FIFO - SYSTEM INTEGRATION DESIGN - Riad Sahara

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Submission date: 10-May-2023 09:37AM (UTC-0700)
Submission ID: 2089602637
File name: FIFO_-_SYSTEM_INTEGRATION_DESIGN_-_Riad_Sahara.pdf (957.86K)
Word count: 3871
Character count: 21053

Integration Design of Academic Information Systems and Learning Management Systems Using Web Services Rest-Based External Database

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(***received***: dd-mm-yy, ***revised***: dd-mm-yy, ***accepted***: dd-mm-yy (diisi oleh editor))

Abstract

ICT products that are widely used in universities in Indonesia are E-Learning with a Learning Management System (LMS) and Academic Information System (SIA). The existence of these two products from ICT will greatly assist the running of academic business processes in a tertiary institution. Of course, if the two are well integrated, especially for managing existing academic data. However, in many tertiary institutions, the two systems are still not integrated, such as in managing academic data. The huge amount of data and the complexity of the two systems will make the management and integration process difficult and inefficient if done conventionally. Seeing these problems, the researcher intends to conduct research on the integration of the two REST-based Web Service systems and the use of the External Database feature. The integration of the two main systems used in the academic process at the university aims to integrate data and synchronize data in real-time which will certainly make it easier for universities to manage academic activity data and reports on the results of academic activities carried out with large amounts of data and complex. From the research that has been done, the system integration design that has been made can be implemented to integrate SIA and LMS with good results in terms of data integration and real-time data synchronization.

Keywords: *Databases, Integrations, LMS, REST, SIA.*

I. Introduction.

At present there is a new paradigm which requires students as active learners to get appropriate facilities to be implemented in the education system in Indonesia, especially in higher education with the existence of Information and Communication Technologies (ICT). ICT plays a very important role in producing various teaching and learning material products that are far more interesting to follow, have highly interactive elements, and are easy for students to understand [1]. One of the ICT products that is widely used in higher education institutions is E-Learning.

In Indonesia, E-Learning has not been widely known and used, especially in rural areas. Even Vice President Ma'ruf Amin explained that only about 20 out of a total of 4,741 tertiary institutions in Indonesia have implemented electronic learning methods or E-Learning [2]. Only after the Covid-19 pandemic did E-Learning experience an increase in use following the government's recommendation to carry out teaching and learning activities from home or learning from home.

One of the products from E-Learning, which is commonly called the Learning Management System (LMS) which is widely used is Moodle. Not only in Indonesia, even in the world. This can be seen from around 250,000,000 (two hundred and fifty million) registered users, and around 251 (two hundred and fifty-one) countries already use Moodle, as shown in the image below. The use of the Moodle LMS is a solution that is very helpful in terms of teaching and learning activities that must continue, even during the Covid-19 pandemic situation. Situations that require everyone to keep their distance or social distancing [3]. Moodle as an application for an E-Learning system is a solution in distance learning. Because all the functions of teaching and learning activities are complete in Moodle. Moodle itself can run on a variety of devices (up to mobile phones) with different operating systems, platforms, machines, to different screen resolutions. So, equitable access to teaching materials and teaching and learning activities can be fulfilled properly [1].

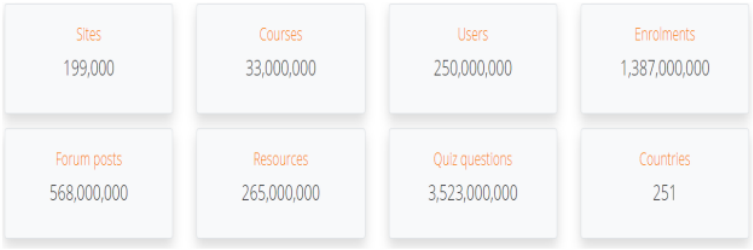

Figure 1. Moodle LMS Usage Statistics [4]

Another product from ICT that is widely used in higher education institutions is the Academic Information System or better known as SIA. SIA is a data management system that is very necessary in a tertiary institution to process student grades data, course data, teaching staff data (lecturers) and faculty/department administration, and so on [5]. The use of SIA in a higher education institution is very important, because if not, the following things will happen: Wasteful of human resources; Difficult to control for lecturers and students; Difficulties in dividing schedules and classes; Data management for lecturers, staff, and students becomes difficult; There will be a lot of paper documents used, etc.

