Lessons Learned: Enterprise Information System Project on Education Institution

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Abstract. This paper addresses the challenges posed by Industry 4.0 and the COVID-19 pandemic, which necessitate digital transformation in educational institutions. It focuses on the specific issues of integrating enterprise information systems to facilitate this transformation. The solution proposed is the development of an integrated information system to manage operational processes within educational institutions. This system targets key domains including student admissions, academics, finance, and human resources, utilizing role-based access control (RBAC) and Single Sign-On (SSO) for efficiency and security. The methodology involves a collaborative effort under the Matching Fund program by the Ministry of Education, Culture, Research, and Technology of Indonesia. This collaboration includes the Universitas Islam Indonesia and the Salman Alfarisi Yogyakarta educational institution. The approach includes defining the project, collecting, and reviewing lessons, creating a repository of these lessons, and disseminating the findings. The project successfully developed and implemented an integrated information system, addressing the initial challenges and improving organizational efficiency in the participating educational institution. The system's deployment covered multiple key operational domains, significantly digitizing the institution's processes. This paper contributes valuable insights and best practices from the integration project, serving as a model for other universities and educational institutions. It showcases the potential of collaborative efforts in accelerating digital transformation in education, especially in the context of Indonesia's vast network of universities and educational institutions.

1 Introduction

Recent developments in Industry 4.0 and the exigencies of the COVID-19 pandemic have necessitated substantial shifts in various sectors, particularly in education. The rapid move towards online modes of operation presents both challenges and opportunities for educational institutions. In response, the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia initiated the Matching Fund program. This initiative synergizes the expertise of universities with the practical needs of the Industrial World Business World (IWBW) to facilitate swift recovery from pandemic-related disruptions.

UII, a pioneer in digital transformation in education since 1999, has escalated its efforts in response to the pandemic. The university transitioned from a monolithic architecture to a more dynamic microservice framework, enabling the development and deployment of over 30 major applications. These applications have significantly digitized the university's core business processes.

As an IWBW partner, Salman Alfarisi Yogyakarta encompasses various educational levels, from playgroup to junior high school. The institution faced challenges in IT governance and infrastructure, marked by siloed operations, delayed data services, and manual errors. These challenges hindered effective organizational management and decision-making.

The collaborative effort focused on developing an integrated information system to streamline operational processes. The integration spanned four key domains: new student admissions, academics, finance, and human resources. A notable feature of this system is the implementation of role-based access control (RBAC) [1] with Single Sign-On (SSO) capabilities, enhancing security and efficiency.

This case study serves as a valuable model for universities and IWBW entities in Indonesia, which encompasses 3,957 universities as of 2021. The lessons drawn from this collaboration underscore the importance of agile digital strategies and integrated systems in advancing educational institutions, especially in times of rapid change.

2 Method

Lessons Learned uses stages created by Mark L White because they have been tested into many models [2]. The stages include five main activities as shown in Figure 1.

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Fig. 1. Stage of lesson learned

2.1. Define the lessons learned project

At this stage define the project and the environment of the implementation of activities. This lesson was captured from a project from the Indonesian ministry of education, culture, research, and technology in the 2022 Matching Fund program. This project involves three entities, namely the ministry, UII, and the educational institution Salman Alfarisi Yogyakarta. Funding was financed from all three entities with total costs reaching Rp 800 million. The duration of the implementation time is five months. The name of the project is the development of the enterprise information system design of educational institutions. The core team consists of UII university lecturers. IWBW's partner team consists of all leaders and managerial-level officials at Salman Alfarisi's educational institution. The implementation of the activity was carried out by ten students involved in this program as an independent learning activity and an independent campus (MBKM).

The system development approach uses general SDLC namely: Initiation, Development, Implementation, Evaluation and recommendations, Documentation and reporting, Plans and follow up [3][4]. At the initiation stage, the activities carried out include analysis of partner needs, analysis of IT infrastructure needs, resource identification, the process of resource acquisition by partners, and documenting the initiation process. At the development stage, two main activities are carried out, namely system development and infrastructure development. In the implementation stage, it is carried out in stages according to the readiness of the system and partners, consisting of the implementation of the system for each domain starting from the PPDB module, academic, finance, HR, and IT infrastructure domains. At the evaluation and recommendation stage, its activities include measuring the efficiency of system implementation, measuring system usability, evaluating infrastructure, and analyzing evaluation results. At the documentation and reporting stage, it is carried out in collaboration with all parties involved and throughout the project. The last stage of the plan and follow-up is carried out in the format of FGD [5][6] which discusses the results of the analysis to make a follow up plan.

