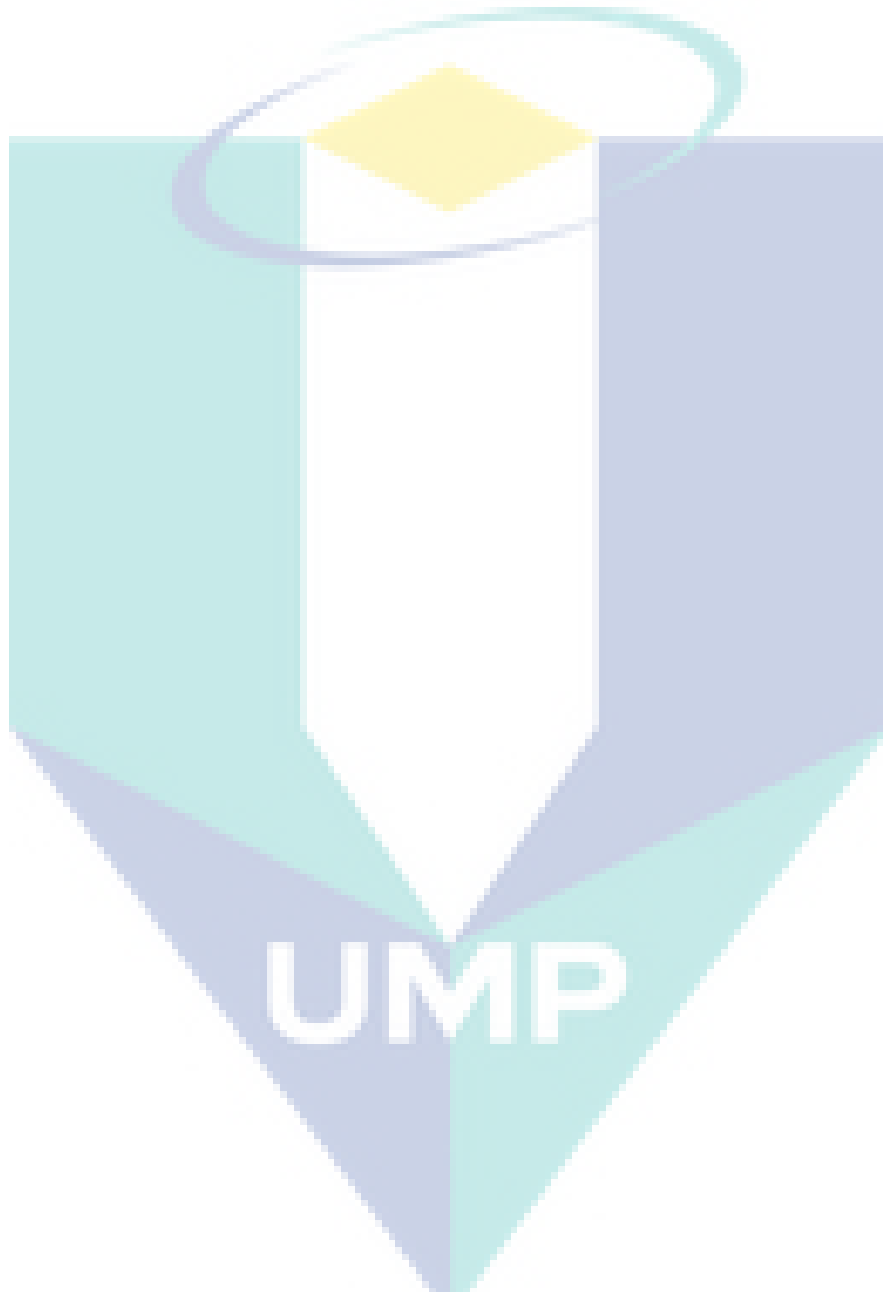


**OUTCOME BASED EDUCATION ATTRIBUTES FOR OSH  
PROGRAMME BASED ON INDUSTRIAL NEEDS**

**(RDU1403170)**

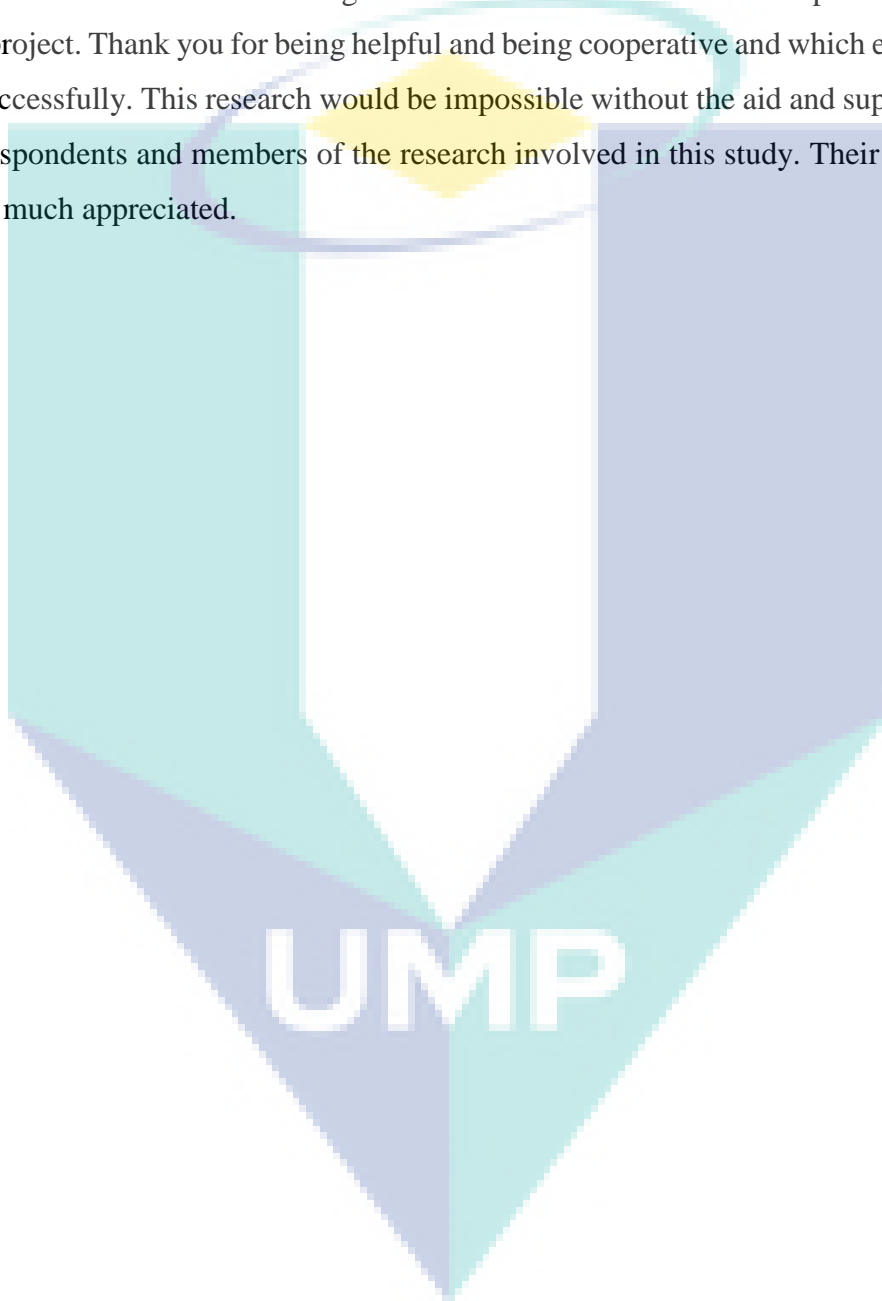


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## **Abstract**

Outcome based education approach is crucial part to be emphasized during Occupational Safety and Health curriculum development and implementation. It is undeniable that employability skills or soft skills reflects graduate employability and significance of the existence and sustainable of a program at the university. Therefore this study aimed to highlight the importance of a structured curriculum development starting from the development of Program Educational Objectives (PEO), the development of PO (Programme Outcome, and after that, the development of Course Outcome (CO). Continual Quality Improvement (CQI) for Occupational Safety and Health Program which is workshop with industrial advisory panel (IAP) and external examiner (EA) were also reported. Both activities are conducted to seek input for any improvement that can be done, so that the programme are sustain and marketable. Data of graduate employability shown that, the graduate of the OSH programme are marketable. Due to that, it is suggesting that the runner of the programme need to maintain the efforts to ensure the OSH program can be sustained and keep improved for time to time to meet the career market demands.

