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Development of Web-Based Industrial Revolution 4.0 Implementation Monitoring System Prototype for Academic Programmes

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Universiti Malaysia Sarawak has moved forward to transform the conventional academic curriculum in line with Industrial Revolution 4.0 and the Ministry of Education's aspiration for future-ready curriculum transformation in academic programmes. The process of monitoring the implementation of Curriculum 4.0 in UNIMAS academic programmes involved a significant number of documents that are done manually due to records being kept in writing, printed using files and manual form. Thus, access to information is less organised, time consumed and require storage space. Furthermore, unsystematic, ununiform reporting on transformative teaching and learning with different formatting. A proposed system is developed by using Unified Modelling Language that consists of Use–Case Diagrams, Activity Diagram and Sequence Diagrams to interact between the users. In this prototype, all lecturers are required to fill in 14 criteria covering future-ready curricula such as curriculum structure, transformative learning teaching delivery, and alternative assessments. This system replaced the manual way of managing to monitoring, recording, analysing, and reporting the implementation of curriculum 4.0 elements and criteria in academic programmes including the transformative learning and teaching delivery practices. Furthermore, this proposed system is more efficient, accurate and user-friendly compared to manual implementation.

Keywords: Industrial Revolution 4.0 criteria; web-based Monitoring system; Unified Modelling Language; OBE

I. INTRODUCTION

Industrial Revolution 4.0 (IR 4.0) is a global stepping stone for equipping future generation with the current and trending skills and knowledge to meet future world. The IR 4.0 has been dominating the world and human system that revolves with technology such as Internet of things (IoT), Information Computer Technology (ICT) and cyber-physical systems (D'Souza & Mudin, 2018; Umachandran *et. al.,* 2018). As IR 4.0 becomes reality, Education 4.0 gives a big impact to researchers, educators and students to adapt the current situation.

In 2016, all UNIMAS initiative were successfully accomplished to ensure all academic programmes in UNIMAS were compliant with Outcome-Based Education (UNIMAS, 2019). Another initiative is to redesign all academic programmes at UNIMAS to be innovative and IR4.0 compliant programs. In 2018, UNIMAS has set fourteen IR4.0 criteria to be implemented in the academic programmes. There are ten faculties with 59 undergraduate and postgraduate programmes at UNIMAS. Curriculum program monitoring was executed by the Center for Academic Development and Management (CADM) manually using a paper form in which the lecturers were required to fill

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and make submission to CADM. There are fourteen (14) criteria listed in a form that is primarily to check the opinions and suggestions of lecturers about the syllabus and courses offered in the academic programmes against IR 4.0. The form is fourteen pages document and it is too thick and tedious which can result in inefficiencies, data errors, and time-consuming for CADM staff to monitor, enter and calculate criteria mapped to the programme. To ensure a holistic implementation of IR 4.0 criteria for academic programmes at UNIMAS, a web-based IR4.0 implementation monitoring system (IR4IMoS) is proposed. IR4IMoS is a web-based system developed to monitor the implementation of 4.0 curriculum elements and criteria in academic programmes. In this system, it is used to record, monitor and report the IR4.0 criteria in academic programmes including the transformative learning and teaching delivery practice. The users and administrators filled in the curriculum 4.0 criteria form online and the data were stored in database. Moreover, the IR4IMoS also expedites the process of calculating the percentage of curriculum IR 4.0 implementation in courses and academic programmes. The pattern of selected curriculum IR 4.0 criteria by the faculties, and the practice of curriculum IR 4.0 in academic programmes can be determined using IR4ImoS, thus allowing the university to monitor the practice of Curriculum IR 4.0 by the academic programmes in UNIMAS. A few studies has been adapt similar features with this project such as web based, print, platform-friendly, login page, implementation cost reasonable and logout (Sunehra D & Ramakrishna P, 2016; Lalas G & Marcial DE, 2016; Adagale *et al.,* 2016). However, these studies (Sunehra D & Ramakrishna P, 2016; Lalas G & Marcial DE, 2016; Adagale *et al.,* 2016) have different application, purpose and methodology used in the system.

The problems and limitations of the project were discussed in Section I. In Section II, Section III and Section IV, the prototype development, implementation and result analysis related to prototype to solve the mentioned problems were explained. Conclusion and future work is explained in Section V.

