Student Attainment Measurement System in Civil Engineering Undergraduate Programme: A Satisfaction Survey

Mazlina Mohamad[1*], Oh Chai Lian[2], Mohd Raizamzamani Md Zain[3], Balqis Md Yunus[4], Norbaya Hj. Sidek[5]

[12345] School of Civil Engineering, College of Engineering,
Universiti Teknologi MARA (UiTM), 40450 Shah Alam, Selangor, Malaysia
mazlina9090@uitm.edu.my
chailian@uitm.edu.my
raizam@uitm.edu.my
balqis1157@uitm.edu.my
norbayasidek@uitm.edu.my
[*]Corresponding Author

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Abstract : In ensuring the quality of the offered programs in Malaysia, it is crucial to comply with the long chain of Quality Management processes in obtaining and maintaining accreditation of undergraduate engineering programs. One of the processes is to continually and effectively measure the students' attainment of program outcomes amid the implementation of Outcome-Based Education. This paper focuses on MyCOPO system, the evaluation of undergraduate bachelor degree engineering students' attainment measurement system in the Faculty of Civil Engineering, Universiti Teknologi MARA, Shah Alam. A quantitative survey has been conducted to measure academic staff and students' satisfaction level of MyCOPO implementation in the faculty. This survey has been conducted in line with the university strategy in promoting organisation operational excellence via MyCOPO system, where 47 and 227 respondents were recorded for academic staff and students, respectively. Two sets of questionnaires were designed to determine the impact of the system, the effectiveness on delivery and quality of the system and users' happiness index. This system is found to be impactful in ease the work, increase the quality and provide satisfaction to related parties. The usage of MyCOPO system is effective and the average rating of happiness index for academic staff and students are 8.2 and 7.2 out of 10 for happiness index, respectively.

Keywords: Attainment measurement system, Civil engineering, outcome-based education, satisfaction.

1.0 introduction

The Outcome-Based Education (OBE) approach has been implemented in tertiary education both nationally and internationally to fulfil the needs for assessing educational outcomes or student attainment to optimize the return on educational investment (Ortega and Cruz, 2016; Sun and Lee, 2020; Ag Damit et al.,2021). As an educational theory (or philosophy), OBE epitomises a range of principles and assumptions concerning teaching, learning, and the systemic structures that underpin these activities. Learners in the OBE pedagogical approaches work collaboratively to pose questions, emerge at and formulate hypotheses, and explain the validity of answers (Lichakane, 2005). The educator's goal is to oversee discourse wherein the learners pay attention to, react appropriately to, and query the educator and one another whilst also attempting to persuade themselves and one another of the validity of contained, solutions, hypotheses, and responses (Owen, 1995). In addition, OBE is intended to focus and organise the learning process and its final outcome,

which reflects students' achievement at the end of their learning experiences (Malan, 2000; Borsoto et al., 2014).

Faculty of Civil Engineering, Universiti Teknologi MARA (UiTM) has started to use the concept of OBE since 2004. Programme accreditation is a main priority in developing an Engineering Degree programme. One of the requirements for accreditation of the Engineering Programme is the implementation of OBE, promoted by the Washington Accord (WA) as being emphasized by the Engineering Accreditation Council (EAC). The EAC is the only recognized body delegated by the Board of Engineer Malaysia (BEM) for accreditation of engineering degree programmes offered in Malaysia. The accredited engineering degree programmes by EAC were given full recognition as equivalent qualifications by other signatories of WA including the United Kingdom, United State, Hong Kong, Australia, Singapore and Japan.

The OBE implementation process encompasses the establishment of Programme Educational Objectives (PEOs), followed by Programme Outcomes (POs), designing curriculum, teaching and learning (T&L) methods, assessment, Continuous Quality Improvement (CQI) and monitoring. POs which consist of aptitudes to be achieved by students before they graduate are expressed based on the PEOs (Sheikh Rahimullah et al., 2020). The characteristics of an effective PEO such as being a distinct, particular, quantifiable, attainable, direct consequence, and possessing a time frame. The graduates' "employability skills," or generic abilities which include personal aspects as well as the willingness to multitask in groups, can be assessed as portion of their attainment (Abdullah et al.,2012). Then, knowledge, skills (cognitive, psychomotor and affective) and attributes to be attained by students were addressed through POs. Arshad et al. (2012) suggest that a study on students' attainment of program outcomes should be done from time to time so that faculty can examine the students' level of knowledge, skills and abilities with regards to POs, for the T&L aspects can be continuously enhanced.