The existence of the two products from ICT, namely, E-Learning and SIA will greatly assist the running of academic business processes in a higher education institution. Of course, if the two are well integrated, especially for managing existing academic data. However, in many higher education institutions, the two systems are still not integrated, such as in the management of academic data. Especially considering that there is certainly a lot of data and complexity in these two systems, which will make the management and integration process difficult and inefficient if done in a conventional way. Seeing this problem, the researcher intends to conduct research to design integration between the E-Learning system and SIA. The planned integration of the two systems will be based on Web Service REST and use the External Database feature which will be used to synchronize data from SIA to E-Learning in real time.

The research that will be carried out is very important because considering the current situation, along with the increasing use of information technology products, such as the use of LMS Moodle and SIA in higher education institutions. However, many are not followed by integrating the two information technologies. This results in the business process of managing data from the two systems becoming complicated and difficult to do. Through the research that will be carried out, it is hoped that it will be able to provide solutions for the integration between LMS Moodle and SIA, which are widely used in higher education institutions today. The integration of the two main systems used in the academic process at the university aims to integrate data and synchronize data in real-time which will certainly make it easier for universities to manage academic activity data and reports on the results of academic activities carried out with large amounts of data and complex.

II. Research Methods.

2.1. Research Review.

Research on the integration between Academic Information Systems and Learning Management Systems (LMS) has been carried out by several researchers. The following is a review of previous research which is the main reference for researchers in conducting research:

In the first previous research, there were several problems. The first problem, every time there is a change in the data structure in SIA which concerns lectures or there is an upgraded version of the LMS system itself, the program must be updated because it must adjust again to the new data structure. And the second problem is when there is a change in data in the middle of the semester such as a user changing passwords, changing lecturers, and changing student Study Plan Cards must be done manually on both sides, namely at the SIA and at the LMS. As well as other problems regarding the disappearance of all teaching and learning activity data when the LMS will be used again in the next semester, this makes lecturers must manually back up their material on the LMS before the current semester ends so that it can be used again in the following semester. Researchers apply the External Database feature which will be used to synchronize data, as well as transfer data in real time from the Academic Information System and/or to the LMS [6].

In the second previous research, the application of the Academic Information System and LMS (Moodle) is still not integrated for the problem of managing existing data. Data in Moodle is still entered manually and has

not been scheduled automatically. The large and complex data in these two systems will certainly make the management and integration process difficult and inefficient. Researchers overcome these problems by applying a data integration model between the Academic Information System and the E-Learning system that uses Moodle. Researchers use the web service REST (REpresentational State Transfer) method, which is the most appropriate choice of method because this method can integrate between systems and between databases [7].

In the third previous study, there were several problems such as every time they entered a new semester, lecturers would create courses, enroll and unenroll manually, and new students would register e-learning manually. The existence of these problems will certainly be very inefficient in data management because the course data in e-learning can be taken from the existing course data in the Academic Information System, as well as student and lecturer data in e-learning can be taken from existing SSO data. Researchers overcome the problem by integrating existing systems with features or web service modules in Moodle that can be used as tools for data integration [8].

In the fourth previous study, it was explained that the application of the Learning Management System would not be separated from its relationship with the Academic Information System. Regarding the two systems, at the research site where the researcher conducted his research, there was a problem that the two applications had not been integrated which had been implemented in the teaching and learning environment, so that users, in this case students, were not easy enough to take advantage of both. From the existing problems, researchers took an alternative to develop SIA plus E-Learning applications and additional applications. Additional applications or so-called bridge applications are designed and developed using the PHP programming language [9].

In the fifth previous study, it was found that there are still many higher education institutions that have not integrated Academic Information Systems and E-Learning. As can be seen in the process, if new student data is entered into the Academic Information System, it is not automatically registered in the e-learning system, this causes other problems and the ineffectiveness of an administrative activity, such as having to enter data manually in e-learning. which can raise the possibility of data redundancy, errors in entering data, and others. Researchers used the data level integration method in the research conducted. The data level integration carried out here is to focus on transferring data between applications with the aim of sharing the same data to several different applications. The databases of the two existing systems are combined into a new database structure that integrates the two applications [5].

