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Measuring Program Attainments (POs) of Bachelor of Chemical Engineering (Environment) using OBE – ANAS v14.0 Tool

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ABSTRACT

Education system is recognised around the globe as an important element for a country's development. Therefore, the prominence of education system around the world cannot be denied. In order to empower the education, the concept of Outcome Based Education (OBE) was first initiated by the academicians (who in particular?). Malaysia is also in line with other countries which pay close attention to the importance of OBE impact in the higher education institutions. The OBE implementation plays an important role in defining skills (psychomotor), knowledge (cognitive) and behavior (affective) for each graduate attributes. This paper is written to measure the program outcomes (POs) of Bachelor of Chemical Engineering (Enviroment) with honors (EH224) for its accreditation purpose. OBE concept system consists of significant aspects for measuring, monitoring and evaluating to determine whether or not the POs are attainable in producing the competencies of the selected graduates. The tool to fulfill the measuring POs is worked out by the Faculty of Electrical Engineering OBE committee members and known as OBE-ANAS system. A graphical user interface (GUI) is designed based on the Microsoft Visual C# programming language and Microsoft SQL Server 2012 (MSSQL 2012) is used as a database system. The tool is useful for measuring POs parameters such as POs average, POs density, individual POs and then, measuring the programme strength by implementing the measurement model which is the Degree of Programme Achievement (DPA).

Keywords: *OBE-ANAS system;Program outcomes;Degree of programme achievement;Outcome based education;Engineering education*

1. INTRODUCTION

Nowadays, accreditation is required for any higher education institutions focusing on its institutional establishment. This is especially true for an institution with the aim that each graduate will be acknowledged in their working field. It is also to maintain the high standards required in the engineering programs in Malaysia. It is the sole responsibility of any institutions to determine how their program meets the specific criteria such as PEO, PO, CO, Assessment, Students, Facilities, Program Criteria and etc. As such, the Engineering Accreditation Commission (EAC) has required a well documented progress on the students' learning

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outcomes' achievement [1]. The documentations should contain the plan, implementation, assessment and evaluation of the program conducted by the faculty [2].

Regardless of this matter, University of Technology MARA (UiTM) has adopted OBE system amongst the staff since the year 2005. Starting 2007, the entire degree courses were imposed on having the OBE elements charted out in each of its syllabus [3]. It is of importance to note that OBE is an approach that focuses on the outcomes especially the achievements of students. The implementation of OBE paradigm and its impact on the entire education system especially to the students and lecturers has become crucial elements in fulfilling the accreditation needs.

According to Spady [4], "Outcomes Based Education means clearly focusing and organizing 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". OBE was characterized as an outcome-oriented approach where it differed from conventional system; the input and the process overruled the output whereas OBE provides the alternative approach to converge the results [5]. The results measure the program outcome level and achievements with the highpoint of educational strategy.

The major components of OBE are divided into three divisions, i) Program Educational Objectives, ii) Program Outcomes and iii) Course Outcomes. However, the focus is on measuring the program attainment (PO) for this course since in the OBE curriculum, the students' progress and improvement are only feasible whenever related data are gathered from the POs. [7].

1.1 Program Outcomes for Accreditation

The program offered by Bachelor of Chemical Engineering (Enviroment) with Honours (EH224) of Faculty of Chemical Engineering, UiTM Pulau Pinang has twelve (12) POs which have been designed to fulfill the requirement of the EAC 2012 manual. It is a four-year programme with a total of 129 credit hours. The curriculum is designed to provide strong fundamentals in Chemical Engineering focusing on the environmental disciplines such as waste minimization, waste treatment and waste management. Throughout the Engineering Accreditation Council (EAC), a Self Assessment Report (SAR) is presented as evidences for the accreditation criteria.

SAR is a report that provides a complete four elements covering the plan, implementation, assessment and evaluation of the programme. All the evidences required include the evaluation from industries towards graduates from chemical engineering performances involving elements of soft skills such as leaderships, communication, critical and problem-solving skills and teamwork which are essential in the real working environment.

Program outcomes are expected to produce a skillful and knowledgeable student after completing the program [2, 7]. Pertaining to ABET Criteria 2015 – 2016 [8], program outcomes define what students are expected to comprehend and able to achieve by the time of graduation. Table 1 shows the program outcomes (POs) offered by Bachelor of Chemical Engineering (Enviroment) that has been designed to produce top quality of abilities and knowledge for each Chemical Engineering graduate in order to cater to the industry's needs.

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Table 1: Program Outcomes by Bachelor of Chemical Engineering (Enviroment)

PO1	Ability to apply knowledge of mathematics, science, engineering fundamentals to solve complex engineering problems in chemical and environmental engineering.
PO2	Ability to identify, formulate, analyze and solve complex chemical and environmental engineering problems using the principles of mathematics, applied science and engineering.
PO3	Ability to design component, system and process for complex chemical and environmental engineering problems with an appropriate consideration on health, safety, society and environment.
PO4	Ability to conduct complex chemical and environmental investigation using research-based knowledge and method including design of experiment, analysis and interpretation of data to provide valid conclusion.
PO5	Ability to utilize modern science, engineering or IT tools and systems to solve complex chemical and environmental engineering problems.
PO6	Ability to assess safety, health, legal and cultural issues in engineering scenarios that affect society.
PO7	Ability to demonstrate professional engineering solution in societal and environmental contexts for sustainable development.
PO8	Ability to recognize the ethical principles and apply the professional conducts in engineering practice.
PO9	Ability to communicate effectively not only with engineers but also with the community at large.
PO10	Ability to function effectively as an individual as well as in a group with the capacity to be a resourceful person, leader and an effective team member.
PO11	Ability to engage in independent and life-long learning.
PO12	Ability to manage projects related to chemical and environmental engineering, and/or entrepreneurial business that involve multidisciplinary roles.