II. METHODOLOGY

In this project, object-oriented systems analysis and design has been adapted to run the system development that must change rapidly. In the software industry, object-oriented methodologies are often used. It breaks down the system into a use case model using the unified modelling language (UML) as depicted in Figure 1.

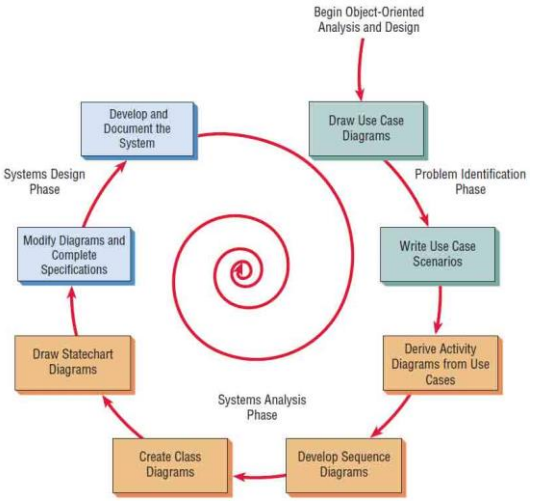

Figure 1. Steps in the UML development process.

A. Define the Use Case Model

First, the actors are identified by the analyst and the key events initiated by the actors. The actors in the Use Case Diagram are the Administrators and Users where the actors can be any stakeholders, whether an organisation, person, device or external system that interacts directly with the system (Sunehra & Ramakrishna, 2016; Nurmoslim *et. al.* 2017; Vino & Rubby, 2018). The Use Case Diagram is used to show the proposed system functionality to the user. It is a simple and powerful strategy for determining the nature of an important system as mentioned by (Solet *et al.,* 2010). As for the IR4IMoS, CADM staffs are the administrators and the lecturers are users of this system. There are six matching functions namely login, select criteria, fill a form, update criteria form, delete criteria form, print summary, and log out as shown in Table 1. Users from different faculties cannot select and print summaries from other faculties. It can only be done by the administrators and the faculty themselves. Figure 2 illustrates the Use Case Diagram for IR4IMoS.

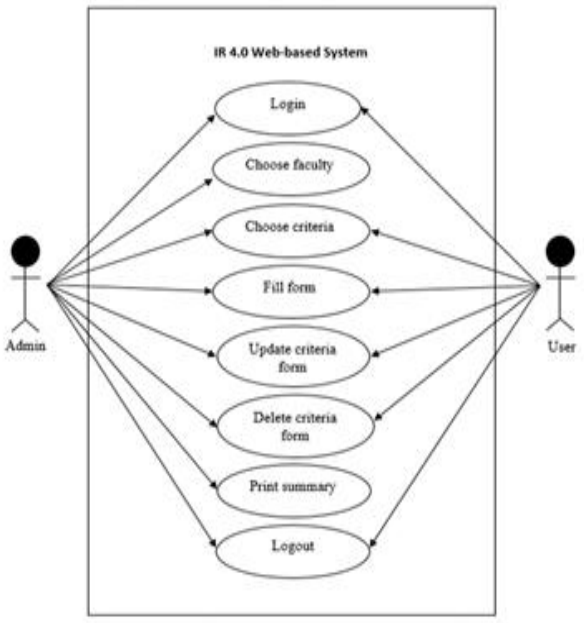

Figure 2. Use Case Diagram of IR4ImoS

B. Drawing UML Diagrams

In this phase, an Activity Diagram is produced, which illustrates all the main activities in the use case. A sequence diagram is created for each use case to describe the process that the user will be expected to go through when using the proposed system, the interactions that the user needs to perform, and some of the messages that the user will receive from the system after completing the interaction (Hussin, 2018).

Table 1. Function Description

Function	Description
Login	A username and password that allows a person to access to the web system
Choose Faculty	Choose faculty involved
Choose criteria	Select a criteria from the fourteen criteria that were listed
Fill form	Complete the form with the necessary information
Update criteria	The form that has been filled and saved will be stored in the database
Delete criteria	Remove unwanted criteria in the form
Print summary	Print all the summary report of all filled criteria
Logout	End a connection to the web system

All the functions in IR4IMoS have their respective sequence diagram. The sequence diagram for the login function is shown in Figure 3, where the user will open a web browser and go to the system website. Users can access the system once they enter their username and password.