Based on literature studies from previous studies with similar themes, the researcher will conduct research that is broadly like the research that has been conducted by Ajib Hanani in 2020 [7] and the research conducted by Muhammad Bunyamin and Ahmad Syazili in 2019 [6]. Researchers will make integration design between E-Learning system and SIA. The planned integration of the two systems will be based on Web Service REST and use the External Database feature which will be used to synchronize data from SIA to E-Learning in real time. However, researchers will develop a broader integration of the two systems, such as integration of value data from Moodle which can be entered into the value data in the SIA.

2.2. Web Services REST.

Gottschalk in Eric Kurniawan said, Web Services are interfaces that describe collections that can be accessed on the network using a standard XML format for exchanging messages. Web Services perform specific tasks. Web Services are described using a standard XML notation format called services description [10]. Web Service is a web server that is made specifically to support the needs of other sites or applications. Client programs use Application Programming Interfaces (APIs) to communicate with Web Services. In general, an API exposes a set of data and functions to facilitate interaction between computer programs and enable them to exchange information. As depicted in Figure 2., the Web API is the face of the Web Service, directly listening to and responding to client requests. Representational State Transfer (REST) is a technical description of how the World Wide Web* works. REST tells us how the Web reached its scale. If the Web can be said to have an "operating system", its architectural style is REST. The REST architectural style is typically applied to the design of APIs for modern web Services. The Web API that fits the REST architectural style is REST API [11].

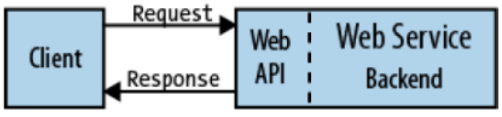

Figure 2. Web API [11]

Having a REST API makes a Web Service "RESTful." The REST API consists of an assembly of interrelated resources. These resource sets are known as REST API model resources. A well-designed REST API can attract client developers to use web services. Today's open market where Web Service competitors compete for attention, aesthetically pleasing REST API designs are a must-have feature [11].

Table 1. Restful API example [10].

Resource	***Method***			
	Get	***Post***	***Put***	***Delete***
/api/student	*Get a list of all student*	*Create a new list of student*	*Update a list of student*	*Delete all student*
/api/student/1	*Get a student by student's ID*	*Treat as a collection. Create a new student in it.*	*If student exists, update the student.* *If student does not exist. Create a new student.*	*Delete the student.*

The following are 5 (five) advantages when using REST Architecture [12]: Light RESTful for Web Services; RESTful simplicity; RESTful architecture is closer in design to the Web; Scalability; Expose API as HTTP Service.

2.3. Moodle External Databases.

External Database is a feature in the Moodle LMS that is useful for synchronizing user and enrollment data with databases outside of Moodle. With this feature, Moodle could read data from other databases that have been mapped in Moodle [6]. An example of using an external database in Moodle for registration of teaching participants at an institution can be seen in Figure 3 and Figure 4 below.

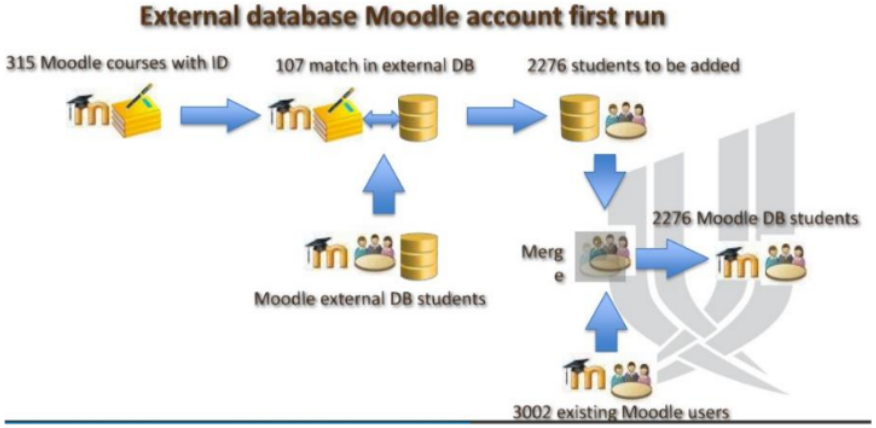

Figure 3. External Database Moodle account first run [13].