All POs stated were reviewed and determined by the top management council whereby it also considered the feedbacks from the stakeholders for instance the industries, employers, alumni and parents [9].

1.2 Implementation Assessment for Accreditation

One of the crucial elements in accreditation is assessment. It plays a very important role in developing cognitive, psychomotor and affective domains of the students so that they are properly assessed. The assessment evaluation was improved with regards to the OBE implementation which assists the students respectively.

Assessments provided was used as an indicator to measure the students' achievements and learning effectiveness. Various methods of measurements and evaluations used such as quizzes, assignments, tests, laboratory works,final examinations, industrial training and etc. will display the achievements of specific program outcomes and the outcomes from assessments are used to improve program constantly [10].

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The evidences from the assessments were evaluated by the faculty to observe the students' works via program requirements. Those assessments were set as an important implementation for OBE system. Therefore, the proposed tools were utilized to ease the data analysis which is compulsory for the EAC accreditation. This tool is believed to provide a better platform for the faculty committee to analyze the outcomes of the students' performances [2].

2. METHODOLOGY

2.1 OBE-ANAS v14.0 System Overview

Generally, OBE-ANAS system is developed based on two main tools which are Microsoft Visual C# and Microsoft SQL Server application programs. These two core programs are implemented as an online system which is shown in Figure 1. The graphical user interface (GUI) is designed, based on Microsoft Visual C# whose user is referred to as an instructor to communicate with the database. Figure 2 shows the front page of OBE-ANAS v14.0 GUI system. To reduce the design cost, the freeware database provided by Microsoft SQL Server 2017 Express Edition is used as its storage system.

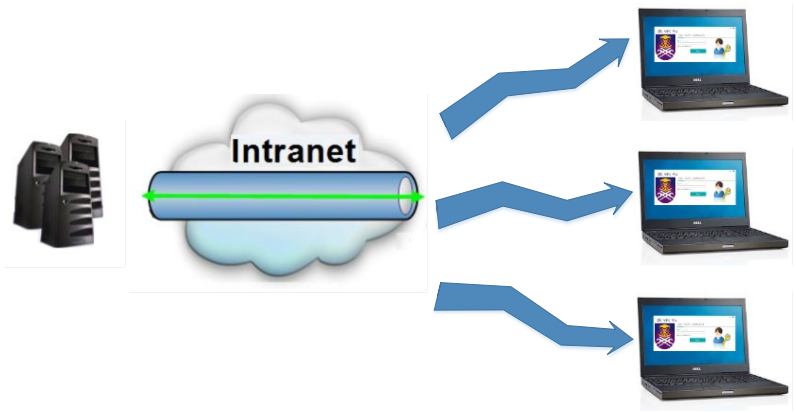

Figure 1: Online system

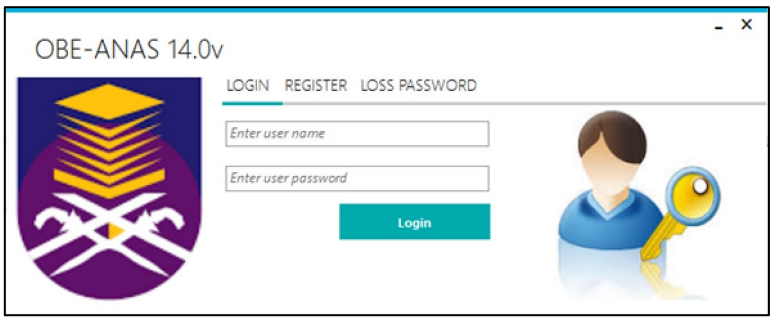

Figure 2: OBE-ANAS v14.0 interface system

In this OBE-ANAS v14.0 GUI, the instructor amongst the faculty members will analyse programme attainment based on the students' OBE marks. The OBE marks are provided from the course assessment which contained the COs and POs detailed marks.

