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# A LEARNING OUTCOME ASSESSMENT INFORMATION SYSTEM TO FACILITATE OUTCOME-BASED EDUCATION (OBE) IMPLEMENTATION

**Berlian Kushari [1*], Lukman Septiadi[2]**
[1,2] Universitas Islam Indonesia, Indonesia
Email: bkushari@uii.ac.id*
*Corresponding author

**ABSTRACT**

Assessment is an integral part of an outcome-based education (OBE) system. It helps to ensure student learning and ultimately attaining the expected outcomes at the time of graduation. Records of assessment results enable a study program to improve its education activities continually. This paper reports the development of an information system and technology that helped the Civil Engineering Program of Islamic University of Indonesia gear towards obtaining international outcome-based accreditation. The system was implemented in an online web environment that facilitates students, faculty, student advisors, and program managers as the system user classes, each with its access authority level. The environment allows us to define the PLOs, their respective performance indicators (PI), and the scoring system of PLO attainment, including setting up the required minimum attainment level for graduation. Secondly, for each PLO, an attainment road map is set up to define the structural relationships between all PLO-PIs and the selected subject courses or curricular activities throughout the semesters in which those indicators are to be measured (i.e., as course learning outcomes). Once these relationships are firmly mapped, the system is ready to assist the program manager, student advisors, and individual students in monitoring and evaluating course and program learning outcomes. The system's main features are highlighted, along with a discussion on development strategies, current operational status, and challenges for future development.

**Keywords:** development strategy, information system, learning outcome assessment, OBE

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## INTRODUCTION

Outcome-based Education (OBE) is considered the brainchild of William Spady. As the sociologist put it forward, OBE means "Clearly focusing and organising everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences" (Spady, 1994). In today's modern engineering profession, OBE has been widely adopted as the golden standard of education model to ensure internationally benchmarked graduate attributes at the entry-level competence to practice engineering (see e.g., IEA (2013, 2021) and IEA and ENAEE (2015)). All accreditation bodies that ratify engineering education accords are under International Engineering Alliance (IEA), such as ABET, JABEE,

and IABEE. It requires programs to get accredited must have adopted OBE and produced at least a graduate out of their education system (IABEE (2016, 2020), JABEE (2013, 2019), ABET (2020)). There has been a global shift to OBE with the scale that some consider as one of the biggest changes in engineering education in the last century (Froyd et al., 2012).

Indonesian higher education formally adopted an outcome-based education approach in 2015, i.e., since a new set of national standards for higher education (Morthe, 2015) was enacted. In common with international best practices, the new standards require study programs to establish a set of Program Learning Outcomes (PLO), which are expected to be achieved by the students upon graduation. However, the standards differ with the best practices regarding learning outcome indicators and assessment. The national standards still advocate using grades and Grade Point Average (GPA) as indicators of attainment of program learning outcomes. On the other hand, the international best practices have discouraged them from being too relative and biased (Johnson, 1997; Lei et al., 2001; Rogers, 2011).

A few years before emergence of the 2015 higher education standards, Civil Engineering Study Program of Islamic University of Indonesia (CESP-UII) has started embracing a transformation process from essentially an "input"-based education program to an outcome-based one in 2012. The drive of the transformation was because CESP was the first program in the university appointed to prepare for an international-level accreditation. Learning from JABEE and ABET accreditation criteria and experience gathered from visiting selected accredited programs in Japan and others, concerted efforts were carefully planned and gradually implemented along the transformation process, knowing well what it took to reform culture.

One of the efforts had to do with learning outcome assessment that should be acceptable to international outcome-based accreditation. On the one hand, this includes defining performance indicators for PLOs and designing how to measure the indicators effectively throughout the curriculum (assessment plan), such as illustrated by good international practices (Holland et al., 2013; Jadhav et al., 2018; Jones & Abdallah, 2016; Naqvi et al., 2019; Rogers, 2017; Shuman et al., 2005; Zeid et al., 2017). These aspects were barely understood then, let alone practised. On the other hand, it also includes developing a support system that would allow the study program to gather outcome assessment data, manage them effectively, make analyses, and suggest quality improvements based on the student learning outcome attainment.