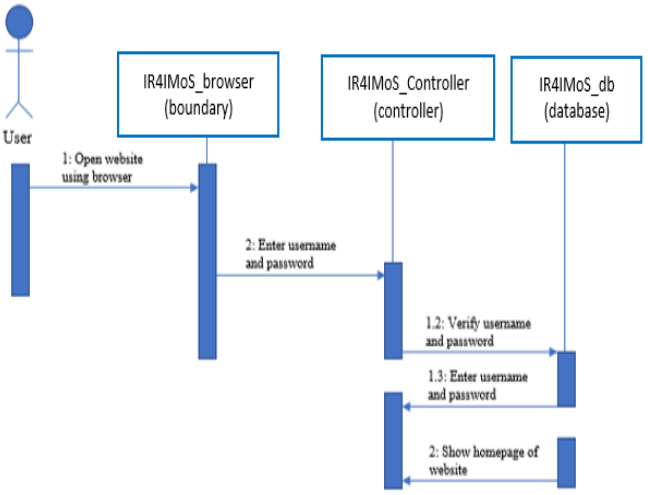

Figure 3. User Login Sequence Diagram

For the criteria form page, the user can select one of the fourteen criteria provided in the form. The user has to fill in the criteria form with the required data as shown in Figure 4. Then, the form will be saved in the database after clicking the save button. Completed criteria summaries and reports can be viewed by the administrators and users.

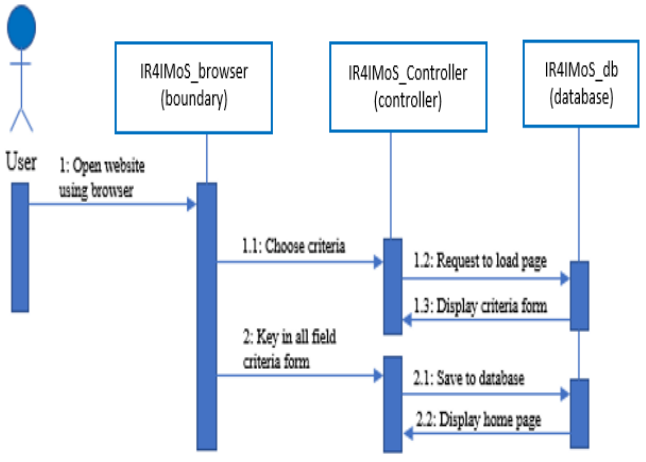

Figure 4. Criteria Form Sequence Diagram

Figure 5 shows the summary page Sequence Diagram for a web system. On this page, users have to select the summary

they want to see. A summary of all criteria that have been filled in or a summary by the selected faculty.