2.2 Collection of lessons and practices

Based on the stages of the project and achievements throughout the   activity, it is also carried out to collect facts and things that are valuable and can be used as lessons for other projects, especially in similar cases. This is important because not all activities have duplicatable values. The method used is a combination of Integrated approach [2] and post-facto approach [2]. The activity performed consists of six steps as shown in Table 1

Table 1. Six steps activity

Step	Description
1	Project managers and field teams meet with IWBW at both management and operational levels to identify and discuss key lessons.
2	The project manager or field team summarizes the lessons captured from the field for deeper analysis into lessons to be produced.
3	Project managers report lessons learned at regular project meetings as a review of project progress.
4	Routine reports or final reports are carried out in the form of FGDs that involve as many stakeholders as possible including third parties.
5	Key lessons recorded during the project are collected and summarized for distribution to all interested participants.
6	The selected lessons are sought for a place for dissemination.

There are four sections that have lesson value throughout the project, namely: the first initiation stage which contains the initiation of cooperation between ministries, universities and IWBW. Photographing issues and elevating them into valuable programs so approved by the ministry is a valuable lesson. Second, the stage of development where the process of developing systems and infrastructure is carried out. Third, the stage of implementation of systems and infrastructure. Implementation was carried out in stages using a piloting approach [7]. Fourth, the stage of measuring the impact felt, especially by IWBW, which receives direct benefits from the MF program from the ministry.

2.3 Review for applicability

This stage will discuss the feasibility of the lessons to be raised. A lesson is declared worthy if it has wisdom for another project or other institution and is declared unworthy if it only has meaning for this project (specific). The discussion method uses FGD which involves the core team of the program from universities and the field team that provides data on findings in the field. This data is important for understanding the context of the lesson so that justification for conformity to a wider area can be obtained better.

2.4 Lessons learned repository

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The lessons that have been learned are subsequently stored to become useful information for the organization and subsequent activities. The storage of this information is carried out in two forms, namely project reports and articles that will be published to the public. Reports are stored to three entities, namely the Ministry of Education and Culture and Research and Technology, internal universities, IWBW. Meanwhile, storage to the community iscarried out in the form of published articles.

2.5 Disseminate past lessons or best practices

The project journey ends with the dissemination process of spreading valuable lessons to the community. Publication is carried out in two forms, namely through international conferences and articles in scientific journals. This publication aims to show the *best practices* obtained during the project to completion.

3 Case Studies

Salman Alfarisi Yogyakarta, an IWBW partner, offers education from playgroup to junior high school levels. The institution confronted significant challenges in its IT governance and infrastructure, marked by fragmented operations, inefficient data services, and manual errors, impeding effective organizational management and decision-making.

4 Result and discussion

The lessons learned from the MF project journey of enterprise information system development in educational institutions were successfully drawn from four parts, namely lessons from the initiation phase, development phase, implementation phase, and impact measurement phase of the implemented system.

4.1 Lessons from initiation phase

The crucial phase is to identify opportunities that universities and IWBW can do in finding suitability before partnering. Not all researchers could solve IWBW problems and not all IWBW easily obtain campus partners who have portfolios that suit their needs.

The team from PT who has been looking for IWBW partners since early 2021 has been disseminating the portfolio generated in the university's digital transformation efforts in the form of an education governance system that has been successfully implemented in an integrated manner for more than 15 years. The last success achieved was the digital transformation from a monolith architecture to a microservices architecture. This achievement is very brilliant because through microservices, educational institutions are increasingly agile in responding to various changes that occur, both regulatory changes and stakeholder demands. This is evidenced by the success of dealing with the pandemic through the transfer of most of its business processes to online services. Digital

transformation during the pandemic has produced at least more than 30 key applications that underpin the process at higher education institutions. Among these applications appear in Figure 2.

Fig. 2. Higher education application portfolio

This experience has been shared in various programs and is most related to trainings especially in the internal environment of the college. Others through several trainings with external campus parties such as Google edu, the UI / IX Indonesia community, and so on. The results of the evaluation state that this system is worthy of sharing or at least the model can be duplicated to other educational institutions.

Through the kedaireka application, which is a system that brings together universities and IWBW, an educational institution is found that has problems in the governance of educational institutions because operations are still fragmented between units, moreover this institution has six educational units, each of which is managed in silos. Various problems have been raised such as difficulty finding data, reading information, unstable data accuracy, and the use of insufficient information for decision making. The institution is Salman Alfarisi Yogyakarta.