Alias and Bhkari (2017) has provided an OBE practices model for civil engineering students. While, Taras (2015), Isa et al. (2019) and Basir et al. (2019) have demonstrated that the strong interconnection between the constructive mapping of the outcomes for graduate attributes, proper teaching and assessment activities affect OBE implementation especially in promoting the T&L process. Furthermore, management and measurement systems of POs attainment have been studied and practiced for degree graduates such as by using neural network (Mahesh and Shunmuganathan, 2015), and most web-based systems (Von Konsky, Loh, Robey, Gribble, Ivins, & Cooper, 2006; Colbran, 2011; and Khwaja, 2018).

The POs were formulated in line with the University's Philosophy, Vision and Mission. Comprehensive outcomes taking inputs from the various stakeholders including academics from within the university, academics from other local universities, professional engineers, industrial advisors, alumni and parents of engineering students must be designed in one curriculum to produce capable and high-quality graduates. Students' achievement (educational excellence) is critical in delivering quality graduates who can become leaders of tomorrow and make a significant contribution to the nation's workforce pool (Azis et al., 2019). According to EAC (2020), the teaching, learning and assessment methods shall be performed consistently in accordance to the appropriate graduate attributes as listed in the Programme Educational Objectives (PEO), Program Outcome (PO) and Course Outcome (CO) of the education content. Figure 1 shows the current PEOs had been formulated to support the vision and mission of the University and Faculty.

To date, OBE is being implemented at all levels of education especially at higher educational institutions especially engineering faculty. Following this, many attempts have been made to measure the program learning outcome (PLO), but data complexity remains as the main problem to be solved. Concerns on the fact that certain measurement or data might be left out that might be equally important, a computerized assessment tools to accurately measure the programme outcome has been successfully developed and applied at Faculty of Civil Engineering (FCE), Universiti Teknologi MARA (UiTM) since 2014. The system is known as MyCOPO also function to expedite the analysis process. This paper discusses survey feedback from users of MyCOPO system after six years has been exercised as a computation approach in assessing students' POs achievement at FCE, UiTM. The analysis of the survey feedback can be a benefit for future improvement of the current system.

Twelve (12) POs have been developed for the programme Bachelor Degree of Civil Engineering, FCE, Universiti Teknologi MARA (UiTM). The programme comprises all the necessary engineering qualities

including engineering knowledge, problem analysis, design of solutions, modern tool usage, society, environment and sustainability, project management and finance, investigation, ethics, individual and teamwork, communication and life-long learning. These are also the desired student attributes highlighted in the Engineering Programme Accreditation Standard by EAC (EAC, 2020). MyCOPO system is a management and measurement systems specially established by the Faculty to calculate and analyze the PO attainment for undergraduate students in the FCE, UiTM Shah Alam, Selangor. This system is owned by the faculty, maintained by the technical staff of the faculty in collaboration with a local developer. The system allows POs measurement by groups, classes, courses, semester and cohort. In addition, the system can be accessed by various users such as administrators, academic advisors, lecturers and students for performance monitoring. A student can view his/her POs performance and an academic advisor can use the system as a monitoring tool in student advising. Figure 2 depicted the average POs for the filter semester September – January 2020 generated by MyCOPO.