Keyword: Outcome based education, OSH programme

## **Abstrak**

Pengajian berasaskan hasil (OBE) adalah sangat penting untuk diaplikasikan ketika membangunkan program Keselamatan dan Kesihatan Pekerjaan (KKP). Adalah tidak dinafikan, kemahiran kebolehpasaran atau kemahiran insaniah menyumbang kepada kebolehpasaran graduan di dalam program-program pengajian di mana-mana universiti. Oleh sebab itu, kajian ini ingin mengetengahkan kepentingan pembangunan kurikulum yang berstruktur bermula dari pembangunan Objektif Pembelajaran Program (PEO), pembangunan Hasil Program (PO) dan setelah itu, pembangunan Hasil Kursus (CO). Penambahbaikan kualiti berterusan (CQI) untuk program KKP iaitu bengkel bersama panel penasihat industri (IAP) dan penasihat luar (EA) turut sama dijalankan. Kedua-dua aktiviti tersebut telah dijalankan untuk mendapatkan input bagi penambahbaikan yang boleh di jalankan supaya program mampu untuk bertahan dan boleh dipasarkan. Data kebolehpasaran graduan telah menunjukkan bahawa graduan dari program KKP mempunyai kebolehpasaran yang tinggi. Oleh sebab itu, adalah disarankan agar mereka yang menjalankan program hendaklah meneruskan usaha-usaha agar progam KKP boleh terus kekal dan terus bertambah baik dari masa ke semasa untuk memenuhi keperluan kerjaya.

Katakunci: Pembelajaran berasaskan hasil, program KKP.

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A large, semi-transparent watermark of the UIMP logo is centered on the page. The logo consists of a downward-pointing arrow shape formed by two overlapping triangles, one light blue and one light purple. The letters 'UIMP' are written in white, bold, sans-serif font across the bottom of the arrow.