Learning from the JABEE accreditation criteria to which the program was to apply, the need for an information system to support the program in implementing OBE, including outcome assessment, was sensed immediately. Rainer et al. (2020) define an information system (IS) as a system that collects, processes, stores, analyses, and disseminates information for a specific purpose. The computer-based tool used to work with information is referred to as information technology (IT). As reported by, e.g., Qadir et al. (2020), commercial accreditation-supporting

software products are available. CampusLabs, Q-OBE, and CLOSO are to name but a few. However, the expensive cost of the products and unfamiliarity and incompatibility concerns make it difficult to purchase such a product. In-house development of the tools was, instead, sought.

This paper reports the development of the Learning Outcomes Assessment (LOA) information system and its implementing technology that assisted CESP-UII in ensuring PLO attainment by its students and conducting continual quality improvement. The development began as the study program was gearing up towards obtaining accreditation from JABEE in 2015 and later from IABEE in 2016. Until recently, the system has continued to be upgraded from its original version with additional functionalities to support an ever-growing need. In addition to technological aspects, this paper discusses the sociotechnical approaches adopted along the development processes to highlight some factors that play a workable in-house accreditation-supporting information system environment.

## METHOD

In-house development of the LOA information system and technology for CESP-UII adopted a sociotechnical approach named by Kidd (2011) as the HiSTOP (High Integration of Strategy, Technology, Organization, and People) method. The method, originally proposed for information system in-house development purposes in small-medium enterprises, was chosen because of its potential in achieving good alignment between technological aspects, the needs of an organisation, and support from the people working for the organisation who will use the developed technology. Such an alignment is essential to pave the way for the organisation's acceptable and effective IT solutions. The method involves four development stages: strategic visioning and assessment, technology analysis, organisational design, and implementation planning and execution. Table 1 summarises the implementation of the four development stages.

### Strategic Visioning and Assessment

The first stage was where existing organisational aspects of the study program were reviewed, and new visions were laid out concerning implementing outcome-based education. Initial condition assessment conducted in 2012 revealed that the program was still at the stage of providing input-based education. Its curriculum and education orientation were inclined towards delivering the learning contents with little emphasis on assuring students' achievement of the learning outcomes. Based on the assessment, the program established a series of PLOs, performance indicators, and a learning outcome assessment component in redesigning the curriculum.

Table 1. Summary of the HiSTOP method in developing the LOA IS for CESP-UII

| Stage | Initial Conditions | Stage Outcomes | Objective |
|---|---|---|---|
| Strategic visioning and assessment | ○ Input-based education with emphasis on content delivery<br>○ Learning outcome assessment component in absence | ○ Program Learning Outcomes, performance indicators, outcome-based curriculum established<br>○ Learning outcome assessment concept established<br>○ LOA accessibility requirement established | Program reoriented to implement OBE, with clear learning outcome assessment concept |
| Analysis of the technology | Original learning implementation activities | ○ Learning implementation activities to be affected by LOA are defined<br>○ Choice of appropriate IS technology defined | A requirement specification in terms of technology, organisation, and people defined |
| Organisational design | Program managers consist only of the program chair and secretary | Additional two positions were introduced to program managers to support OBE & assessment implementation | Organisational design aligned with chosen strategy and technology |
| Implementation planning and execution | Unidentified resources and persons in charge | Available resources identified, persons in charge assigned | Accessible and effective LOA Information System |

The concept of PLO assessment established in this stage is depicted in Figure 1. A certain number of performance indicators (PI) are defined for each PLO statement. PIs are specific, measurable, dan demonstrable performances of a student as a result of his/her participation in learning. These shall be attained at a certain minimum by graduation if one is to achieve the LO. The PIs are measured through selected relevant course-level learning outcomes (CLOs) from supporting subject courses or other curricular activities (such as internship, civil services, etc.) offered throughout the semesters. This shows the constructive alignment between the established PLOs and the derived curriculum structure. Comprehensive mapping such as this one has been used as a strategy for program assessment. See, for example, Lam and Tsui (2016), Pestovs et al. (2020), Veltri et al. (2011). It is also important to clarify the concept on the attainment of PLOs which is ultimately targeted at graduation to ensure the attainment at a satisfactory level, each PLO needs to have a clear road map through which it will be introduced, reinforced, and finally demonstrated by the students for final achievement. With this concept, the PLO assessment plan should ideally consist of formative, diagnostic, and summative assessments. At the course-level, achievement of a course's CLOs defines the course grade. In turn, course grades are averaged to get GPA indexes, which remain a requirement for academic transcripts defined by the national standards.