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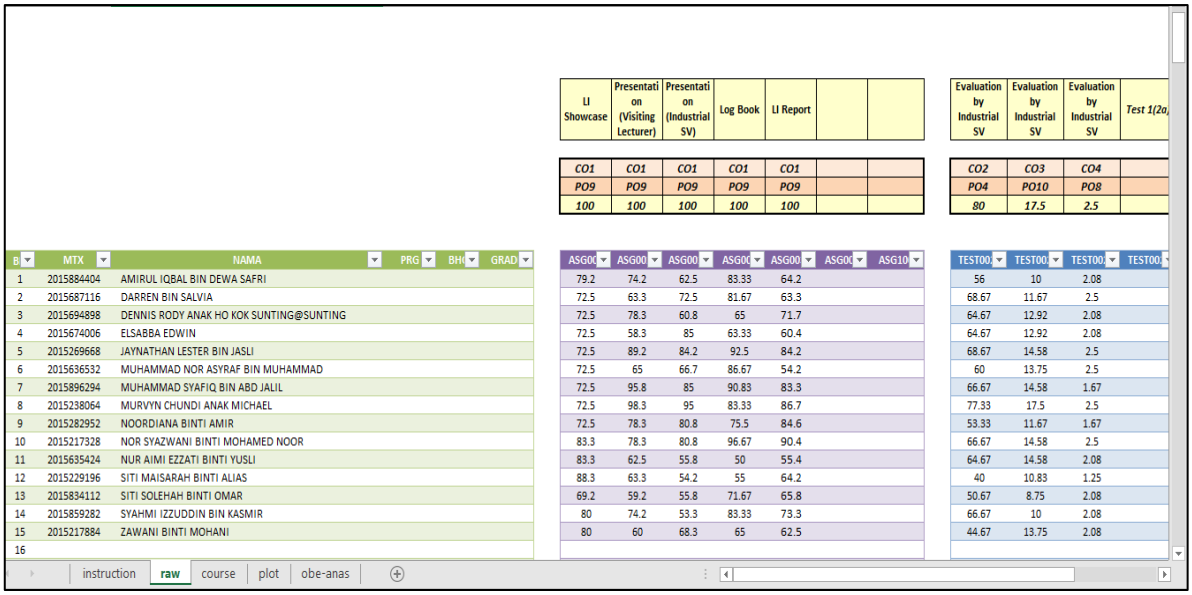
Thus, to simplify this process, a special Excel template has been developed by the faculty to ease the calculation of student scores in the particular course. Figure 3 shows the sample of the respective developed excel template.



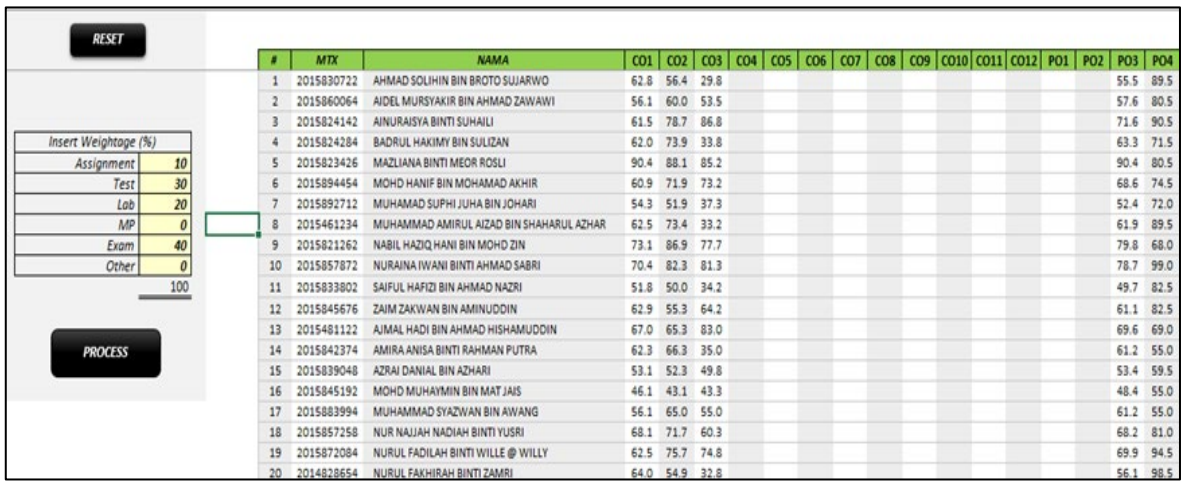
	LI Showcase	Presentation (Visiting Lecturer)	Presentation (Industrial SV)	Log Book	LI Report			Evaluation by Industrial SV	Evaluation by Industrial SV	Evaluation by Industrial SV	Test 1(2a)
	CO1	CO1	CO1	CO1	CO1			CO2	CO3	CO4	
	PO9	PO9	PO9	PO9	PO9			PO4	PO10	PO8	
	100	100	100	100	100			80	17.5	2.5	

B	MTX	NAMA	PRG	BH	GRAD	ASG00	ASG00	ASG00	ASG00	ASG00	ASG0	ASG10	TEST00	TEST00	TEST00	TEST00
1	2015884404	AMIRUL IQBAL BIN DEWA SAFRI				79.2	74.2	62.5	83.33	64.2			56	10	2.08	
2	2015687116	DARREN BIN SALVIA				72.5	63.3	72.5	81.67	63.3			68.67	11.67	2.5	
3	2015694898	DENNIS RODY ANAK HO KOK SUNTING@SUNTING				72.5	78.3	60.8	65	71.7			64.67	12.92	2.08	
4	2015674006	ELSABBA EDWIN				72.5	58.3	85	63.33	60.4			64.67	12.92	2.08	
5	2015269668	JAYNATHAN LESTER BIN JASLI				72.5	89.2	84.2	92.5	84.2			68.67	14.58	2.5	
6	2015636532	MUHAMMAD NOR ASYRAF BIN MUHAMMAD				72.5	65	66.7	86.67	54.2			60	13.75	2.5	
7	2015896294	MUHAMMAD SYAFIQ BIN ABD JALIL				72.5	95.8	85	90.83	83.3			66.67	14.58	1.67	
8	2015238064	MURVYN CHUNDI ANAK MICHAEL				72.5	98.3	95	83.33	86.7			77.33	17.5	2.5	
9	2015282952	NOORDIANA BINTI AMIR				72.5	78.3	80.8	75.5	84.6			53.33	11.67	1.67	
10	2015217328	NOR SYAZWANI BINTI MOHAMED NOOR				83.3	78.3	80.8	96.67	90.4			66.67	14.58	2.5	
11	2015635424	NUR AIMI EZZATI BINTI YUSLI				83.3	62.5	55.8	50	55.4			64.67	14.58	2.08	
12	2015229196	SITI MAISARAH BINTI ALIAS				88.3	63.3	54.2	55	64.2			40	10.83	1.25	
13	2015834112	SITI SOLEHAH BINTI OMAR				69.2	59.2	55.8	71.67	65.8			50.67	8.75	2.08	
14	2015859282	SYAHMI IZZUDDIN BIN KASMIR				80	74.2	53.3	83.33	73.3			66.67	10	2.08	
15	2015217884	ZAWANI BINTI MOHANI				80	60	68.3	65	62.5			44.67	13.75	2.08	
16																