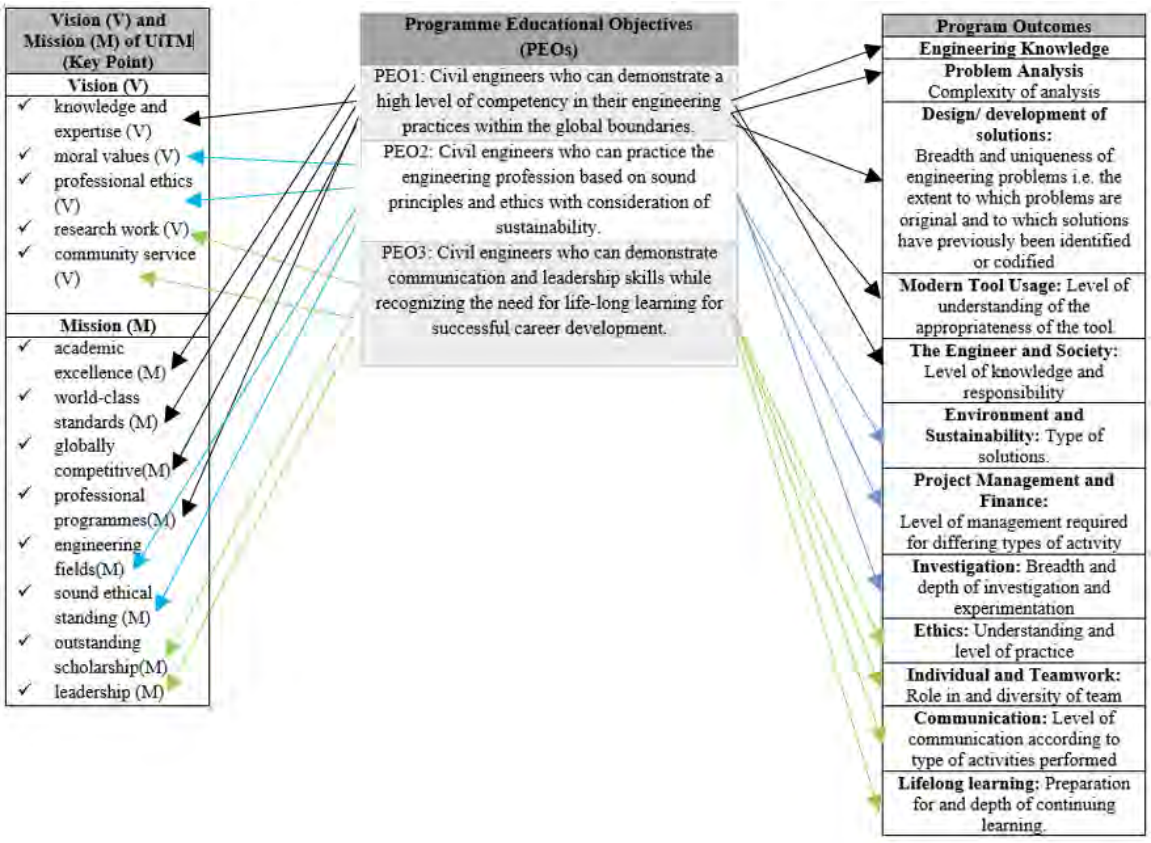

Fig 1. PO linking to PEOs and the Vision and Mission of UiTM

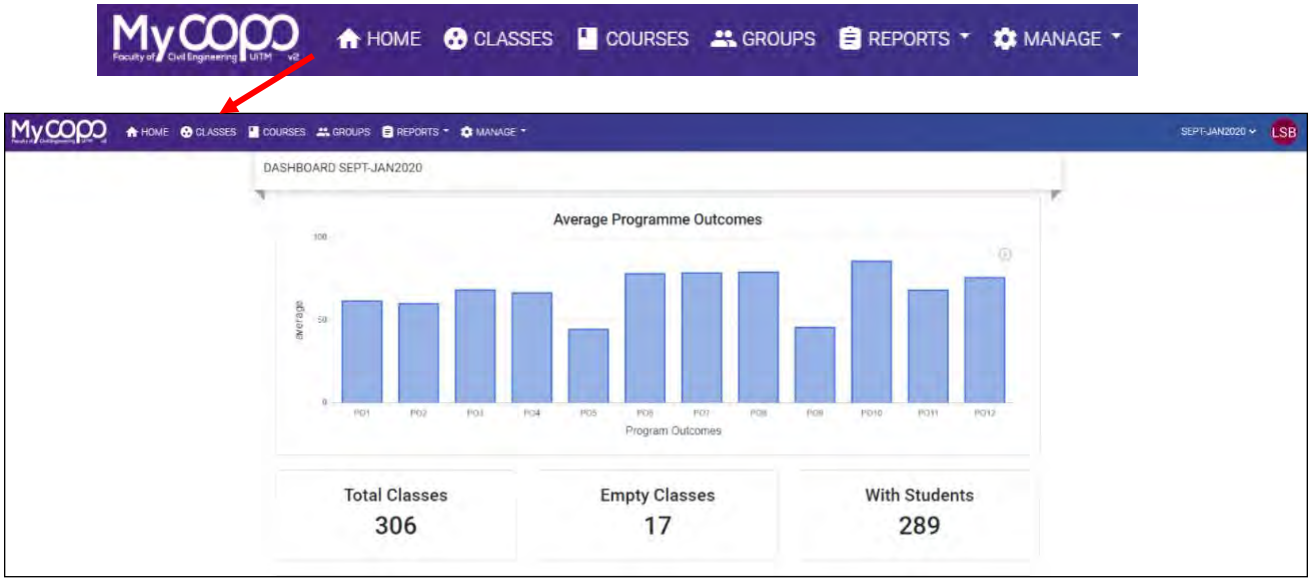

Fig. 2 Sample of MyCOPO output

MyCOPO POs ATTAINMENT MODEL

PO achievement for each course assessment engaged by the student was estimated by gaining the average PO attainment. The following sub-sections designate the PO estimation of individual student PO achievement and subsequently, the attainment model adopted, followed by the PO Performance Indicators.

Estimation of Individual Student PO Attainment

PO attainments for individual student were evaluated based on the cumulative average model. An example of the average model for Student X was elaborated on in the following steps**.** Table 1 demonstrates an example of calculations of one PO (e.g. PO1) attained by Student X with regards to the assessment in Dynamics Course (ECS429) comprising of a common test, assignment/project and final exam.