During this development stage, a requirement was established for the PLO assessment component to access the students and their academic advisors and the study program manager. This will provide an opportunity for individual students to self-reflect and evaluate how they are progressing. Also, student advisors could monitor the progress of their advisees so that they could provide better consultation services. At the higher level, the study program manager could use

assessment results to plan continual improvements and show the attainment of PLO to program's stakeholders.

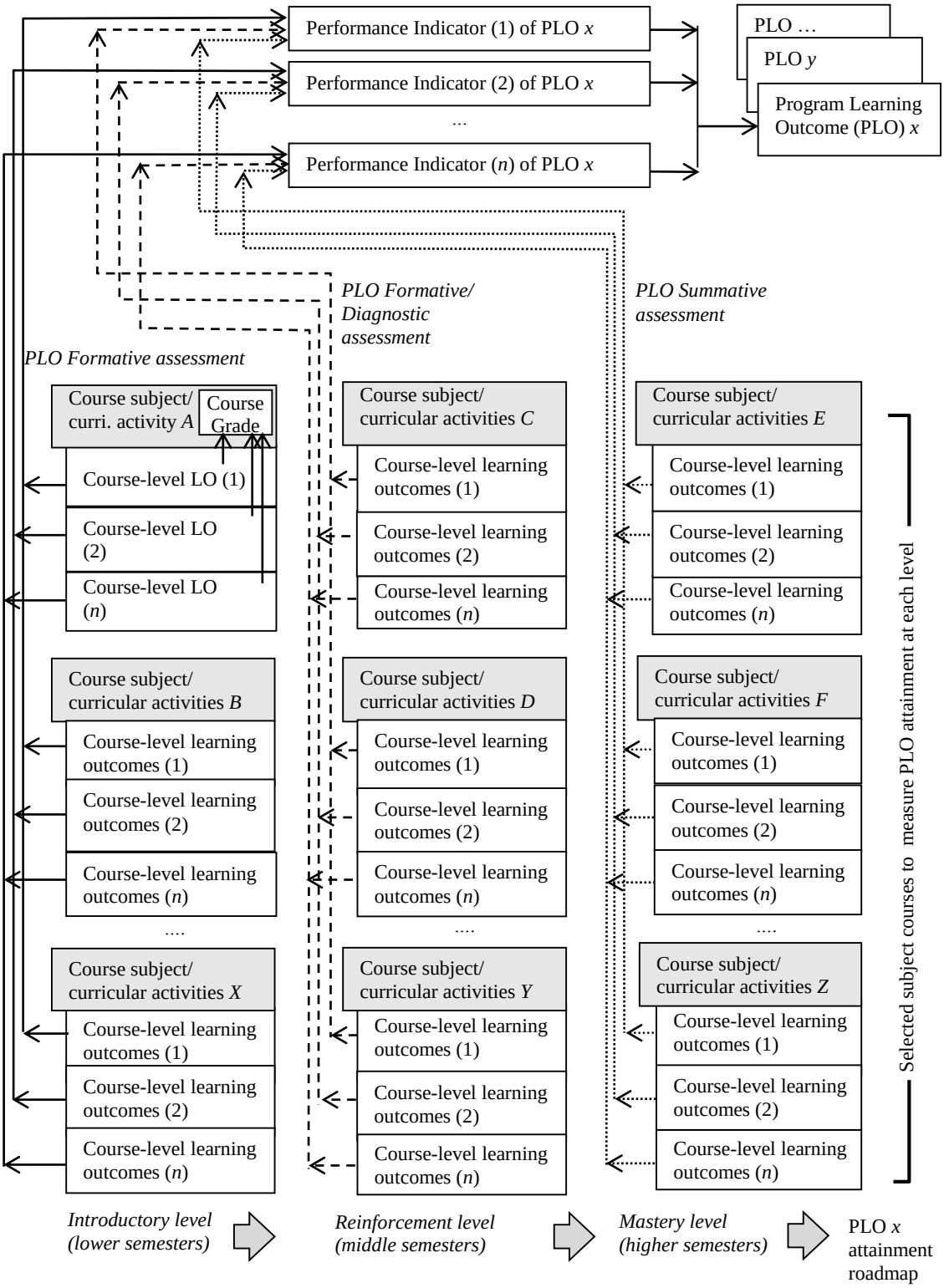


Figure 1. PLO Assessment Concept Implemented in LOA-IS

**Analysis of the Technology**

This stage involved establishing a common understanding, firstly among faculty members and later among the students, about the IS and the academic work processes affected by the new system and technologies. During this stage, the features of the IS and the selected technologies to implement the IS were defined. All these led to specification requirement of the IS related to organisation, people, and technology. Main academic processes to support learning outcomes attainment and continual quality improvement of the study program were grouped according to the "Plan-Do-Check-Act" quality management cycle. Concerning this cycle, academic activities carried out by program manager, faculty members, and students were listed to serve the basis to develop the feature modules of the IS (Table 2). In the table, activities preceded with code are those facilitated by the LOA-IS.

Choice of technologies was made by considering how the three user classes above would interact and work with the system most effectively. Web-based online IS was chosen, with additional mobile notification application to pave a smooth interaction between the IS and its users. Virtual private server to develop the IS was provided by the university. A standardised spreadsheet file to assist the collection of course-level outcome assessment data was also developed and provided for all faculty members. The system should also feature auxiliary functions to connect with the university-wide academic IS, mainly to execute the PM5 activity before starting a semester and eventually store course grades by the end of each semester.

Record of PLO attainment for individual student is one of the outputs of LOA-IS. However, since there was hardly a place to show this output in the current format of academic transcript, it was made to appear in an accompanying document known as diploma supplement. In addition to individual PLO attainment records, the IS should let program managers monitor and compare attainment records between course classes, semesters, student batches, and graduate batches. These would enable study program performance to be evaluated from various angles.

The use of a specific IS technology for a group of people can be less effective if the issues of digital literacy (or illiteracy) are not well addressed (see, e.g., Sudana et al., 2020). This was the case too with CESP-UII. To solve this issue, volumes of training on how to work with the IS were conducted. Also, junior faculty members who were usually more digitally literate were involved to assist their senior fellows temporarily, within 1-2 semesters, to familiarise them with the new system. No serious issue of digital illiteracy was indicated among the students.