Figure 3 above shows that the External Database is used to match class data that has been created and followed by students who take the class. Student data is taken from another system, in this case the Academic Information System (SIA). If there is redundant data, the data will be merged so that data integrity is better.

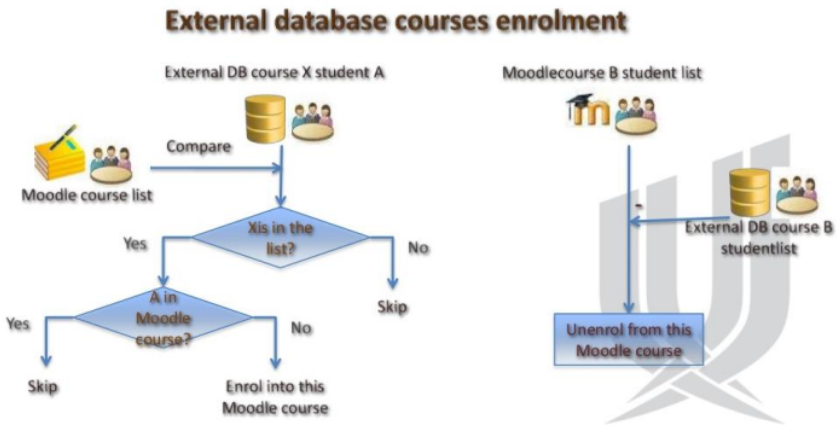

Figure 4. External database course enrolment [13].

In Figure 4 above, it is illustrated how the External Database can handle or be used to check whether students are really taking classes according to the class plans that have been carried out by these students. If the student takes the class, then the student will automatically be enrolled into the class. But if not, then the student will be unenrolled from the class.

2.4. Research Methods.

Web service REST method.

In research conducted by researchers using the Web Service REST method to integrate AIS with Moodle LMS. REST web services consist of web service servers and web service clients [7]. REST is an architectural style for designing network applications. The idea is that, instead of using complex mechanisms like CORBA, RPC, or SOAP to connect between machines, simple HTTP can be used to carry out communication between machines. RESTful applications use HTTP requests to post data (create and/or update), read data (for example, make queries), and delete data. So, REST uses HTTP for all four CRUD (Create / Read / Update / Delete) operations [12].

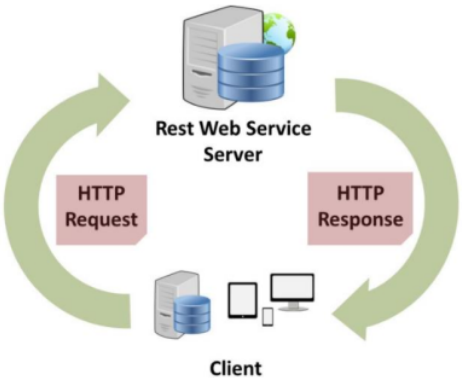

Figure 5. REST architecture [12].

REST is a software application architecture that is modeled after data is represented in some way, accessed, and modified on the web. It is an architectural style for distributed hypermedia systems. In the REST architecture,

data and functionality are considered as resources, and these resources are accessed using a Uniform Resource Identifier (URI), usually a link on the web [14].

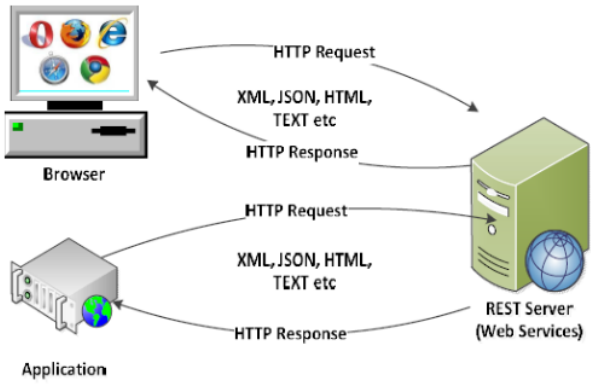

Figure 6. RESTFul Web Service Architecture [14].