instruction | raw | course | plot | obe-anas

Figure 3: COs and POs assessment template

With reference to the template, the instructor will include student scores based on assessment types obtained in the course information. This Excel template generally covers on the assessment such as assignment, test, laboratory, mini project, final exam and others (any related assessment type). The instructor will have provided the student marks based on the assessment type which are mapped out to the corresponding COs/POs marks. After all the assessment marks are applied, only thus, overall marks will be analysed on the worksheet with the name of "PLOT". In this worksheet, all the students' marks based on OBE is tabulated as a graph. Figure 4 shows a sample of students' result obtained from the CEV645 course – Industrial Training.



RESET

Insert Weightage (%)	
Assignment	10
Test	30
Lab	20
MP	0
Exam	40
Other	0
	100

PROCESS

#	MTX	NAMA	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10	CO11	CO12	PO1	PO2	PO3	PO4
1	2015830722	AHMAD SOLIHIN BIN BROTO SUJARWO	62.8	56.4	29.8												55.5	89.5
2	2015860064	AIDEL MURSYAKIR BIN AHMAD ZAWAWI	56.1	60.0	53.5												57.6	80.5
3	2015824142	AINURAISYA BINTI SUHAILI	61.5	78.7	86.8												71.6	90.5
4	2015824284	BADRUL HAKIMY BIN SULIZAN	62.0	73.9	33.8												63.3	71.5
5	2015823426	MAZLIANA BINTI MEOR ROSLI	90.4	88.1	85.2												90.4	80.5
6	2015894454	MOHD HANIF BIN MOHAMAD AKHIR	60.9	71.9	73.2												68.6	74.5
7	2015892712	MUHAMAD SUPHI JUHA BIN JOHARI	54.3	51.9	37.3												52.4	72.0
8	2015461234	MUHAMMAD AMIRUL AIZAD BIN SHAHARUL AZHAR	62.5	73.4	33.2												61.9	89.5
9	2015821262	NABIL HAZIQ HANI BIN MOHD ZIN	73.1	86.9	77.7												79.8	68.0
10	2015857872	NURAINA IWANI BINTI AHMAD SABRI	70.4	82.3	81.3												78.7	99.0
11	2015833802	SAIFUL HAFIZI BIN AHMAD NAZRI	51.8	50.0	34.2												49.7	82.5
12	2015845676	ZAIM ZAKWAN BIN AMINUDDIN	62.9	55.3	64.2												61.1	82.5
13	2015481122	AJMAL HADI BIN AHMAD HISHAMUDDIN	67.0	65.3	83.0												69.6	69.0
14	2015842374	AMIRA ANISA BINTI RAHMAN PUTRA	62.3	66.3	35.0												61.2	55.0
15	2015839048	AZRAI DANIAL BIN AZHARI	53.1	52.3	49.8												53.4	59.5
16	2015845192	MOHD MUHAYMIN BIN MAT JAIS	46.1	43.1	43.3												48.4	55.0
17	2015883994	MUHAMMAD SYAZWAN BIN AWANG	56.1	65.0	55.0												61.2	55.0
18	2015857258	NUR NAJJAH NADIAH BINTI YUSRI	68.1	71.7	60.3												68.2	81.0
19	2015872084	NURUL FADILAH BINTI WILLE @ WILLY	62.5	75.7	74.8												69.9	94.5
20	2014828654	NURUL FAKHIRAH BINTI ZAMRI	64.0	54.9	32.8												56.1	98.5

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Figure 4: Overall student results based on COs and POs marks distribution

In the same of excel template, the instructor will generate an “OBE-ANAS” file which extracts marks of COs and POs according to the format required by the OBE-ANAS v14.0 tool. At this point, the instructor will access the tool to upload the students’ marks onto the OBE-ANAS server.

Once the instructor enters the correct username and password, the system will display four main tabs which are "FLOW", "MANUAL", "UPLOAD" and "VIEW" in the welcome menu as shown in Figure 5. On the "FLOW" and “MANUAL” tabs, it shows the procedure for the process of uploading students’ mark into the OBE-ANAS database. On the third tab namely as “UPLOAD” is the one to be used by the instructor to upload OBE-ANAS excel template. The instructor is required to select the correct program and course by enabling the “Search” button. Then, the “Browse” button is used to import corresponding excel template and to start the upload process, the “Upload” button is used. The system automatically searches the students’ detail and stores the data in the OBE-ANAS database. The system also generates information if the upload process consists of any error or success. Figure 6 below shows the interfaces (interface or interfaces) of the "UPLOAD" tab.