This phase is used to get to know more about the problems faced and the contributions that will be made so that they are worthy of being submitted to the MF program of the Ministry of Education and Culture. After meeting with IWBW partners three times and involving leaders such as the chairman of the foundation and the head of the educational institution there, four main problem domains were determined. This problem, if solved, will improve governance, and become a valuable lesson for many other educational institutions. These domains include PPDB governance, academics, finance, and human resources.
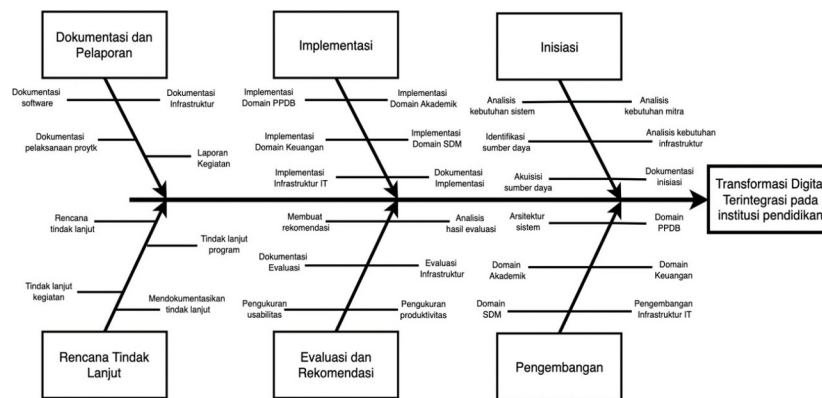
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Fig. 3. Fishbone integrated digital transformation targets

The results of the problem map and the purpose of the solution are shown in Figure 3.

Contribution through the impact of acceleration in improving the governance of digital-based educational institutions is a determined target. The stages and problems of each stage obtained consist of six stages, namely: initiation, system development, implementation, evaluation and recommendations, documentation, and reporting, and finally a follow-up plan as shown in Figure 3.

This plan is a short-term plan that can be completed for a period of one year. This program must be sustainable because IT is essentially a journey not a destination. Together with IWBW, a sustainable program roadmap was created as shown in Figure 4.

Fig. 4. Sustainable roadmap program

The program is proposed and carried out in 2022. As a capital to implement the program is to identify what has been done before, namely the portfolio from 2016-2022. In that period, several achievements have been made, including: the digital transformation process at UII, infrastructure rejuvenation, system development, strengthening digital culture, integration of SSO and eduroam Indonesia, application of adaptive technology, development of microservice architecture, and increasing adoption of various information technologies such as Zoom, Google Edu, Panopto, and so on.

In 2022 is a program to share benefits of sharing experiences and products with other educational institutions and is proposed in the MF program of the Ministry of Education and Culture and Research and Technology. The proposed flagship program is the development of enterprise information systems in educational institutions. This program is funded by the ministry of Rp 361 million and pt partners with IWBW amounting to Rp 484 million.

Planned for the following year i.e. 2023 is an upgrade program. Enhanced activities towards the adoption and adaptation of middle and high-level technologies through platform standardization and adding IWBW partners. In 2024, it is planned to expand the benefits through the application of Artificial Intelligence (AI) and data science to increase the use of information to strategic and tactical level stakeholders, namely top management and midle managers at the level of section heads and departments.

The results of the review conducted by reviewers of the Ministry of Education and Culture and Research and Technology stated that this program was feasible. It has potential valuable benefits and can be duplicated to many other educational institutions. The advantage of this program is that it carries the progress of education which was slumped during the pandemic. The program accelerates digital transformation in an era that demands that all organizations be friendly to the shift towards digitalization.

4.2 Lessons from development phase

This phase brings great challenges because it is only given five months. How can it solve the problem of ineffective and inefficient governance in higher education institutions that have more than one institution such as Salman Alfarisi to be more effective and efficient.