Table 1. Assessment in Dynamics Course ECS429 addressing PO1 (Example)

Assessment	Assignment/Project	Common Test		Final Exam
Question (Q)	Assignment 1	Q1(a)	Q2(a)	Q1(a), Q2(a)
Marks Obtained	10	8	12	38
Full Marks	15	15	15	50
Weightage	10%	15%	15%	60%

Based on this assessment (see, Table 1), the attainment of PO1 by student X evaluated from Dynamics course ECS429 are given as in Equation (1).

$$\text{PO1} = \frac{10}{15}(10\%) + \frac{8}{15}(15\%) + \frac{12}{150}(15\%) + \frac{38}{50}(60\%) = 72.3\% \quad (1)$$

Meanwhile, the determination of PO1 for Student X in a semester at the FCE, UiTM Shah Alam, Selangor was based on an average of PO1 attained from several courses assessing PO1 in that particular semester. The average PO1 for the semester was then calculated using the empirical formulae as in Equation (2).

$$\text{Average PO} = \frac{\sum(No\ of\ credits\ x\ PO1\ marks)}{\sum(No\ of\ credit)} \quad (2)$$

On the other hand, the final PO1 attainment for Student X after several semesters was calculate based on cumulative average using the written formulae as in Equation (3).

$$\text{Cumulative PO} = \frac{\sum(No\ of\ credits\ x\ PO\ marks)+\cdots+\sum(No\ of\ credits\ x\ PO\ marks)}{\sum(No\ of\ total\ credit)} \quad (3)$$

PO performance indicators

In the end, civil engineering students are expected to pass each PO upon graduation and the performance indicators of PO attainment are shown in Table 2. The key performance indicator (KPI) for the POs attainment was based on the passing mark of the final examination mark (50%) set by the Faculty.

Table 2. Key Performance Indicator (KPI) for the attainment of PO

PO score (%)	Category	Indicator
80-100	Excellent	
60-79	Good	PASS
50-59	Satisfactory	
0-49	Fail	FAIL

2. Methodology

A quantitative survey was used to measure both the academic staff and student satisfaction levels across the Faculty's implementation of MyCOPO system. Since the academic staff and students play different roles in MyCOPO system, two different sets of questionnaires (Set A for staff and Set B for students) were designed for these groups of users. The academic staff has the responsibility to upload their student's attainment in terms of POs in the system whereas the students use the system to view their academic transcript, particularly on POs every semester. Only academic staff and undergraduate students in FCE, Universiti Teknologi MARA Shah Alam were targeted.

Both the questionnaires consisted of approximately 15 questions preceded by few demographic questions and the remaining with specific questions on MyCOPO system. The demographic question in set A such as name and identity number of staff indirectly provides the staff background, years of service and departmental workplace of staff. While students were required to provide student identity numbers, year of study and education qualification in set B. The specific questions were subdivided into three main characteristics in both questionnaires: (1) impactful of the system, (2) effectiveness on delivery and quality of the system, and (3) users' happiness index of using the system.

Figure 3 shows the main characteristics and their components for both sets of questionnaires. In order to accommodate these characteristics, the questionnaires were designed in a mixed mode of 5-point Likert scale, checkbox, multiple choices and comments. The 5-point Likert scale questions require respondent's opinion either: (1) strongly disagree; (2) disagree; (3) neutral; (4) agree; or (5) strongly agree on a topic. Checkbox and multiple choices questions were designed when in-depth opinions are required from the respondents such as the roles of MyCOPO and effectiveness of the system are time-saving. In the end, staff and students were asked to rate the system and make recommendations for the faculty to improve the system.

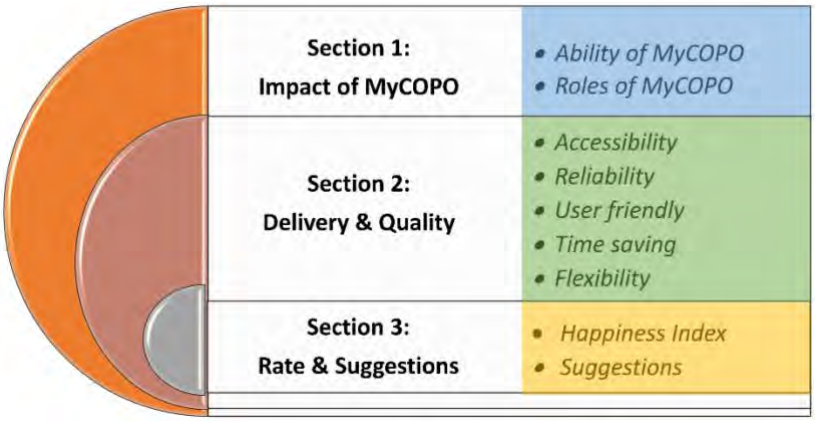

Fig.3 Main characteristics in questionnaires

The survey was conducted online in the faculty within the period between 23rd-29th October 2019. The survey link provided by google form was announced through chat media, circulated among staff and students in the faculty. Participation in the survey was solely voluntary. Based on the feedback given, the respondents took less than 5 minutes to answer the survey. A sample of 47 out of 105 (44.8%) academic staff and 227 out of 1730 (13.12%) Year 1 to Year 4 undergraduate students answered the survey. The survey was analyzed using charts and the results were presented and discussed in the next section.