2.5. Research Stages.

The research to be carried out begins with studying related studies regarding the Integration of Academic Information Systems (SIA) with LMS, which is then followed by designing the integration of the two systems. Next, develop the configuration of the two systems for the integration process which will be continued with the implementation of system integration. The results of system integration will be analyzed to see whether the integration process and the results of the integration are as expected. The flow of research steps to be carried out can be seen in Figure 7 as below.

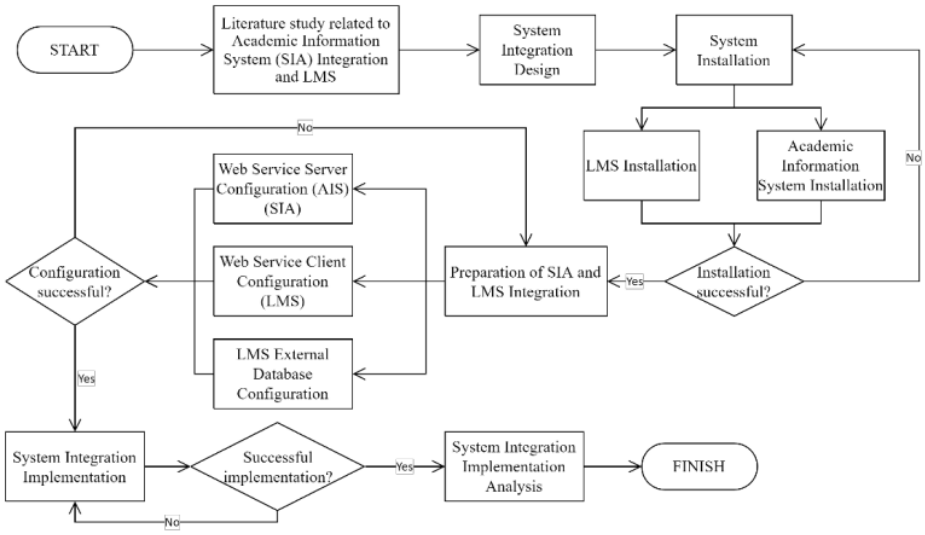

Figure 7. Research Stages

III. Results.

3.1. System Integration Design.

Web Services Architecture Design.

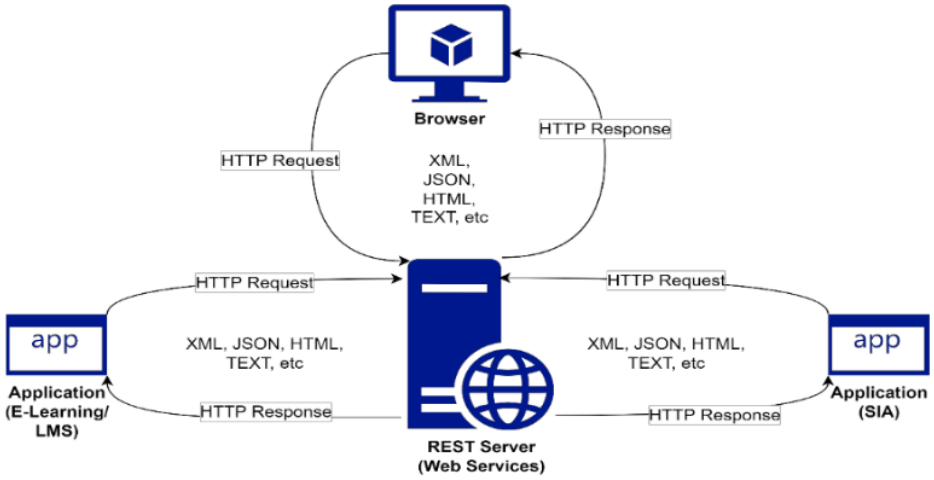

Figure 8. Web Services Architecture Design.

Figure 8. above is the design of the Web Services Architecture as an illustration of the main architectural designs that will be made in integration. The Web Services used are REST, which for communication between machines or applications use simple HTTP for posting data, reading data, and deleting data.