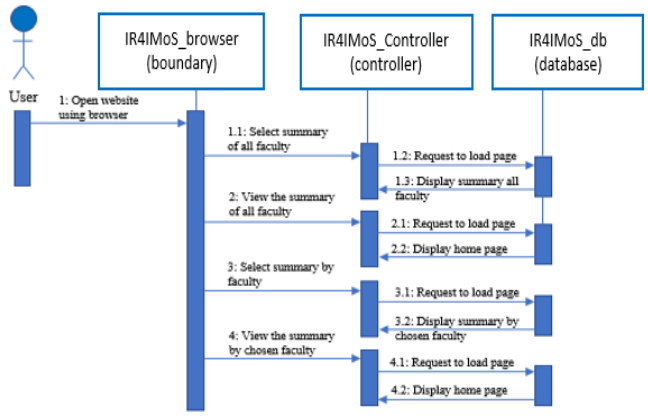

Figure 5. Summary Page sequence Diagram

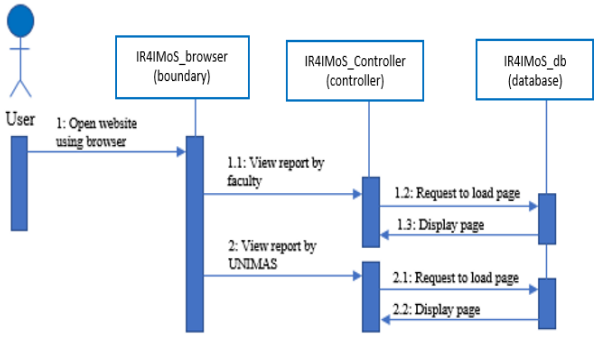

Figure 6. Report Page Sequence Diagram

Figure 6 depicts the Sequence Diagram for a web system report. The users will be able to view reports by faculty. Figure 7 illustrates the Sequence Diagram for user logout. The user will log out of the system and a login page will be displayed once the user clicks the logout icon.

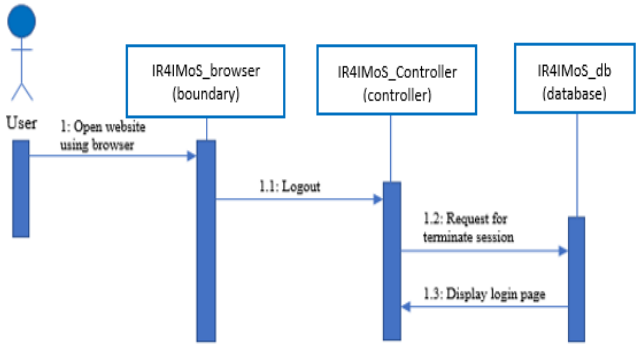

Figure 7. User Logout Sequence Diagram

III. IMPLEMENTATION

In the proposed system, Bootstrap, Hypertext Preprocessor (PHP), Cascading Style Sheet (CSS), and JavaScript are used to create the web system.

Bootstrap that includes with HTML adn CSS design template is used in this system because it is a free front-end framework so that web development becomes faster and easier. CSS is used to design and style the user interface of the system. PHP is employed to control the transmission of data from the system interface to its database with the necessary functions, such as updating and deleting data. Meanwhile, JavaScript is a statement set that perform a job or compute a value.

A. Login

Figure 8 shows the system interface login page. All users can access the system by entering their username and password correctly.

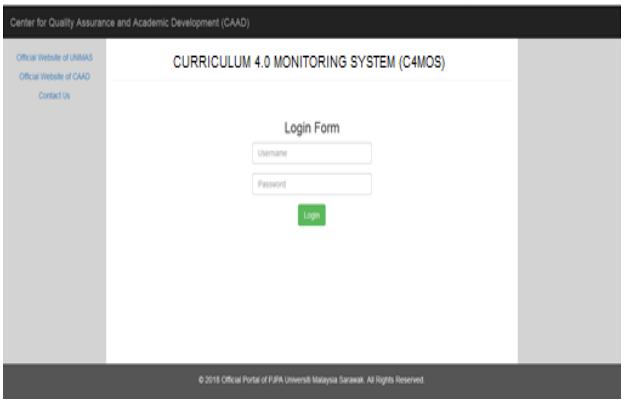

Figure 8. Login page of IR4ImoS

B. Choose Faculty, Choose Criteria, Fill Form, Update Criteria Form and Delete Form

Users need to select one of the faculties and academic programmes before users start filling out the form. After successfully completing the login page, the user will be directed to a second page, which contains fourteen criteria as part of the selection. There is a button on the description of each criterion as users right-click the criteria. This will ease the users to select alternative criteria. All criteria buttons will be linked to the corresponding criteria form. A list of fourteen IR 4.0 criteria are shown in Table 2.

Table 2. List of 14 criteria in the system

Criteria	Description
1	Program with educational objectives aligned with course learning outcomes that support the Industrial Revolution 4.0 needs
2	A program that recognises lifelong learning
3	Program with flexibility features
4	Industry-based program
5	Hybrid program
6	Global program
7	Program with a non-conventional curriculum structure
8	Programs that implement significant 21st-century skill (in most courses)
9	Program with the following learning approach: 1. Heutagogy, II. Peeragogy., iii. Cybergogy
10	Programs that use technology 4.0 is significant in teaching and learning
11	Programs involving Work-Based Learning (WBL)
12	Programs involving experimental Learning
13	Programs that practice non-conventional teaching and learning methods (in most courses)
14	Programs that practice substantial alternative assessments (in most courses)

Meanwhile, Figure 9 illustrates an example of the form of Criterion 1 in the system. When Criterion 1, i.e., 'Programmes with educational objectives aligned with course learning outcomes that support the requirements of IR 4.0 is selected, the users must fill in all fields. Users can select faculty, programme code, justification for the implementation of criteria, number of courses involved, and curriculum change categories. The form is saved in the database system when the users click 'Save' button before the session ends.