3. Results

The results discussed in this paper are based on the 47 respondents among the academic staff and 227 students from the FCE, UiTM. Results are discussed in three sections as in the main characteristics of the questionnaire. The three sections are the impact of MyCOPO, delivery and quality and users' happiness index rating.

Impact of MyCOPO

One of the advantages of MyCOPO system, students' performance could be monitored and analyzed in every semester until they completed their study. Staff and students rating on MyCOPO system is depicted in Figure 4. Based on surveys conducted, 46.8% of the academic staff claimed that the system is excellent while another 46.8% agreed that this is a good system. Good and excellent rating have dominated students' rating for MyCOPO system. 17.2% voted for excellent while another 68.3% voted for good. From there, it can be summarized that 93.6% of staff and 85.5% of students stated that the MyCOPO system is good.

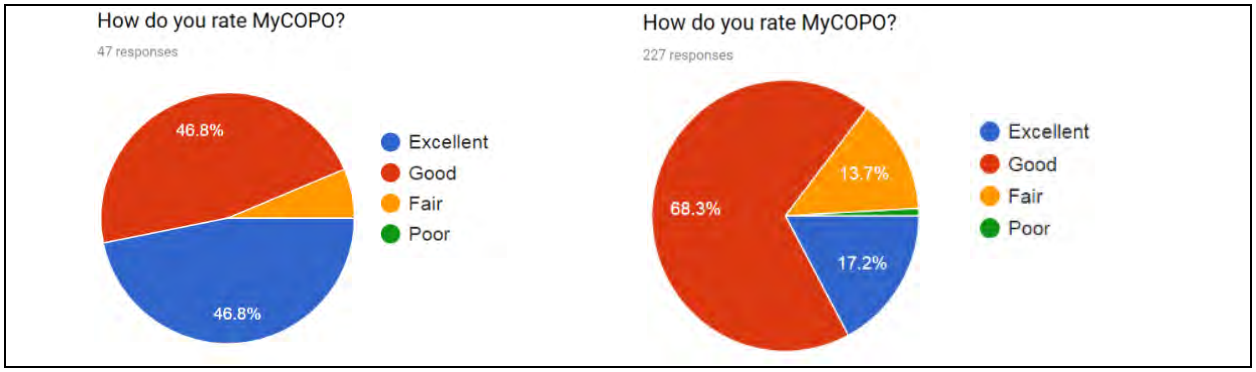

Fig. 4 Staff and students rating on MyCOPO system

All academic staff of the faculty have involved with the measurement and analysis of PO attainment

at the course and programme level before and after the implementation of MyCOPO system. Figure 5 depicted the comparison of time allocation before and after MyCOPO implementation based on the feedback from academic staff. Almost 50% of academic staff agreed that before the implementation of MyCOPO, the time taken for the POs analysis is more than 1 week. However, after the implementation, more than 78.7% of academic staff agreed that the analysis can be conducted within 1 day and 19.1% able to do it within 1 week. Evaluation in terms of time-saving was further conducted based on the equivalency criteria set by the committee: (within 1 day = 1 day, within 1 week = 7 days, within 1 month = 30 days, within 6 months = 180 days, more than 6 months = 365 days). By using these criteria, it is found that the allocation of time used before the implementation of the MyCOPO system was 64.9 days and it has been reduced to just 2.78 days. In other words, it has reduced workforces. Besides, this system is also cost-saving for operation. It was found that the system is capable of reducing the cost of purchasing paper and printer ink. This shows that the system is a better option compared to the previous POs measurement process which was conducted via conventional approach such as manual inputs and spreadsheet calculation and importantly it can be deployed in the future.