**Organizational Design**

In this stage, adjustments to the original organisational structure of the study program were proposed to align with the strategy of implementing OBE and the chosen information system

design. Originally, managers of study program consisted of two officials holding structural positions as program chair and program secretary. With the implementation of OBE and the introduction of the IS, two additional ad-hoc positions were proposed to be included as managers of study program, namely curriculum development coordinator and student learning coordinator.

Table 2. Activities in the Academic Processes with respect to LOA-IS Development

| | **Managers of Study Program (M)** | | **Faculty (F)** | | **Students (S)** | |
|---|---|---|---|---|---|---|
| | Code | Activity | Code | Activity | Code | Activity |
| **Plan** | PM1 | Input all courses/ curricular activities and related CLOs offered in the curriculum | | | | |
| | PM2 | Input all Performance Indicators of each PLO | | | | |
| | PM3 | Create Assessment Mapping Plan at Curriculum level. For all set of assessment (introductory, reinforcement, and mastery), Map PLO Performance Indicators to related CLOs of courses designated for PLO assessment | | | | |
| | PM4 | Input all PLO statements, map Performance Indicators to related PLOs | | | | |
| | PM5 | Set academic period (year & semester), input results of course registration for related semester | PF1 | Input Course Learning Plan (CLP) for related semester for (as course instructor) | PS1 | Study CLPs for related semester to prepare for learning |
| | | | PF2 | Input student assessment documents (e.g., exam problems, project-based learning TOR) based on CLP (as course instructor) | | |
| | PM6 | Assign selected faculty as reviewers of assessment documents | PF3 | Review and verify assessment documents of other faculty member(s) as assigned (as peer reviewer) | | |
| **Do** | | Provide necessary support for learning process | | Implement and facilitate learning process according to CLP | | Learning |
| **Check** | | | CF1 | Assess student learning using verified assessment document | | Demonstrate assessed abilities |
| | | | CF2 | Input CLO assessment results for related courses | CS1 | Receive course assessment results and feedbacks |
| | CM1 | Monitor development of CLO and PLO attainment at program level | CF3 | Monitor development of PLO attainment (as academic advisor) | CS2 | Self-reflect and evaluate development of CLO & PLO attainment |
| | | | CF4 | Give advice to students, write consultation record | CS3 | Ask to consult with academic advisor |
| | CM2 | Evaluate learning performance at program level (all courses offered for related semester) | CF5 | Evaluate learning performance as instructor, complete course portfolio for related semester | | |
| **Act** | | Discuss, plan, and execute improvements at program level based, among others, on LO assessment results, involve faculty | | Discuss, plan, and execute improvements at course level for the next semester/year based on CLO assessment results | | |
| | AM1 | Approve proposed judicium by students | AF2 | Recommend judicium proposals (as academic advisor) | AS1 | Propose judicium having attained all CLOs and PLOs |