Fig. 5. FGD with partners determine priorities

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The target system to be developed includes four domains, namely PPDB, academic, financial, and HR. Choosing which priorities to develop first is a crucial step. Through FGDs conducted with partners, the financial domain is selected. This domain is prone to error and can lead to slander. The F G D performed i s s h o w n i n F i g u r e 5. Completing finances will be able to improve payment services made by parents and expenses for more transparent and integrated institutional operations. With this choice, it is hoped that there will be equality of welfare at both the institutional level and the level of resources involved. The second priority is the academic domain as this becomes the main activity carried out by educational institutions. Furthermore, simultaneously the HR and PPDB domains.
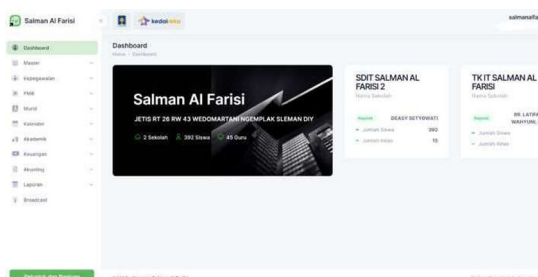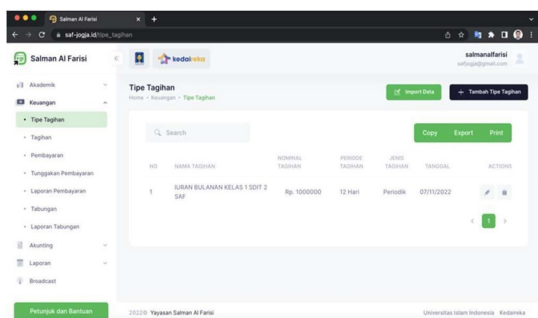

Fig. 6. Dashboard system

Fig. 7. Financial modul

The second challenge is to determine the method of development. The team proposed using an Agile approach [8][9] by adopting Scrum [10]. This method has proven to be effective and faster in delivering the value of benefits [11]. The obstacles faced when this method is used are the bureaucracy and the condition of the stakeholders involved who are bureaucratic (campus) and busy (IWBW institutions). The key to success in the Agile method is effective communication [12]. To overcome these limitations, the team chose to use the general SDLC method [3][13] by adapting Scrum in the stages of working and delivering the product. The adoption includes the division of backlog products in small pieces and is worked on in a short duration. Each duration is carried out intensive review with IWBW partners to get feedback faster. The successfully created system is shown in Figure 6 and Figure 7.

In the development process, there were several problems. The first problem is the delay due to the busyness of IWBW partners. The resolution of this problem was resolved after IWBW appointed the PIC who was the main resource person in the development process. This PIC is given the authority to make decisions so that the development process can run faster. The next problem is that the governance standards used by each institution are different. The work culture and characteristics of parents as partners of each institution are also different. This problem can be solved by developing dynamic features by adding configurations. Standards on other units and not used by other institutions can be turned off and on through such configurations. Matters of a common institutional nature are agreed upon by all leaders moderated by the chairman of the foundation. Meanwhile, things that are local wisdom are resolved through configuration.

4.3 Lessons from the implementation phase

The crucial phase is the implementation carried out in the smallest and crucial area, namely the financial module area. Success at this stage will affect other areas. So ensuring the most crucial and smallest units becomes more important. It will gradually be implemented on other units, after the pilot unit is successful.

The method used at this stage is *piloting* in which the system is implemented on the most crucial areas and a small scope. Success at this stage will affect other areas so ensuring crucial and smaller units succeed is important. It will gradually be implemented on other units after the pilot unit is successful. In this method, the old working system is not immediately abandoned. The two go hand in hand until the system successfully replaces the previous process.

The role of stakeholders at this stage for partners is to attend training using the system and provide feedback on results using the system. The role of the college team will be to conduct training and record various findings for the technical team to correct. Students will carry out the *process of deployment* and installation of the system to oversee the technical implementation of the implementation.

The resulting outcome, for partners will increase the performance of work from manual to system-based and technology that is more efficient and effective. The college team will learn lessons from the findings in each implementation process. Students will get lessons and experience applying systems to real organizations.

4.4 Lessons from the impact measurements

This crucial phase has six main activities, namely Efficiency measurement; post-implementation reusability measurement; Evaluation of IT infrastructure implementation; Analysis of evaluation results; Make recommendations on the results of the evaluation; and Evaluation documentation.

The method for measuring efficiency will use units of time and process stages. The results are compared with before using the system so that the right increase rate is obtained. The measurement of usability will use the *Moderated Usability Testing* technique, where the user will be given instructions to use the system and the results will be given questions both in person and online

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regarding the experience when using the system. IT infrastructure measurement will calculate infrastructure performance in terms of speed, availability or adequacy of infrastructure, and failures that occur during implementation. With a model of long-duration meetings and fast frequency between developers and users, the system is successfully received and implemented faster with an acceptance score of up to 85% (target). This acceptance in the group was successful.