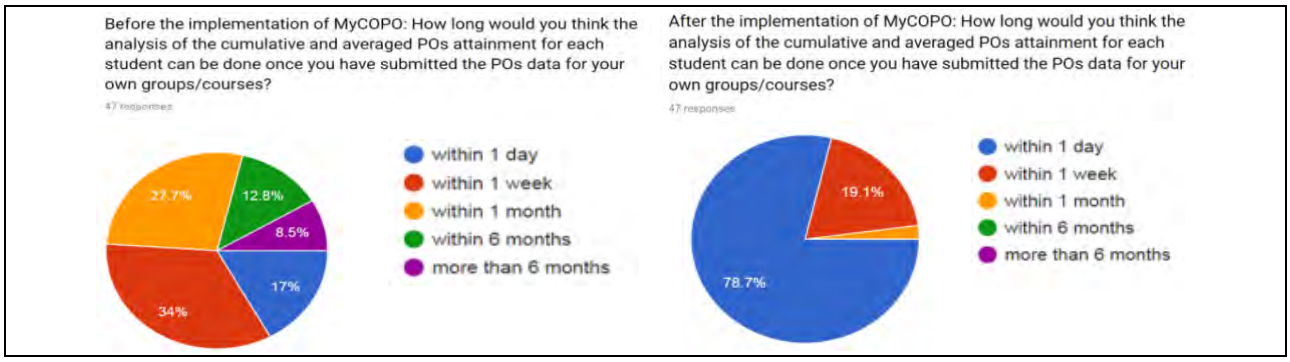

Fig. 5 Comparison of time allocation for analysis before and after MyCOPO implementation

Delivery and Quality of the System

In Figure 6, data from academic staff survey on delivery and quality of the system can be seen. Based on the results, 98.7% agreed that MyCOPO is easily accessible while 85.1% of the academic staff claims that MyCOPO is flexible and can adopt changes made in curriculum reviews, for instance, allowance for new POs to courses mapping matrix. From the findings, most of the respondents, with 95.1 %, agreed on the process of uploading PO data in MyCOPO is fast, easy and user friendly. While for students' surveys (refer to Figure 7), 62.1 % agree MyCOPO is easily accessible. In terms of data presentation in MyCOPO, 65.1% claimed that it can be easily understood.