Curriculum coordinator was tasked to assist program chair and secretary in: (1) ensuring the constructive alignment of OBE components mapped appropriately in the IS, (2) coordinating peer-reviews to make sure the use of appropriate assessment tools to measure learning outcomes, and (3) evaluating outcome assessment for continual improvement planning related to curriculum contents. Meanwhile, student learning coordinator was to assist in: (1) ensuring academic consultation services provided to students by the advisors, (2) proposing activities to motivate and treat students indicated as having low-level of outcome attainment, (3) designing tracer study.

**Implementation Planning and Execution**

This was the final stage where available resources and the gap to the requirements were mapped, implementation schedule was drawn, and post-implementation follow-up actions were defined. A combination of senior faculty with sizeable knowledge about the OBE system and a mid-aged one with a close relationship with the student union was promoted to the two coordinator positions. Faculty interested in IS and technology was appointed to chair the in-house IS development and team up with IT developer.

Considering the availability of time until submission of accreditation documents, it was decided that staged development should be sought for the IS. In the first phase, basic functionalities and modules about course learning outcome (CLO) assessment was implemented in the web-based system. All user classes, i.e., program managers, faculty, and students, can access the online CLO module using a unique username and password. The PLO assessment part was initially implemented as spreadsheet file. Students can download the file from the CESP public website and manually fill in their CLO attainment for self-assessment purposes.

An android-based supporting mobile application that works as notification center was also developed initially in this phase. With it, students will get notified instantly when their course instructors upload assessment results, faculty notified whenever program manager asks them to review assessment tools, and all parties receive any announcement uploaded by program manager in the system. The second development phase included implementation of modules pertaining to PLO assessment, monitoring, and evaluation, as well as course portfolio module. During this phase, the mobile application was upgraded to integrate notifications from another IS developed for the purpose of Student Internship and Final Project management (not reported in this paper). Having the second phase accomplished, the LOA-IS is ready to facilitate all coded activities in Table 2.

## RESULTS AND DISCUSSION

### The current State of LOA IS

Since the second stage development accomplished in 2018, the LOA-IS has had the capability to serve all coded activities shown in Table 2. Gradual development that integrates people, organisation, and technology through communicated vision and strategy seemed to pave the way for acceptance and willingness to work together among all parties involved for the transformation to OBE. Moreover, sense of ownership has started to grow as indicated by many suggestions for improvements received from faculty members and succeeding program managers as they began to feel accustomed to work with the IS.