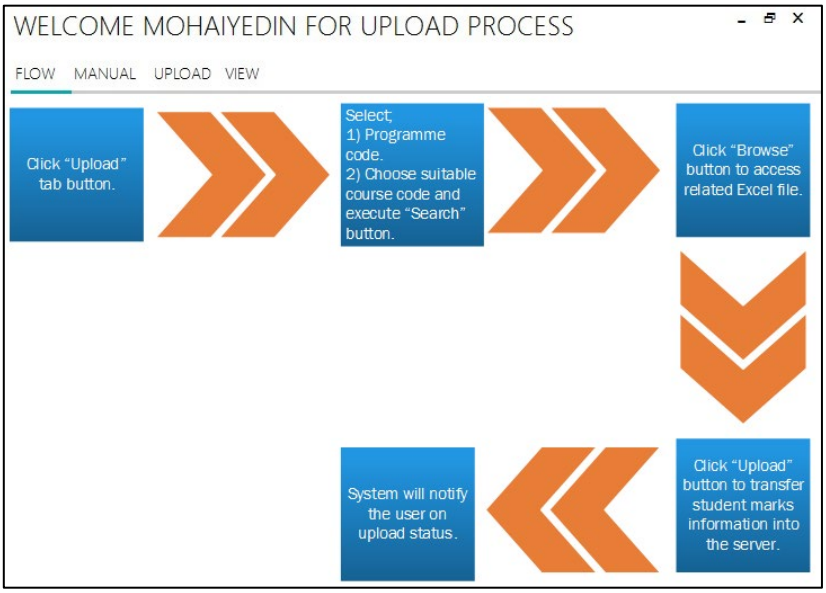

Figure 5: OBE-ANAS v14.0 welcome menu

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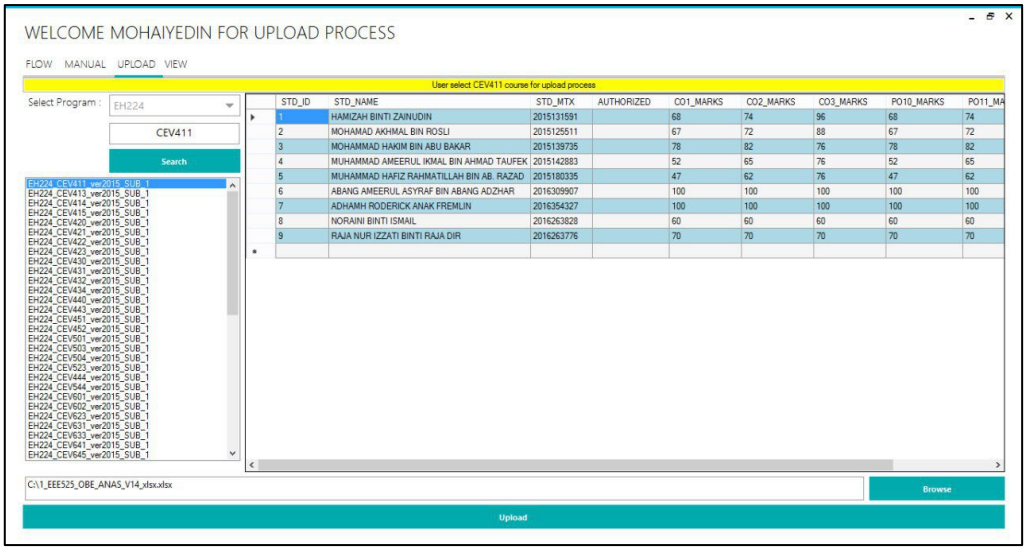

Figure 6: OBE-ANAS v14.0 "UPLOAD" tab

The instructor is able to view the student marks information stored in the OBE-ANAS database by selecting the "VIEW" tab. Fig 7 shows sample of the information which is retrieved from the database.

