In this system, only the admin can manage teacher data by inputting the teacher code, teacher name, teacher status, teacher education, phone number, email, and color. Once the data is successfully input into the system, it will be verified. If the data is successfully saved, it will be displayed. To modify the data, the admin selects the data to be updated and clicks the update button. The system will validate the data according to the input. Data that is no longer needed will be deleted by the system through the delete button.

Class Diagram: This diagram is commonly found in object-oriented system modeling. It illustrates the relationships between entities within the system. Each entity has attributes such as key attributes and descriptive attributes. Class diagrams typically include active classes. In the subject scheduling system, there are eleven classes depicted in the diagram.

3.2.2. Detailed System Design

The detailed system design is as follows. Input design includes the following forms: login form, user data addition form, department data addition form, class data addition form, subject data addition form, teacher data addition form, schedule request addition form, teacher assignment data addition form, special schedule data addition form, and scheduling form. The design of the login form is illustrated in the image below.

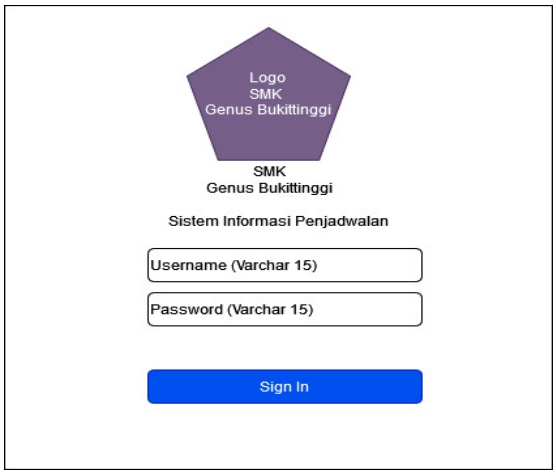

Figure 14. Login Form Input Design

The next input design is the department data addition form. This data entry page is used to input the department code and department name. Below is the display of the department data entry form:

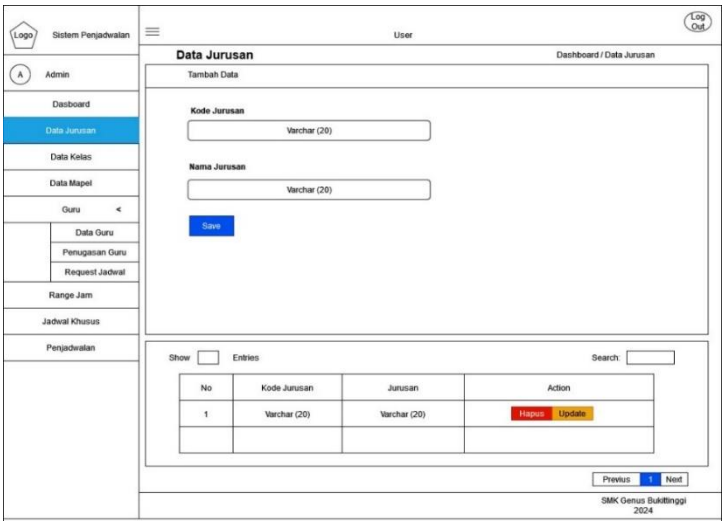

Figure 15. Department Data Input Design

Next is the class data entry. The class data entry page is used to input the class level, department, and class name. Below is the display of the class data entry form:

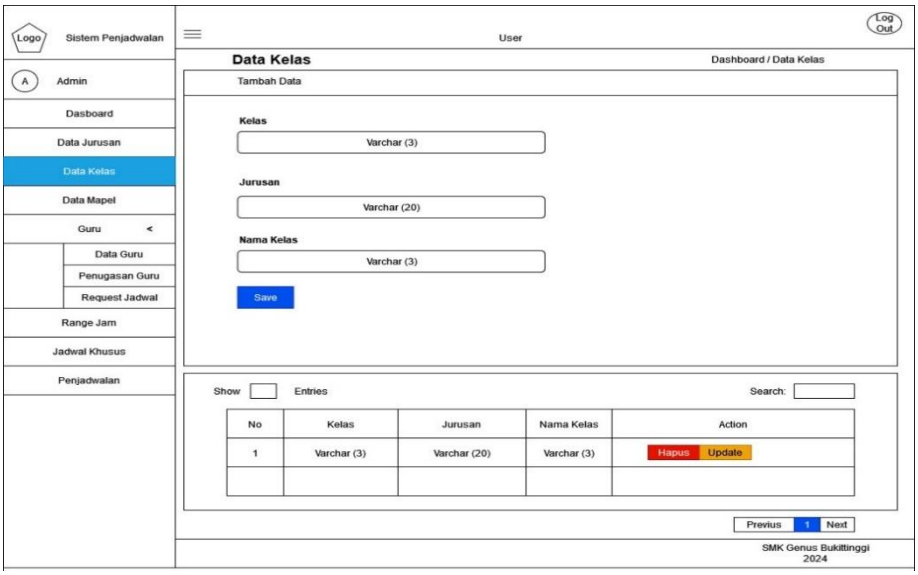

Figure 16. Class Data Input Design

Next is the subject data entry. The subject data entry page is used to input the subject code, subject name, class, credit hours for the subject, department, and subject group. Below is the display of the subject data entry form:

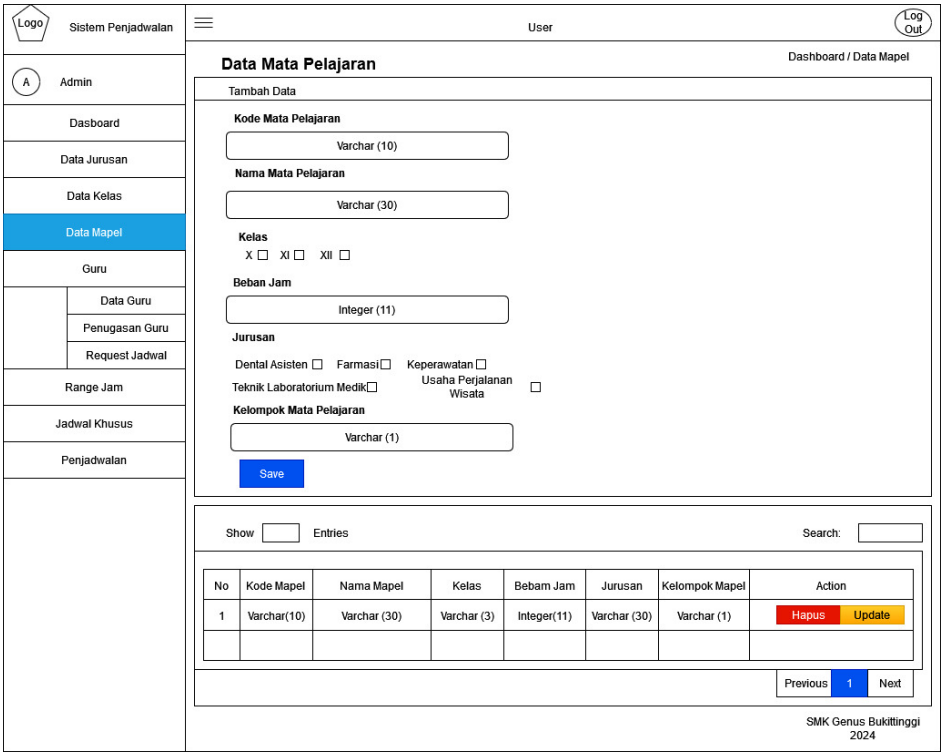

Figure 17. Subject Data Input Design

Next is the teacher data entry. The teacher data entry page is used to input the teacher code, teacher name, teacher status, most recent educational background, phone number, email, and color associated with the teacher according to the department at SMK Genus Bukittinggi. Below is the display of the teacher data entry page:

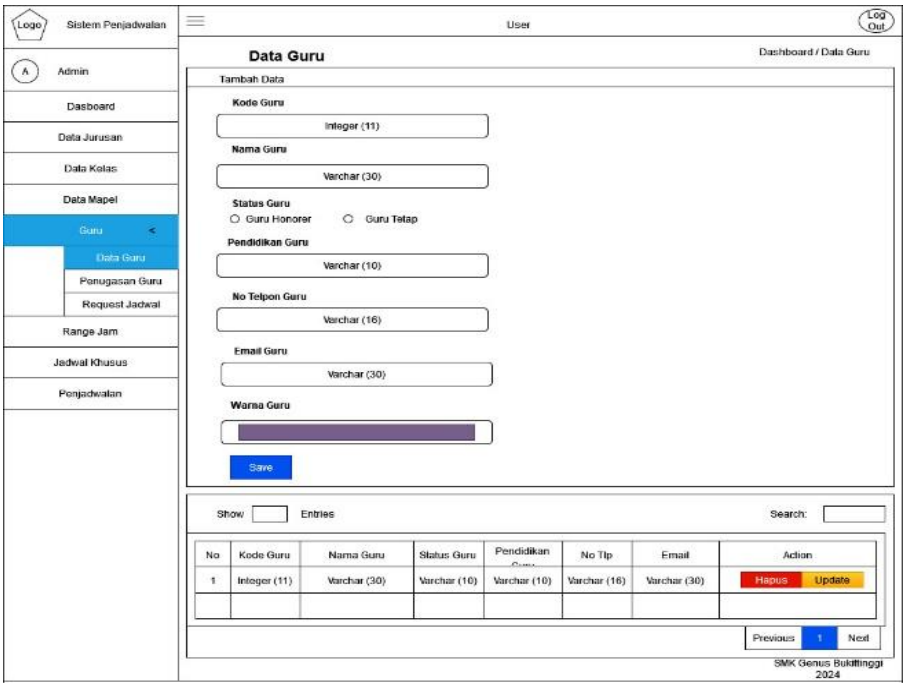

Figure 18. Teacher Data Input Design

The next data input involves teacher assignment data. The teacher assignment data entry page is used to input the teacher's name in accordance with the classes previously entered. Below is the display of the teacher assignment data entry page:

Figure 19. Teacher Assignment Data Input Design

The next data input involves schedule request data. The schedule request data entry page is used to input the teacher's name and the day specified by the curriculum vice principal and administrative staff, as determined by the teachers' meeting. Below is the display of the schedule request data entry page:

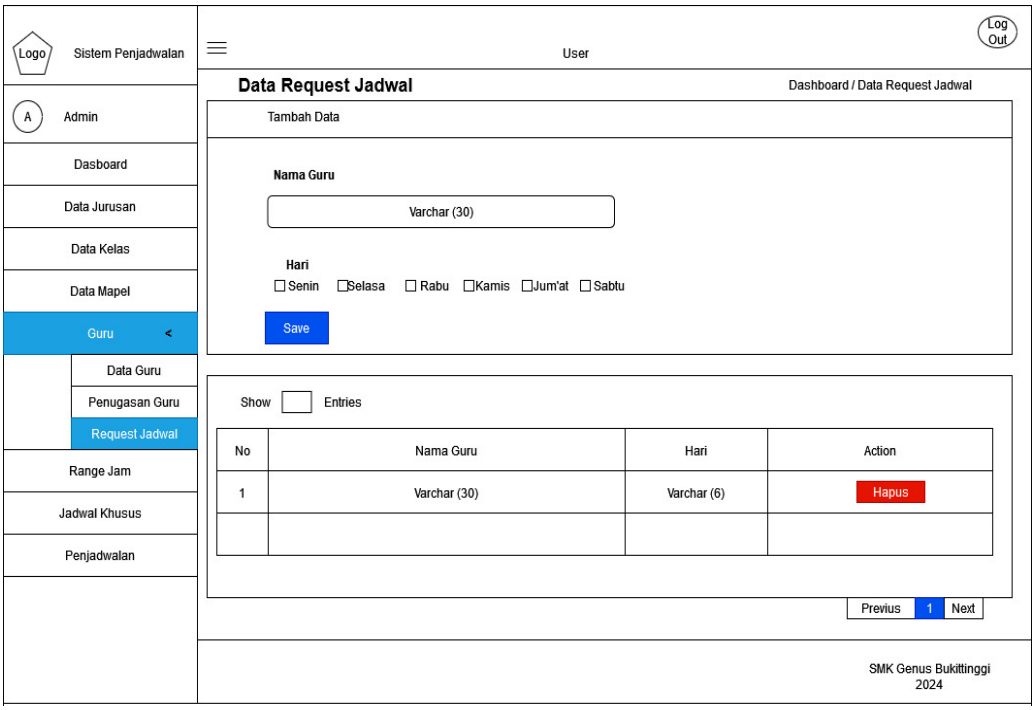

Figure 20. Request Schedule Data Input Design

Next is the input for time range data. The time range data entry page is used to input the day, number of sessions per day, and time per session. Below is the display of the time range data entry page:

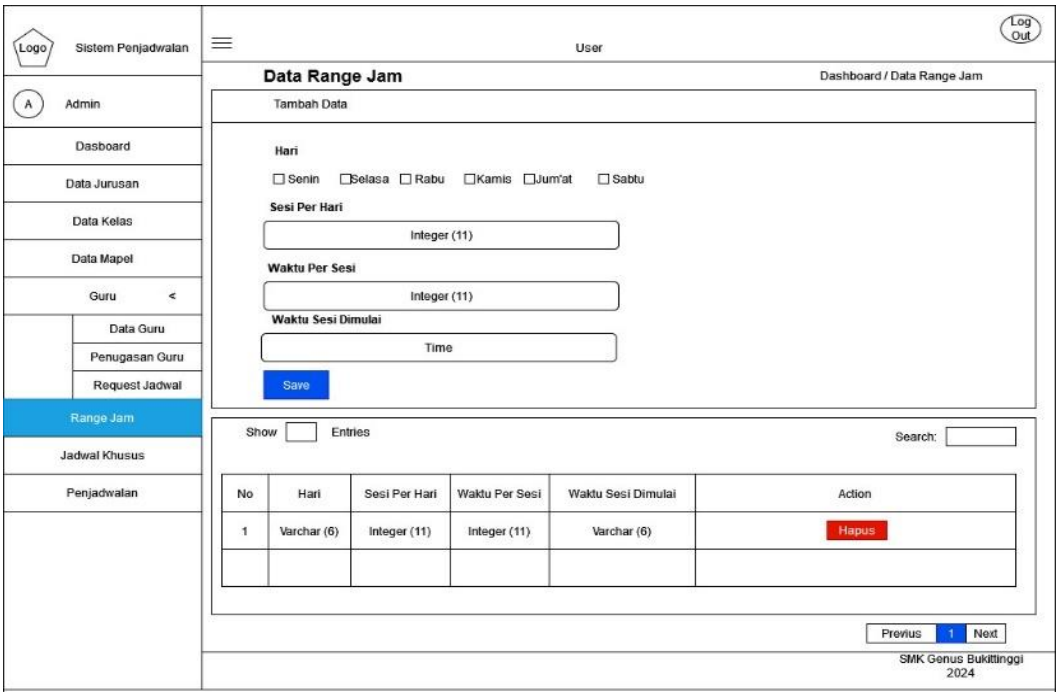

Figure 21. Hour Range Data Input Design

Next is the input for special schedule data. The special schedule data entry page is used to input the day, class, description, session number, and duration. This special schedule data includes items such as break times or extracurricular activities. Below is the display of the special schedule data entry page:

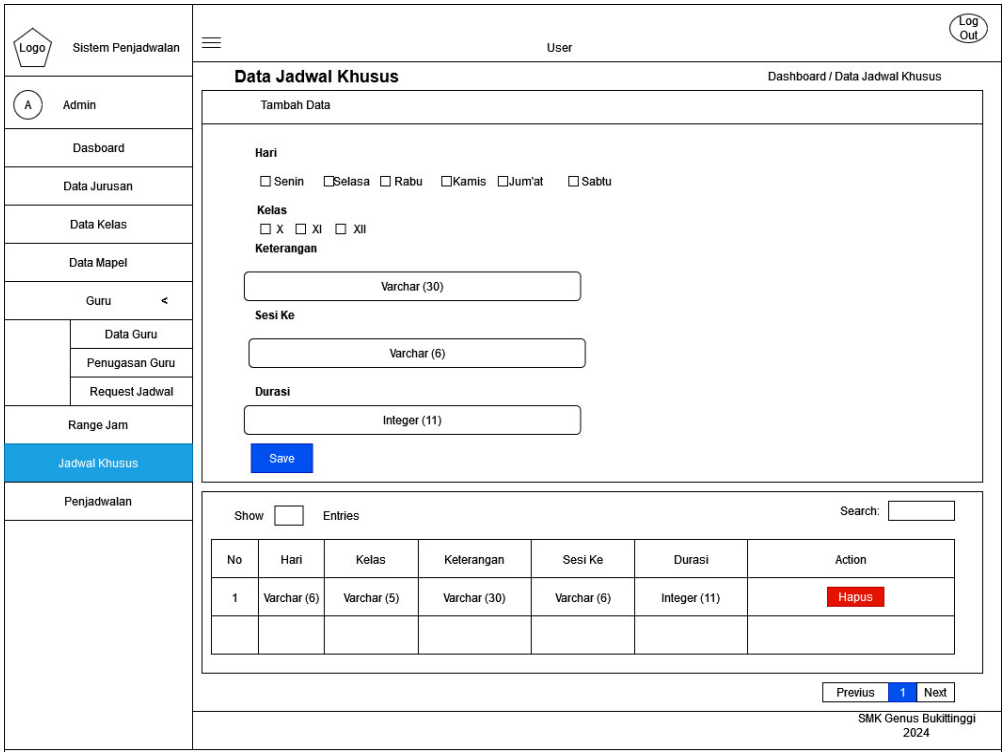

Figure 22. Special Schedule Data Input Design

Next is the input for user data. The user data entry page is used to input the username, password, and user role. Below is the display of the user data entry page:

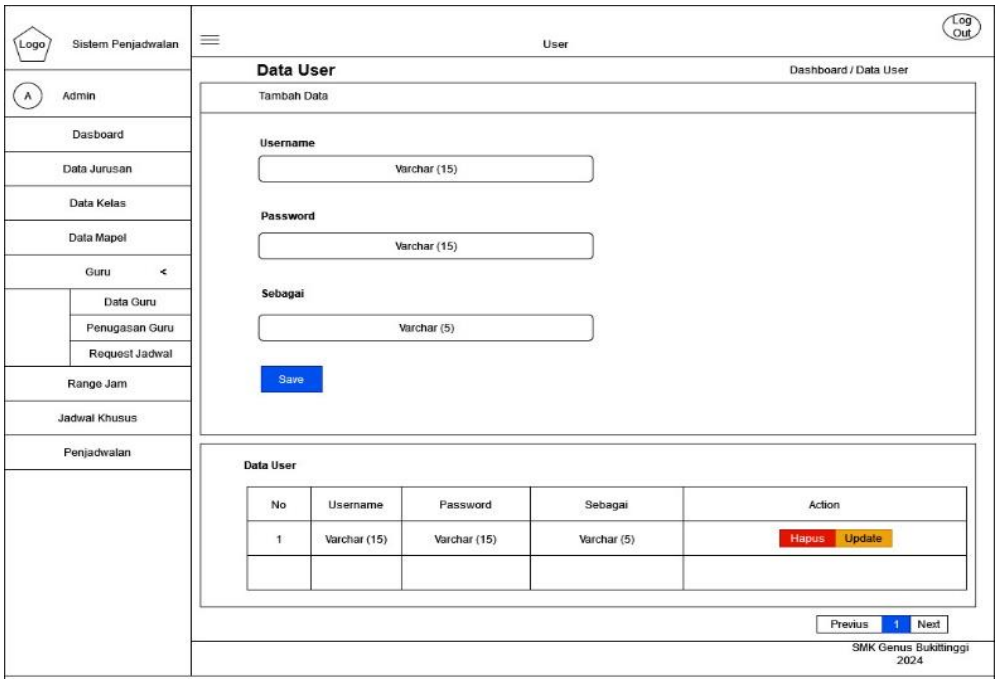

Figure 23. User Data Input Design

3.3. Code

The steps involved are translating the designed layout into a program or implementing the system design based on the established design.

3.4. Test

Testing is the phase of evaluating the system in an integrated and comprehensive manner after the integration of all system components [16]. If errors are found in the system, system corrections will be made, and once the program is functioning correctly, it will be deployed (distribution). Black-box testing is conducted to evaluate the software interface, aiming to ensure that all functions operate correctly as specified. Below is the table for testing using the Black-box testing method.

Table 2. Table of Test Results with Blackbox Testing

No	Design and Process	Expected	Information
1	Open the login page	Display login page for admin, teacher and student	Succeed
2	Enter username and password	Display main page	Succeed
3	Click User	Display user data input form	Succeed
4	Click the delete button on the user page	Data deleted	Succeed
5	Click the update button on the user page	Data updated	Succeed
6	Click the department data menu	Display department data input form	Succeed
7	Click the delete button on the department data page	Data deleted	Succeed
8	Click the update button on the department data page	Data updated	Succeed
9	Click the class data menu	Display class data input form	Succeed
10	Click the delete button on the class data page	Data deleted	Succeed
11	Click the subject data menu	Display maple data input form	Succeed
12	Click the delete button on the subject data page	Data deleted	Succeed
13	Click the update button on the subject data page	Data updated	Succeed
14	Click the Teacher menu	Display teacher data sub menu, teacher assignment, and schedule request	Succeed
15	Click the teacher data sub menu	Display teacher data input form	Succeed
16	Click the delete button on the teacher data page	Data deleted	Succeed
17	Click the update button on the teacher data page	Data updated	Succeed
18	Click the teacher assignment sub menu	Display teacher assignment data input form	Succeed
19	Click the delete button on the teacher assignment page	Data deleted	Succeed