The stakeholders involved from the partners are operator officers or *system users*. From the college is the entire MF team including students. The output at this stage is twofold, namely first, system evaluation documents and information technology. Second, recommendation documents based on the results of the evaluation.

The resulting outcomes for partners are improving work performance in the organization and improving the management of educational organizations. For the MF team, the college will increase confidence that the system installed has succeeded and get a clear success rate. For students, they will improve the ability of the evaluation process and experience in measuring the implementation of systems and technology in real companies.

A profound exploration of the intersection between educational needs and technological advancement is undertaken. This document, reflective of the meticulous and insightful approach characteristic of Mukhammad Andri Setiawan, delves into the intricate dynamics of fostering synergy between educational institutions and the IWBW. It underscores the criticality of discerning and leveraging collaborative opportunities, where the alignment of educational expertise and resources with the industrial needs becomes paramount.

The developmental phase of the project is portrayed as a crucible of innovation and challenge, where the exigencies of crafting integrated information systems within stringent timeframes are meticulously navigated. This phase, emblematic of the complex yet rewarding journey of system development, reveals the multifaceted nature of technological integration in educational settings.

Adopting a pilot implementation approach, the project elucidates the strategic significance of a phased and controlled expansion of the system. This methodology underscores the merit of iterative testing and refinement, paving the way for a more seamless and risk-mitigated transition to sophisticated digital frameworks.

Further, the project embarks on a rigorous evaluation of impact, meticulously measuring the efficacy and utility of the implemented systems. This evaluative phase, replete with critical analyses and feedback mechanisms, sheds light on the tangible benefits and potential enhancements of the system, underscoring its practical implications.

The success of this endeavor, marked by high usability and collaborative efficacy, is a testament to the harmonious confluence of diverse stakeholders – academicians, industry experts, and governmental entities. It exemplifies the quintessential power of collaborative ventures in educational innovation.

Finally, the scalability and broader applicability of these insights are profoundly emphasized. The lessons gleaned from this initiative extend beyond the confines of the involved institutions, offering a paradigmatic guide for other educational entities poised on the brink of similar digital transformations. This document, thus, stands as a beacon of knowledge and guidance, illuminating the path for future educational and technological endeavors.

4.4 Tools and Frameworks

The project employed a comprehensive set of tools and frameworks to facilitate their transition to a microservices architecture. This included the utilization of the Microservices TechStack, which encompasses a variety of programming languages, databases, and tools tailored for microservices development and operation. A key component in the infrastructure was the Docker Engine, a platform that allows for the development, shipment, and running of applications in portable containers, ensuring consistency across computing environments. Complementing Docker, Kubernetes was adopted as an open-source system for automating deployment, scaling, and management of containerized applications.

For managing multiple Kubernetes clusters, the Rancher Kubernetes Management Platform was employed, providing integrated tools for containerized workload management. The infrastructure was underpinned by Cluster Nodes, which are individual nodes in a Kubernetes cluster, each capable of running pods and managed by master components. Monitoring and observability of the system were enabled by Grafana, an open-source platform used for visualizing performance metrics. Longhorn Distributed Storage was integrated to manage persistent storage for Kubernetes environments, essential for stateful workloads.

The architecture also included an API Gateway, a critical component for managing API requests and responses within the microservices environment. The Deployment Workflow outlined the process for deploying new services, encompassing development, testing, staging, and production stages. Finally, GitLab served as the DevOps lifecycle tool, providing a Git repository manager along with features for issue tracking and continuous integration/continuous deployment (CI/CD), streamlining the management and automation of application deployment and lifecycle. Collectively, these tools and frameworks established a robust and scalable platform for the education enterprise information systems, enhancing their digital infrastructure capabilities.

5 Conclusion

Lesson learned that can be obtained in this paper is divided into several parts, namely learning at the initiation stage, learning at the development stage, learning at the implementation stage, and learning at the impact measurement stage. The success of a project can be seen from the collaborative power of the team running the project. The integration of enterprise information systems for educational institutions provides good usability evaluation results with a value of 85%. So that it shows

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the success of the integration and collaboration process of the team is well implemented.

This could involve exploring the long-term impacts of digital transformation in education, examining the scalability of the implemented systems across different educational contexts, or investigating the socio-cultural impacts of digitalization on the educational community. Suggesting these future research paths not only continues the academic conversation but also encourages deeper and broader exploration of digital transformation in education.

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