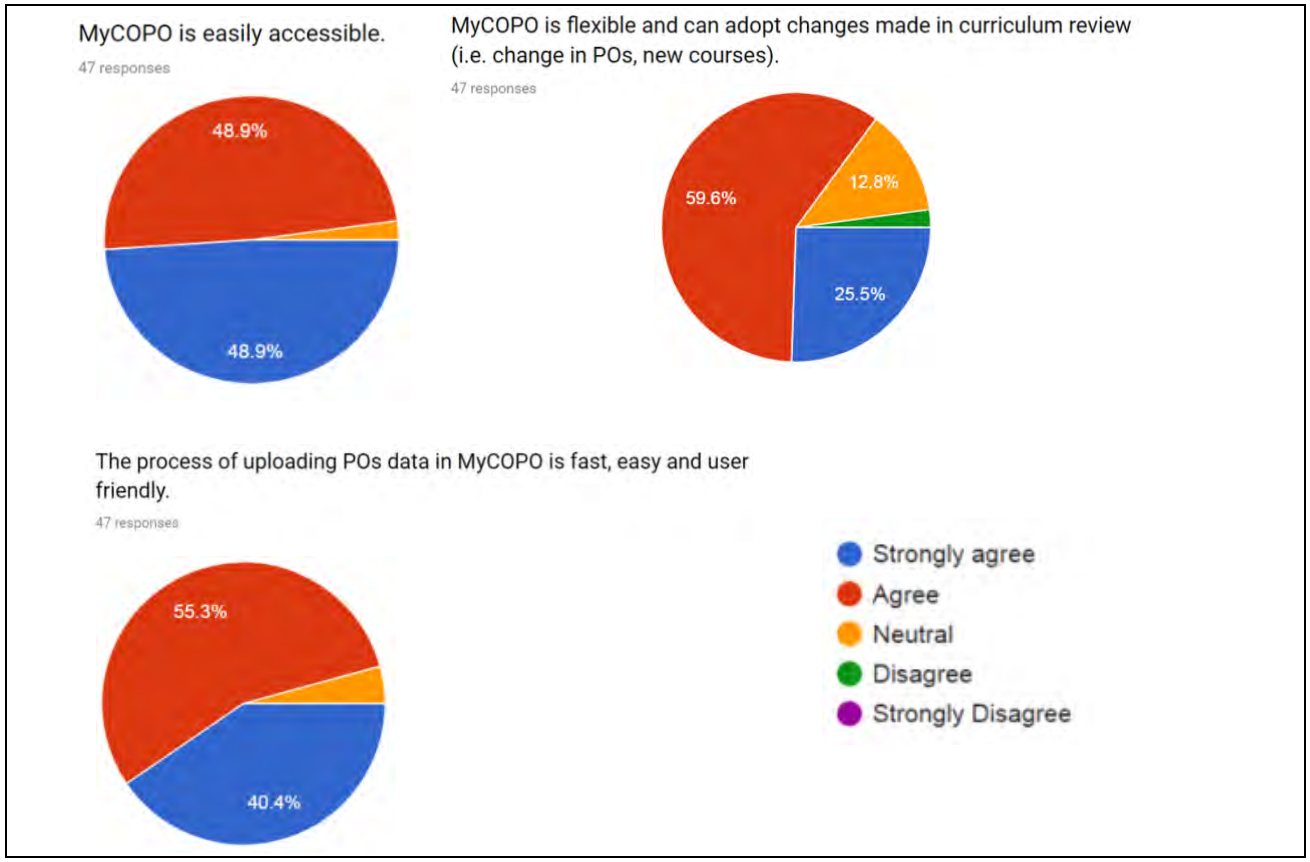

Fig. 6 Data from academic staff survey on delivery and quality of the system

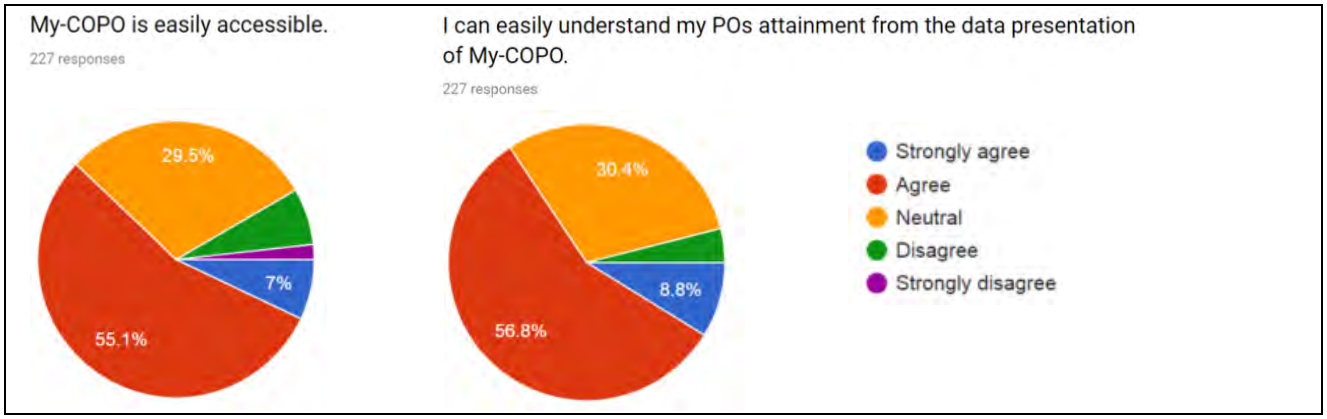

Fig. 7 Data from students' survey on delivery and quality

Users' Happiness Index Rating

Figure 8 presents academic staff and students' survey on the happiness index in using MyCOPO system. The happiness index of scales less than 5 is considered unhappy, scales 5-6 is satisfactory and scales 7-8 is happy and scales 9-10 is strongly happy with the system. In term of the happiness index rating given by the respondents, analysis of data shows that 80.9% of the academic staff and 69.2% of students are happy with the system. From the findings, the average rating of happiness index for academic staff and students are 8.2

and 7.2, respectively.