No	Design and Process	Expected	Information
20	Click the request schedule sub menu	Display request schedule data input form	Succeed
21	Click the delete button on the schedule determination data page	Data deleted	Succeed
22	Click the hour range menu	Display hour range data input form	Succeed
23	Click the delete button on the hour range data page	Data deleted	Succeed
24	Click the special schedule menu	Display special schedule data input form	Succeed
25	Click the delete button on the special schedule data page	Data deleted	Succeed
26	Click the scheduling menu	Display scheduling board	Succeed
27	Click create schedule	Display schedule board	Succeed
28	Export scheduling	Data exported	Succeed
29	Export teacher data	Data exported	Succeed
30	Reset scheduling	Schedule reset	Succeed

3.5. Product Test

After the system has been successfully implemented, the next phase involves product testing, including validity testing. Validity testing utilizes a questionnaire instrument comprising three aspects: content, construct, and language. This test is administered to three experts: Mr. Riri Okra, M.Kom, Mrs. Gusnita Darmawati, S.Pd, M.Kom, and Mrs. Miftahul Khairi, S.Pd. Below are the details of the validity testing data.

Table 3. Validity Test Results

No	Validator	Validation	Average value
1	Riri Okra, M.Kom	Content	0,81
2	Gusnita Darmawati, S.Pd, M.Kom	Construction	0,85
3	Miftahul Khairi, S.Pd	Language	0,75
	Total		2,41
	Average		0,80
	Criteria		Valid

The practicality testing was conducted with three teachers serving as school administrators: Mrs. Devi Asra, S.Pd, Mrs. Irmawati, S.Pd, and Mrs. Miftahul Khairi, S.Pd. Below are the results of the product's practicality testing:

Table 4. Practicality Test Results

	Assessor			
No	Devi Asra, S.Pd	Irmawati, S.Pd	Miftahul Khairi, S.Pd	Max score
Item 1	5	5	4	5
Item 2	5	5	5	5
Item 3	4	5	5	5

No	Assessor			Max score
	Devi Asra, S.Pd	Irmawati, S.Pd	Miftahul Khairi, S.Pd	
Item 4	5	5	5	5
Item 5	5	5	5	5
Item 6	5	5	4	5
Item 7	5	5	5	5
Item 8	5	5	5	5
P	0,97	1	0,95	Total = 2,92
Pe	0,02	0	0,05	Average = 0,97
K	0,97	1	0,94	

The product effectiveness test was aimed at 15 teachers, the following is data from 15 teachers in the effectiveness test:

Table 5. Results of Effectiveness Test

No	Assessor	Before (Si)	After (Sf)	Gain Score (G)	Indicators Effectiveness
1	Miftahul Khairi, S.Pd	64	88	0,95	Very Effective
2	Nova Susanti, S.Pd.I	56	100	0,95	Very Effective
3	Apt.Sarniva, S.Farm	64	96	0,95	Very Effective
4	Meri Susanti, SS	40	100	0,95	Very Effective
5	Ns. Okta Handayana	48	100	0,95	Very Effective
6	Rahmawati, S.Pd	100	98	0,95	Very Effective
7	Ade Ermayanti, S.Pd	43,3	96	0,95	Very Effective
8	Tari Sundari, S.Pd	56	100	0,95	Very Effective
9	Najeli Engla Hasyasa	48	100	0,95	Very Effective
10	Loura Angraini, S.Hum	60	96	0,95	Very Effective
11	Intan Putri Mardatillah, S.Tr.Par	40	100	0,95	Very Effective
12	Desi Erlina Sari, S.Pd	20	96	0,95	Very Effective
13	Zahrani, S.Pd	56	96	0,95	Very Effective
14	Lola Manda Sari, S.Pd	68	100	0,95	Very Effective
15	Miza Zonika, S.Pd	60	100	0,95	Very Effective

4. Conclusion

This research produced a web-based subject scheduling system for SMK Kesehatan Gema Nusantara Bukittinggi. The system has been tested by experts, yielding a validity score of 0.80, indicating that it is valid. Practicality testing resulted in a score of 0.97, indicating that the system is highly practical. Effectiveness testing, conducted with 15 teachers, resulted in a score of 0.95, demonstrating that the system is highly effective. Based on the results of the product testing, it can be concluded that the subject scheduling information system, which is the outcome of this research, is suitable for implementation at SMK Kesehatan Gema Nusantara Bukittinggi. The system can assist administrative staff and the curriculum vice principal in scheduling subjects, while also allowing teachers to request teaching schedules and students to access the schedules once they have been entered by the administrative staff.

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