In this system, users can select the report type to be displayed as illustrated in Figure 10. Users can generate two reports namely, by the Faculty & Programme and by the entire UNIMAS from this system.

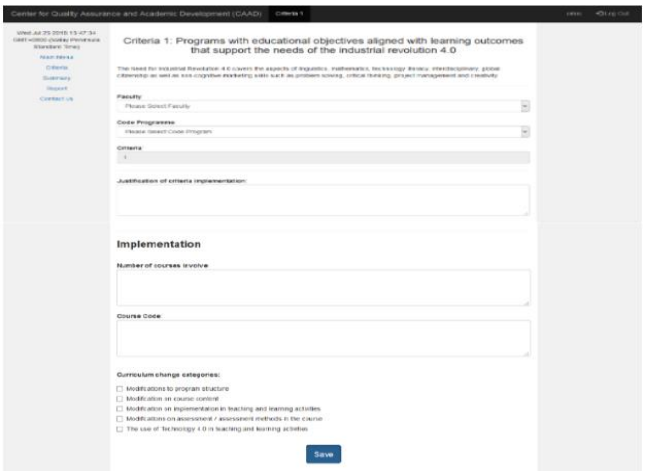

Figure 9. Criteria 1 form

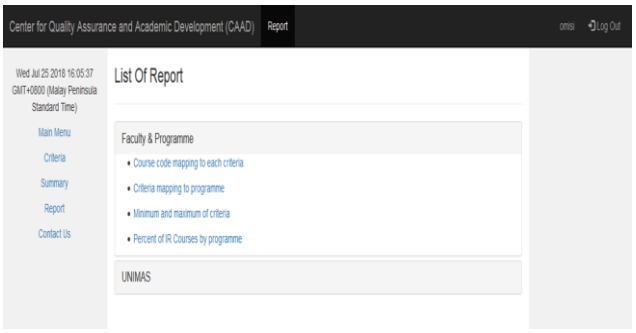

Figure 10. Report page display

In the Faculty & Programme section, there are four options namely Course code mapping to each criterion, Criteria mapping to programme, minimum and maximum criteria, and Percentage of IR 4.0 courses by the programme. The main function of this report is a summary of the criteria form the output with a report of the percentage analysis involved in the IR4.0 criteria as shown in Table 3. HTML was used to develop the table's interface because it has the effective feature to visualise relational information on web pages (Adagale *et al.,* 2016). This table displays the information such as faculty, code programme, IR 4.0 criteria, rational implementation justification, course code, curriculum change categories and the user information.

Table 3. Summary of filled criteria forms

No	User	Faculty	Code Programme	Criteria	Rational	Number courses	Course code	Curriculum	*Print this page*
1	omisi	FSKPM	WP04	1	test	test	tmk9087	Modification on course content. Modification on implementation in teaching and learning activities	*Update* *Delete*
2	FSKTM	FSKTM	WC09	1	test	test	tmn2099	The use of Technology 4.0 in teaching and learning activities	*Update* *Delete*
3	omisi	FSKTM	WC11	1	test	test	tmx1022	Modification on assessment/ assessment methods in the course. The use of Technology 4.0 in teaching	*Update* *Delete*
4.	omisi	FSKTM	WC11	1	test1	Test1	Tmx0987	Modifications to program structure. The use of Technology 4.0 in teaching and learning activities	*Update* *Delete*

C. Print Summary

On this page, the users will be able to print all the criteria summary. Also, the users can update or delete the form by clicking the update and delete button. The results of the comparison between the proposed system and other systems are shown in Table 4. The comparison is based on a web-based system, printing function, platform friendly, login page, and logout and reasonable cost implementation. Moreover, based on the analysis study conducted on the existing system in UNIMAS, it is reported that the existing system has a conventional way of monitoring the curriculum 4.0 elements and criteria is time and resources consuming, and inefficient compared to IR4IMoS. IR4IMoS is a systematic IR4.0 criterion for academic programmes mapping, automated analysis and reporting, a user-friendly system that is accessible at anytime and anywhere. This system also facilitates the Curriculum 4.0 implementation in UNIMAS and provides inclusive feedback to academic programmes to redesign curriculum, learning and teaching delivery as well as assessment.