REST Server (Web Services) mediates data integration from Academic Information Systems (SIA) with Learning Management Systems (LMS). This REST Server will handle requests and responses to data made by the two systems that will be integrated. This process tends to have good speed and performance, considering the type of communication that is done based on HTTP Requests.

Briefly, how it works is as follows: HTTP client establishes a connection, then sends a document request to the web server. While the HTTP server is processing the client's request, the HTTP client is waiting for a response. After processing, the web server answers the request with a data status code, then closes the connection.

The benefit of HTTP is that it can regulate the format and how data is transmitted. Furthermore, HTTP can function to regulate how web servers and browsers process various incoming commands.

External Database Architecture Design for System Integration.

The following is a draft design of the External Database Architecture which will be used as a tool for the integration of the LMS and SIA systems.

In Figure 9 below it can be seen that there are 2 applications, namely the LMS application and the SIA application. The two applications communicate using an External Database based on REST Web Services.

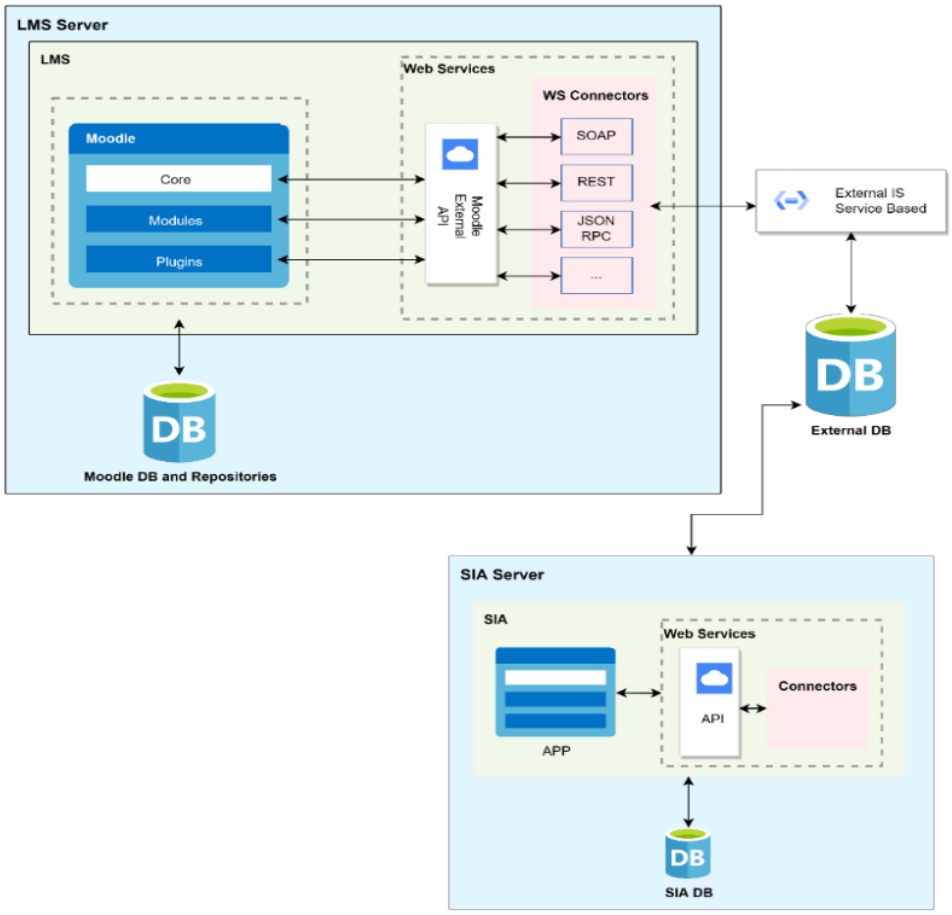

Figure 9. External Database Architecture Design for System Integration.

Some of the functions of the External Database in system integration are as follows:

1. Integrate existing LMS users in the SIA and LMS applications.

With this integration, there will be no duplication of users with the same identity, if there is, a merger process will be carried out. If a new user is to be entered or registered into the system, there will always be a process of checking whether the user is an existing user or a new user with the scheme shown in Figure 10 below.