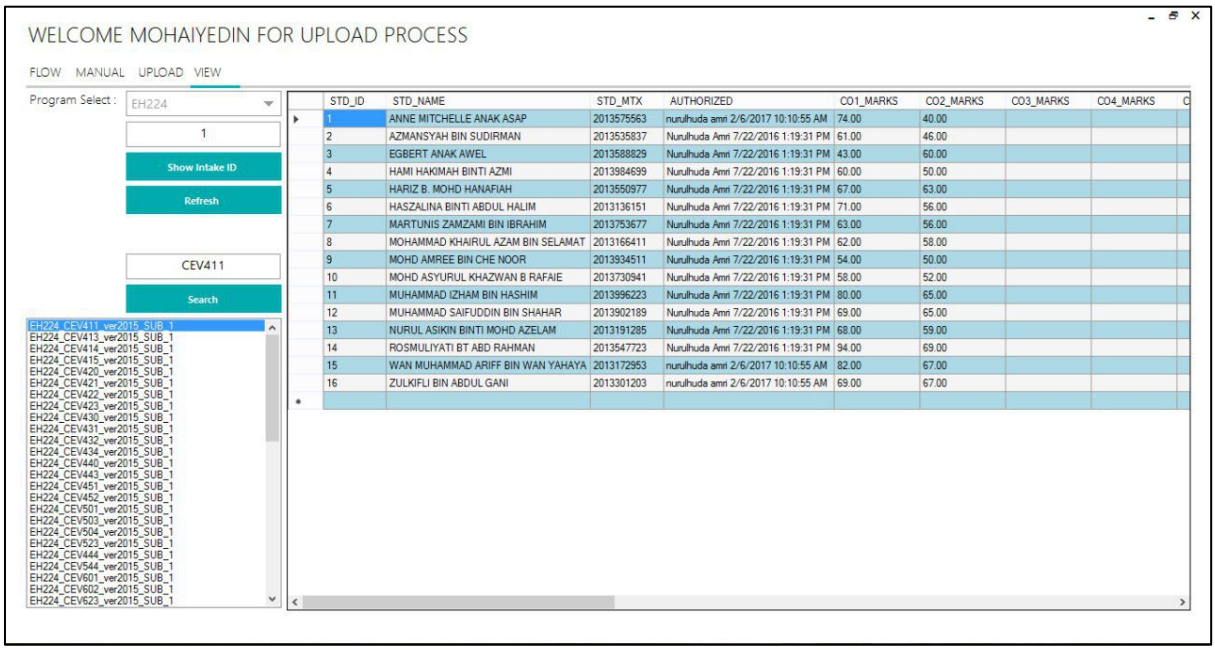

Figure 7: OBE-ANAS v14.0 "VIEW" tab

After all the students' information has been uploaded by the instructor, the representative of OBE unit in the faculty will access the same tool to carry out the process of analysing the POs attainment of the programme. To enable this process, the unique username and password are used to access this section. Figure 8 shows the POs attainment analysis section obtained by the OBE-ANAS v14.0 tool. Inside the tool, four (4) main tabs which are "SETUP", "ANALYSIS", "CALCULATE PO(s) AVERAGE" and "CALCULATE PO(s) DENSITY" are utilised for measuring the programme POs.

The beginning of the section is known as "SETUP". In this part, it is necessary for the user to choose the correct programme and student cohort code. Based on the user selection, system will automatically

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retrieve all information from the OBE-ANAS database. In the "ANALYSIS" tab section, the POs measurement result is obtained by enabling "Analysis Overall POs" button. In Figure 8, the marks which appear in the system are based on the average of an individual student's marks. This average mark is calculated by the system by mapping the total courses in the database with the corresponding POs. Next, another two Windows tabs named "Calculate POs Average" and "Calculate POs Density"are used to measure average score obtained from the dataset in the "Analysis" tab. The POs average score shows the percentage of total average which represents the programme score while for the POs density score, this represents the percentage of total frequent score of the marks that passes the 50% mark score. Both analysisare calculated by the system automatically and the result is tabulated by histogram chart which discusses in more detail in the Result and Discussion section.

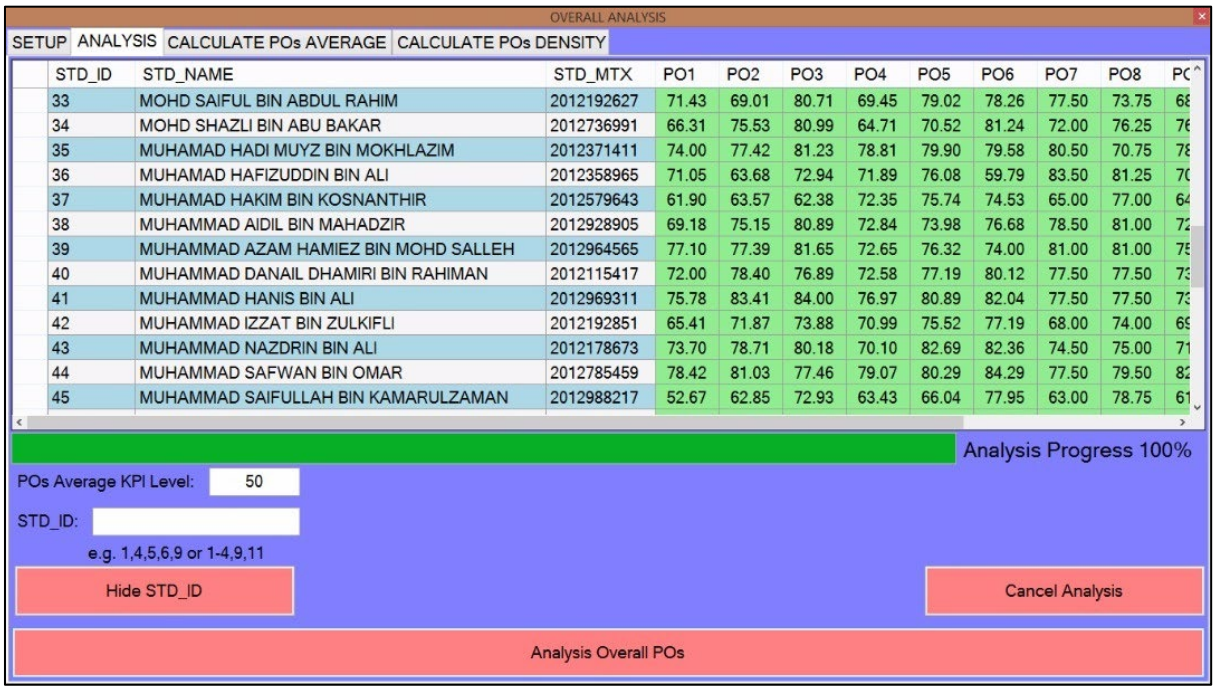

Figure 8: OBE-ANAS v14.0 Overall POs analysis tab.