Table 4. Comparison results with other researchers

Function	Proposed work	Sunehra D & Ramakrishna P, 2016	Lalas G & Marcial DE, 2016	Adagale *et al.*, 2016
Web Based	✓	✓	✓	✓
Printing Function	✓	×	×	✓
Platform Friendly	✓	✓	×	✓
Login Page	✓	×	✓	×
Implementation Cost Reasonable	✓	×	✓	✓
Logout	✓	×	✓	×

IV. RESULTS AND DISCUSSION

User acceptance testing has been conducted to test the system's usability among real-life users. The survey has been administered to 10 respondents through the System Usability Scale (SUS). SUS is a scoring system that consists of ten questions that must be answered by respondents on a scale of strongly agree to strongly disagree for each topic. SUS enable the users to test a wide range of products and services. This result is generated based on the SUS score calculation algorithm. For odd number statements (1,3,5,7,9) the score will be equal to the scale position minus 1. For even number statements (2,4,6,8,10) the score will be equal to five minus the scale position. Table 5 shows a list of questions provided by SUS.

Table 5. SUS Question

1.	I think that I will use this system frequently.
2.	I found the system excessively complicated.
3.	The system appeared to be simple to operate.
4.	To use this system, I believe I would require the assistance of a technical person.
5.	I found many functions were integrated in this system.
6.	I thought there was too much inconsistency in this system.
7.	I believe that most people would learn to use this system very quickly
8.	I found the system very inconvenient to use.
9.	The system give me a lot of confidence
10.	I needed to know a lot of things before I use this system.

Table 6. Evaluation Result for IR4IMoS

	Respondent	Score	Score Grade Ranking
1	R1	67.5	OK
2	R2	70	GOOD
3	R3	75	GOOD
4	R4	57.5	OK
5	R5	57.5	OK
6	R6	65	OK
7	R7	67.5	OK
8	R8	77.5	GOOD
9	R9	90	Best imaginable
10	R10	70	GOOD

Table 6 illustrates the SUS score result from the IR4IMoS user testing survey. All of the respondents' SUS scores were 50 which were above average and appeared to be in the OK range based on the SUS score grade rankings. To view the overall grade of the system, an average calculation was made and the result is 69.75 which was approximately an average score and appeared to be in the OK range. This concludes that the system is acceptable to the users but still can be improved. Figure 11 shows the grade rankings of SUS scores to make any measure more meaningful and produce an accurate result.

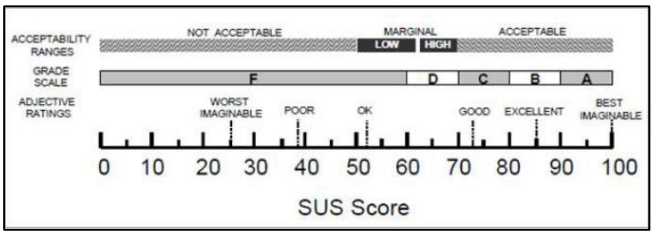

Figure 11. SUS scores

V. CONCLUSION

A web-based system for academic monitoring, recording, analysing, reporting the implementation of curriculum 4.0 elements and criteria in academic programmes including the transformative learning and teaching delivery practice has been developed. UML object-oriented modelling methodology is used to visualise the concept design of this system. This system has the login feature, choose faculty and criteria, delete option, fill form, print, and logout. This system is useful for UNIMAS academic programmes as well as UNIMAS management because it offers reasonable cost, is user-friendly, and time-efficient. For future work, this system can be further enhanced by integrating the existing system in UNIMAS through big data applications for future-ready education.

VI. ACKNOWLEDGEMENTS

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