UIMP

## 1.1 Concept of outcome based education

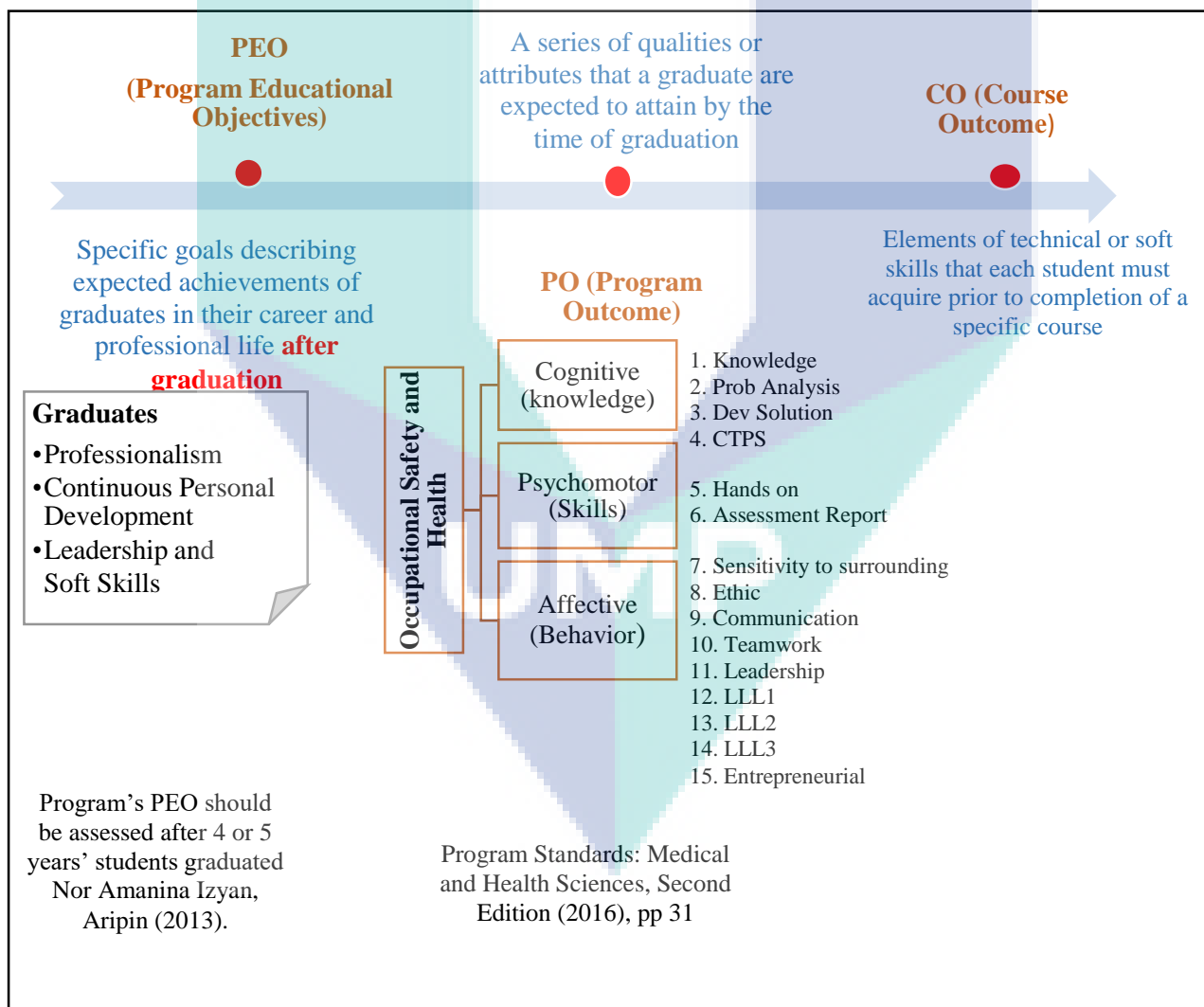
Outcome based education (OBE) can be best define as clearly focusing and organizing everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences (Spady, 1994). Furthermore, its focuses on students achieving outcomes including required attributes, skills, and qualities after undergoing the learning process through curriculum design. OBE comprises of four major components which cover curriculum design, teaching and learning methods, assessment and lastly continual improvement (CQI). The fundamentals of OBE implementation process encompass of three development phases as shown in Figure 1.

The first phase is to develop Program Educational Objectives (PEO). PEO is developed based on the vision and mission of the university. PEO has specific goals in describing expected achievements of graduates in their career and professional life after (3- 5 years) graduation Nor Amanina Izyan, Aripin (2013). After PEO is well developed, Program Outcome (PO) is needed to be established. Programme outcomes are statements that describe what students are expected to know and be able to perform or attain by the time of graduation. These relate to skills, knowledge, and attitude that students acquire throughout the program. It has been established that outcome based education system build everything on a clearly defined framework of exit outcomes. In OBE, curriculum design strategies, assessments and performance standards are developed and implemented to facilitate the outcomes and should be viewed as flexible and alterable means for accomplishing clearly defined learning ends.

For Occupational Safety and Health (OSH) field, four PO to cater knowledge, two PO for psychomotor and 9 PO to cater affective which make all 15 PO are developed during the curriculum design. All those PO are also proposed by the latest program standard for Medical and Health Sciences (MQA 2016). To achieve PO and PEO, each offered course in the curriculum, need to have course outcome (CO). Normally, three CO will be developed for each course. Each developed CO, will be mapped with program's PO and finally PO is mapped to PEO. CO for courses need to be communicated with students who enrol that particular courses. CO also need to be documented for future references. For students to better understand how CO may help them throughout the semester, CO need to be translated in the teaching plan. With good attributes and skills, graduates will be able to work in any field and adapt to any environment. The main challenge faced by Higher Education Provider today is to produce graduates with high ability in problem solving skills, deal with non-routine processes, have good communication skills and capacity to see workplace developments in a

broader context. The new economy demands new ways of thinking, managing and working since specific skills required to enter and succeed in the workplace. It is well understood that education and training are the main instruments available to prepare individuals for a rapidly changing, increasingly demanding world of work, and to improve their employability (Kirby, 2000). Thus, OBE implementation play a vital role to ensure the developed curriculum is align with the desired outcomes and has ability to shifts the paradigm from the teacher cantered to student cantered learning. This paper intends to discuss outcome based education system implementation in occupational safety and health program UMP with current industrial needs focusing in employability skills.