3. RESULTS AND DISCUSSION

The POs achievement for the EH224 programme was implemented in two (2) main stages. The POs average and density are used to measure the programme performance. The OBE-ANAS system is used to retrieve the student information marks and analyse the measurement type discussed earlier. In addition, the Key Performance Index known as KPI is used to indicate the programme performance. This indication is described in Table 2 and Table 3. With reference to Table 2 highlighting the KPI for PO Average indicates that the batch of students achieved the POs score ranging from 0 to 49 percent is considered in the "Fail" category. If the students achieved the POs score ranging from 50 to 100 percent, then they are considered in the "Pass" category. Each of student's cohort is expected to achieve a PO Average of at least a "Pass" category for all the POs.

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Next, the POs density analysis where the KPI for this POs is stated in the Table 3. Here, two type of levels which are Non-compliance (NC) and Compliance (C). The KPI target for PO density is equal or exceeds 75%. This means that at least 75% of student intakes are required to be 'Pass' for a particular PO in order to obtain the 'Compliance' status.

Table 2: KPI for POs average achievement

KPI RANKING	
POs (%)	Category
0 – 49	Fail
50 - 100	Pass

Table 3: KPI for POs density achievement

KPI RANKING	
Benchmarking (%)	**Level**
0 -74	NC: Non-Compliance
75-100	C: Compliance

Based on the analysis type available in Table 2 and Table 3, the additional analysis which is the strength of programme is assessed using a model named as the Degree of Programme Achievement (DPA). In Table 4, the rubric scale for the DPA which is related to the number of POs that exceeds the KPI target of POs average and density is illustrated. In order to ensure the achievement of POs, FKKPP implements various teaching and learning activities as well as assessment methods that are relevant to the nature of the courses in the EH224 programme. Every semester, the POs attainments are reviewed and areas for improvement are identified via the CQI process. Every course in EH224 programme is developed in a manner whereby the Course Outcomes (COs) are mapped directly and explicitly onto the POs. This allows for direct PO measurements from the assessment results for each COs. The following subsections provide detailed discussions on the evaluation of PO achievements

Table 4: Rubric of DPA

Scale	**Number of POs Achieved KPI**
1 -Very Concern	If 1 - 3 bars exceed KPI benchmark
2- Concern	If 4 - 5 bars exceed KPI benchmark
3 -Good	If 6 - 7 bars exceed KPI benchmark
4 -Very Good	If 8 - 9 bars exceed KPI benchmark
5 -Excellent	If 10 – 12 bars exceed KPI benchmark

The PO Average results for the first cohort (Intake March 2014) and second cohort (Intake September 2014) is shown in Figure 9. The red dot line indicated the KPI for POs average

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which is 50% (Pass category). The analysis indicates that POs average attainment for all POs (PO1 to PO12) have achieved the KPI target for Cohort 1 and 2. However, PO3 and PO6 were identified as focus areas for continuous improvement opportunities. Figure 10 shows the result of DPA for Cohort 1 and Cohort 2 as referred to in the POs average, whereby both achieved scores 12 out of 12 POs that exceed KPI for POs Average. Thus, the EH224 programme can be considered as 'Excellent' achievement for both cohorts. The POs Density attainment for Cohort 1 and Cohort 2 is shown in Figure 11. The KPI for POs Density is set at 75% as shown in Table 3.