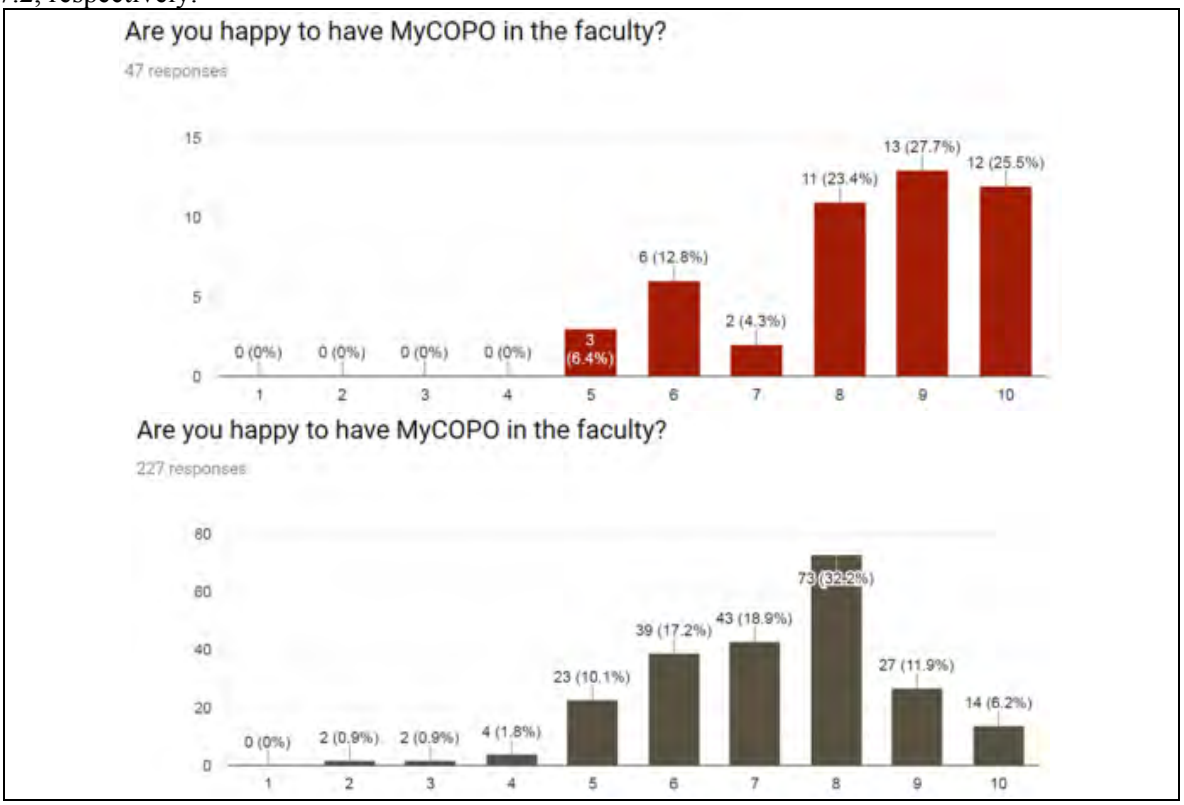

Fig. 8 Academic staff and students' survey on happiness index in using MyCOPO system

In addition to the positive impacts mentioned before, MyCOPO system has also been used as a reference. Several educational institutions have carried out benchmarking programs to obtain more detailed information on how the system being developed. Proudly, this system has won several awards in innovation competitions such as IIDEX and ITEX. Also, it has been presented during the Programme accreditation activities, and in the process of obtaining a copyright.

4. Discussion

Satisfaction of students and the staff as client and operation team in the higher education institution are crucial in improving the performance of higher education (Al Khattab and Frajj, 2011; Mahmood et al., 2014; Adnan et al., 2016; Razinkina et al., 2018). Thus, monitoring students and staff satisfaction for a system that was developed to continuously improving the learning experience is also essential (Razinkina et al., 2018). Therefore, MyCOPO was designed as part of the continuous quality improvement outcome to improve the academic performance by providing a direct report in monitoring students' attainment throughout their study year. Students' can monitor their performance due to easy access to the system and also user friendly. It also helps the academician to monitor students' performance, especially as the academic advisor.

In this study, a quantitative survey has been conducted to measure academic staff and students' satisfaction level of MyCOPO implementation in the faculty. Due to different role, two different sets of questionnaires (Set A for staff and Set B for students) were designed for these groups of users. The 5-point Likert scale questions require respondent's opinion either: (1) strongly disagree; (2) disagree; (3) neutral; (4) agree; or (5) strongly agree on a topic were included. The specific questions were subdivided into three main characteristics in both questionnaires to highlight impactful of the system, effectiveness on delivery and quality of the system, and users' happiness index of using the system.

The impact of MyCOPO on users was measured by rating where more than 80% of the users found that MyCOPO is a good system. Furthermore, 78.7% of the staff also agree that MyCOPO has reduced the time allocated for cumulative analysis to just 1 day. In term of delivery and quality of the system, result from academic staff portrayed that MyCOPO is easily accessible can adopt changes made in curriculum review and it helps data uploading process become easy, fast and user friendly. Students;' survey support that MyCOPO is easily accessible and the data are presentable and easily understood. Results on users' happiness index rating show that 80% of the academic staff and 69% of the students are happy with the system.

Overall, the implementation of MyCOPO has improved the process of data monitoring for students' attainment in FCE. MyCOPO is capable to provide an instant report of the overall students' attainment for audit and reporting purpose especially as required by EAC. This system has potential and can be implemented for other faculty as well as organisations.

5. Conclusion

This study presents the satisfaction levels from both the academic staff and students across the Faculty's implementation of MyCOPO system through a quantitative survey. Academic staff and students' perceptions on the impact of MyCOPO, delivery and quality as well as users' happiness index were analysed. Both the academic staff (93.6%) and student (85.5%) agreed that MyCOPO is an impactful system in the measurement of all students' twelve POs achievement at the programme level for a Civil Engineering programme. The effectiveness of the system in terms of delivery and quality was evaluated based on the saving in time, cost and human resources. Implementation of MyCOPO was found to effectively save the operation time for up to two months compared to the conventional approach (i.e. spreadsheet calculation). Furthermore, academic staff strongly agrees that this system is easily accessible, user friendly and able to cope with change during curricular development. Since only about 65% of the students agreed that they can understand the data presentation, it is recommended that the academic supervisor of the Faculty discuss the attainments with their student periodically. Overall, the benefits of MyCOPO have obtained high ratings from academic staff (8.2) and students (7.2) in terms of the users' happiness index. MyCOPO analysis results are direct and help the students by portraying the overall POs achievement, which allows them to see the overall view of their academic achievements. The study can provide useful information about the needs in the development of a similar measurement system for undergraduate engineering programmes. A good and reliable attainment measurement system is important especially in planning the continual improvement actions for the programme delivery.

6. Acknowledgement

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