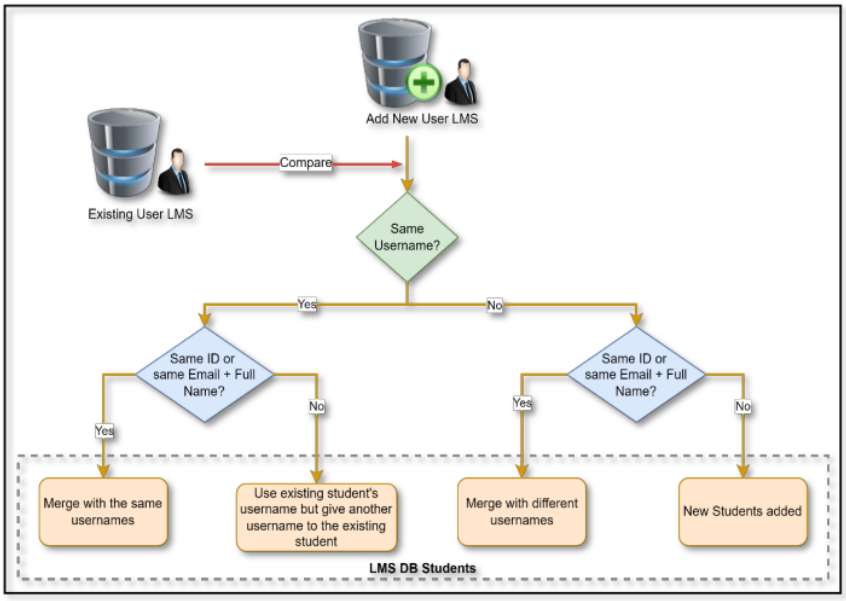

Figure 10. Integration of existing LMS users in the SIA and LMS applications.

2. Controlling Enrollments and Un-enrolments

The External database enrolment event will occur when the student user logs into the LMS. The plugin in the LMS will try to automatically register student users in all courses/classes according to the data in the external database, and optionally create empty courses/classes where the user student has not been enrolled in any courses/classes. In this process it will also cancel the registration of the student user if their data is no longer in the database. However, this external database plugin can only unenroll student users registered by the plugin. The scheme of control Enrollments and Un-enrolments is as shown in Figure 10 below.

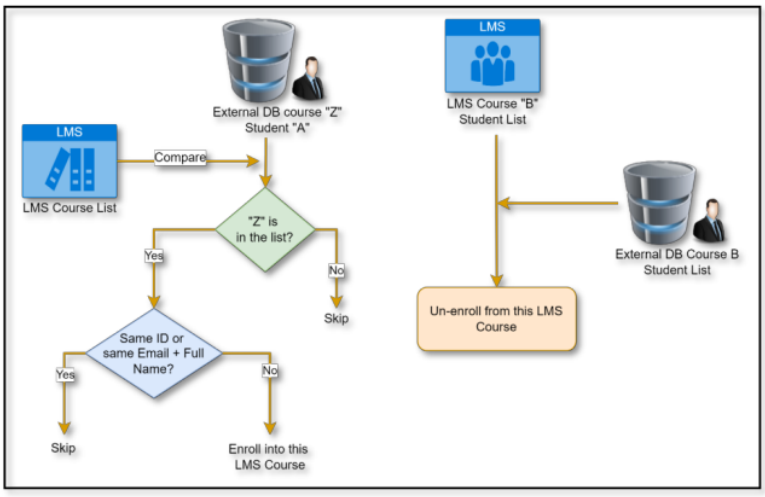

Figure 11. Control Enrollments and Un-enrolments

IV. Conclusions and Recommendations.

4.1. Conclusion.

From the research that has been carried out, some research conclusions are obtained as follows:

1. There is an integration design between LMS and Academic Information System which can be used as a system integration prototype as a reference in its implementation.
2. Data synchronization between LMS and Academic Information System can be done in real time because the integration of the two systems is based on Web Service REST and is also supported using the External Database feature.

4.2. Suggestion.

It is necessary to realize the implementation of integration between the LMS and Academic Information System systems to get more optimal results from this initial research conducted. When the realization of system integration implementation is implemented, it can be tested whether data synchronization between the LMS system and SIA can occur in real time without delay, and it can also be known what obstacles will exist for the synchronization process.

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