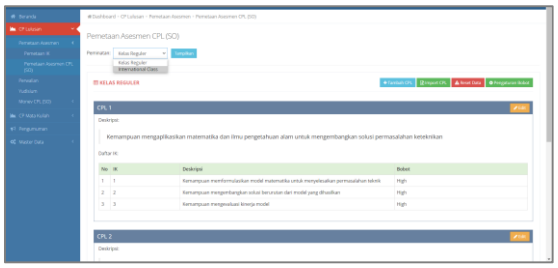

Figure 2. Feature for PLO and PI mapping

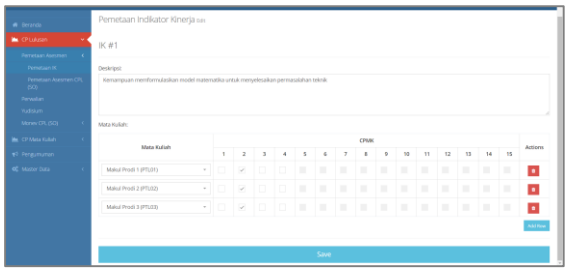

Figure 3. Feature for PI and CLO mapping

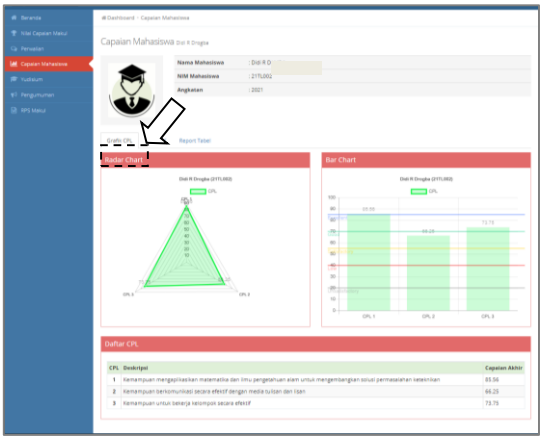

Figure 4. Individual Student's PLO Attainment, Aggregated

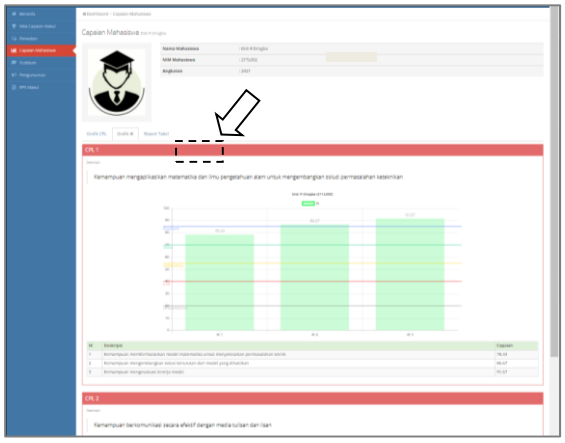

Figure 5. Individual Student's PLO Attainment, broken down at Performance Indicator level

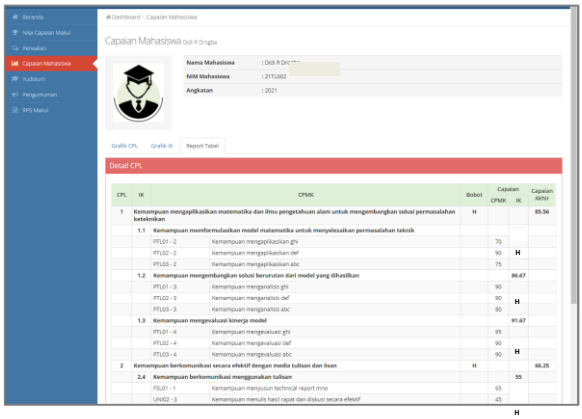

Figure 6. Individual Student's PLO Attainment, broken down as a detailed table

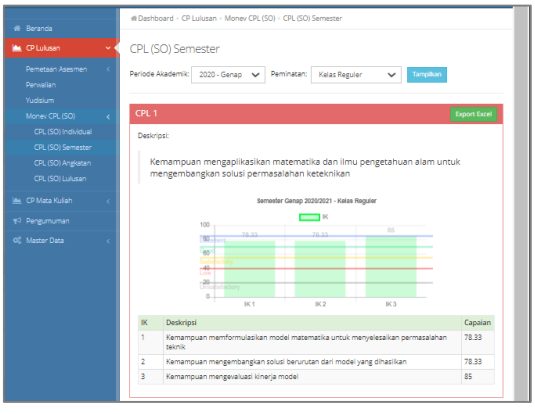

Figure 7. Monitoring of PLO Attainment at PIs in a selected semester

Screenshots depicting some of the LOA-IS features are shown in Figures 2 to 8. Figures 2 and 3 show the mapping features in which program managers can define the structural relationships between PLO statements and their respective PIs (Figure 2). Accordingly, each PI with subject courses and the relevant course-level LO where the PI will be measured (i.e., will take value from the mapped CLOs) throughout the curriculum. The mapping feature includes mapping facility (not shown in the figures) for assessment sets at multiple PLO development level, for example, introductory, reinforcement, and mastery levels. These figures represent the implementation of PM 2, PM 3, and PM 4 listed in Table 2. As seen in Figure 2, a feature is given to assign relative importance of a PI to contribute to a PLO. For each PLO statement, an aggregate score of attainment for individual students would be calculated from the weighted average score of its PIs. Meanwhile, score of a PI would be taken as the average of each related CLOs. For example, Figure 4 shows individual PLO attainment monitoring pages as viewed from a student-class user in a case of a study program establishing only 3 PLO statements. The aggregated score of each PLO is shown. Figures 5 shows the scores of each PI of a PLO statement. Finally, Figure and 6 show the breakdown of PLO attainment at the levels of PI and CLO, respectively. In Figure 6, the breakdown is presented as a detailed table exportable to a file with spreadsheet format.