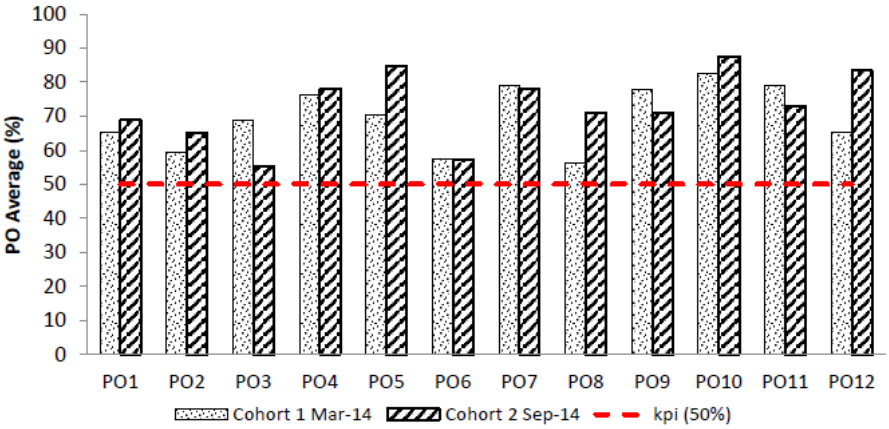

Figure 9: POs average attainment based on cohort of students

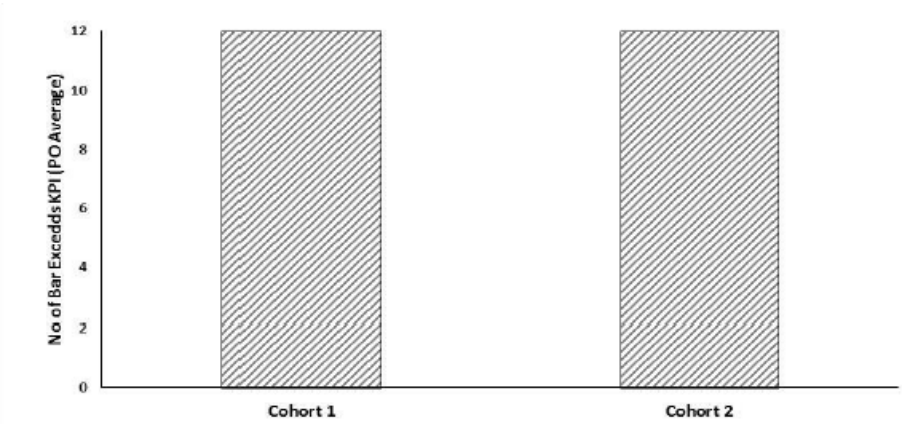

Figure 10: Strength of EH224 Programme Based on PO Average Measurement

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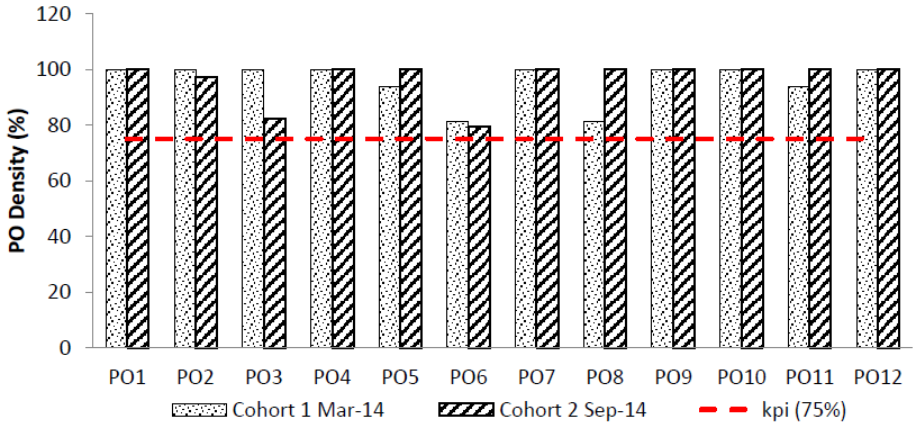

Figure 11: POs density attainment based on Cohort of the students

The attainment of all POs (PO1 to PO12) has achieved the KPI target for both cohorts. As mentioned before, the POs density measures the indicator on the number of students for a particular cohort, in which their PO average score is equal or exceeds 50% (pass). The PO Density analysis showed that PO3 and PO6 have lower POs score which correlates with the POs average analysis as stated before. Figure 12 shows the result of DPA for Cohort 1 and Cohort 2. Both cohorts score 12 out of 12 POs that exceed KPI for POs Density. Thus, the EH224 programme can be considered as 'Excellent' achievement for the first two cohorts of students that already graduated in January 2017 and July 2017, respectively.

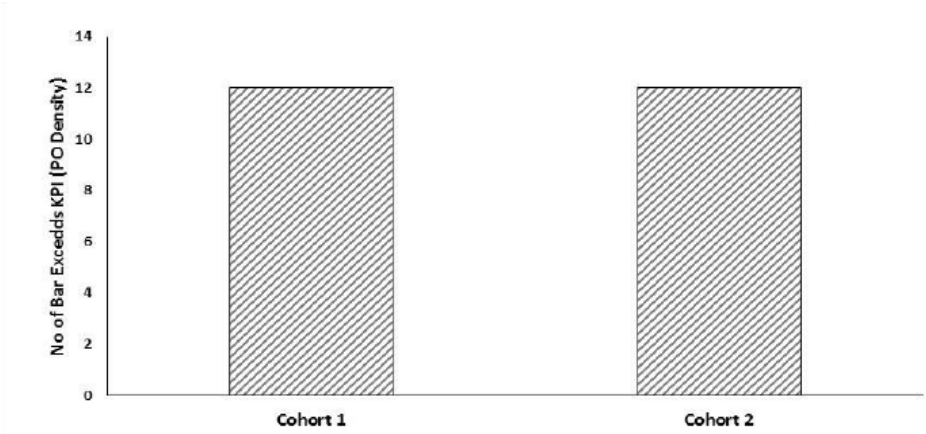

Figure 12: Strength of EH224 programme based on POs density measurement

4. CONCLUSION

In the process of the EAC accreditation, POs measurement represents the important elements for evaluating and demonstrates the respective result of a programme in the faculty. The development tool known as OBE-ANAS v14.0 provides a better platform and easier means for the analysis of programme attainment .Moreover, it consumes minimum time for such analysisto be conducted. In addition, this tool is also able to generate the measurement of POs average and density based on the analysis of individual student's POs marks. The DPA analysis

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is introduced as an additional mechanism to evaluate the programme strength and used as a KPI benchmark to indicate and observe programme performance from time to time.

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