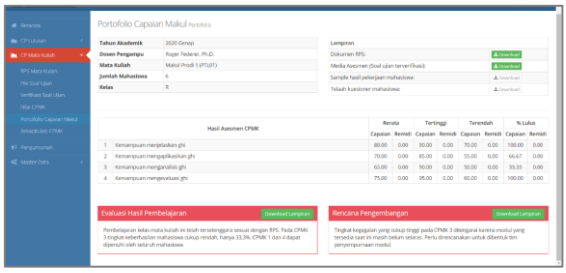


Figure 8. Class Portfolio Report Feature

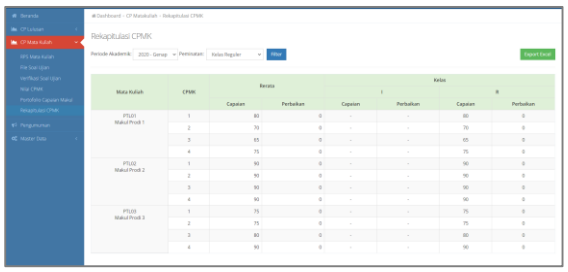


Figure 9. Feature for CLO Achievement Monitoring

Figure 7 presents PLO attainment viewed from program manager or administrator page. PLO attainment can be monitored in several modes, i.e., individual students, by semesters, by years of admission, and by graduation batches. Following the design of PLO attainment roadmap, distinct PLO monitoring can be conducted for different assessment stages, namely formative, diagnostic, and summative assessments (not shown in the figures). A student advisor can monitor the development of PLO attainment of his/her advisees. This feature serves the academic counselling provided by advisors to the advisees. Figure 8 shows the feature module in which an instructor must complete his/her class portfolio report at the end of each semester. A lecturer would be asked to upload some samples of student's works after graded, write a reflection based on the results of CLO assessment, and write suggestions for future improvement. Lastly, Figure 9 shows the feature where program managers can monitor and compare the achievement of CLOs

for all subject-course classes offered in a semester. These features facilitate evaluation meetings by the end of each semester for discussions on continual improvements.

LOA-IS continues to be developed with auxiliary features. Recent development includes, for example, improved connectivity with university-wide academic information system. While previously had to be carried out manually, importing results registration results of offered classes of a semester (PM5) and exporting course grades can now be conducted automatically through an Application Programming Interface (API) developed between the two systems. Also, as this paper is written, a new feature that will allow program manager to manage overall continual improvement records at study program level is being developed.

**Challenges for Future Works**

A series of workshops have identified some immediate challenges that need to be addressed for future works of LOA-IS development. For example, as CESP-UII is extending its education services to international students, the IS's user interface should be bilingual or multilingual. This is perhaps one of the easier challenges. As a consequence of adopting the "Plan-Do-Check-Act" (P-D-C-A) management cycle, at some point in time PLOs and their indicators, CLOs, and even the curriculum itself will be reviewed for necessary changes adaptable to the dynamics of the environment. Currently, the LOA-IS is designed to accommodate one curriculum. In the near future, they should expand to handle multiple curricula so that changes and transitions emerge to adopt a new curriculum. Also, those programs as customised learning, immersion learning, or work-integrated learning models (termed as "Merdeka Belajar" in Bahasa Indonesia) have become a national policy in higher education, the IS should give more flexibilities, for example, to accommodate external users involved in assessing student learning outcomes through learning modes other than courses offered by the study program.

## CONCLUSION

The development of an information system to assist CESP-UII in implementing the OBE, particularly in ensuring the attainment of PLOs and conducting the P-D-C-A management cycle for continual improvement, has been discussed. It highlights important features, staged development, current operational status, and future challenges. The HiSTOP model used in the in-house development process can lead to the birth of a workable IS with subjective evidence of acceptability, willingness to work with, and sense of ownership among the users. These aspects deserve to be adequately studied in the future.

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