**Figure 1: Three phases of OBE development in the simplified version.**



## 1.2 Graduates attributes and employability skills for OSH graduates

Recent shifts in education paradigm have resulted in universities being placed under increasing pressure to produce employable graduates. Designing enhanced and robust curriculum of offered courses is essential to ensure strong ties is linked to higher education provider desire to improve graduate attributes and employability. However, debate exists regarding what constitutes employability and which graduate attributes are required to foster employability in tertiary students. Graduates attributes are the qualities, skills and understandings a university community agrees its students would desirably develop during their time at the institution and, consequently shape the contribution they are able to make to their profession and as a citizen (Bowden et al, 2000). Nowadays, industries focus on the adaptation and use of new technologies in production and delivery of goods and services. With this adaptation and use of new technology, coupled with cost reduction, industries intend to increase productivity and they will only be recruiting people with skill, which can assure that they remain competitive, innovative, at reduced cost, and at the same time maintain or improve profitability (Bakar, 2011).

According to (Lync, 2009) technical and technological skills remain important, but must be modified and grounded in employees' ability to think in the context of big picture to ensure the growth of the organization. The scenario for today is more likely jobs are not guaranteed where a person with the necessary qualifications may not necessarily be hired for the post for which he or she applies. Brown and Lauder, 2001 suggest that employability is seen as a competitive advantage as national prosperity depends on upgrading the knowledge, skills, and entrepreneurial passion of the workforce. Employability skills has its own definitions and concept across countries. The Confederation of British Industry (1999) defined employability as being 'the possession by the individual of the qualities and competencies required to meet the changing needs of employers and customers. Table 1 shows the difference.

**Table 1: Terminology relating to employability skills as used in different countries**

Countries	Terminology
United Kingdom	Core skills, key skills, common skills
New Zealand	Essential skills
Australia	Key competencies. Generic skills, employability skills
Canada	Employability skills

United States of America	Basic skills, necessary skills, work-place know-how
Singapore	Critical enabling skills
France	Transferable skills
Germany	Key qualification
Switzerland	Trans-disciplinary goals
Denmark	Process independent qualification
Malaysia	Soft skills, employability skills

Source: Australia National Training Authority (2003)

Employability skills are further categorized into three main domains namely basic skills, intellectual abilities and personal attributes which contribute to the development of employability skills (ANTA, 2003). Specific skills for each domain are displayed in table 2, table 3 and table 4.

**Table 2: Components of Basic Skills**

Foundation Skills	Information and Communication Technology
Listens, understands and speaks clearly and directly	Is aware of and willing to use a range of technologies
Understand written documents and writes clearly	Uses technologies to seek, process, and present information
Understands tables and figures, able to interpret graphs, able to calculate	

**Table 3: Components of Intellectual Abilities**

Thinking Skills	Contextual Understanding	Organizational Goals
Able to make decisions. Capable problem solver. Innovative. Creative.	Knows own role in the work station. Understands the relationship among workplace processes and systems. Can design, implement, and monitor corrective actions.	Able to manage own time and seek needed resources to complete set tasks. Establish clear project goals and deliverables. Allocate people and other resources (budget, material, and space) to task. Set timelines and coordinate sub-tasks. Able to adapt resource allocation to accommodate contingencies.



**Table 4: Components of Personal Attributes**

Continuous Learning	Personal Attributes	Interpersonal Skills
Acknowledge the need to learn in order to accommodate change	Has positive self-esteem	Show cultural sensitivity
Open to new ideas and techniques	Understands that own actions influence others	Committed to client service
Is prepared to invest time and effort in learning new skills	Is self-manager, resourceful, shows initiative and effort	Works well with others, individually and in teams
	Displays sense of ethics including integrity and honesty	Shows leadership qualities
	Accepts responsibility for own actions	Can develop strategic vision, set goals and monitor performance
	Seeks and accept feedback	Communicate goals and targets, engage and motivate subordinates toward a shared vision

As mentioned earlier, graduates’ employability skills demand by the industry are very much related to individual’s assets in term of knowledge, skills and attitude they possess, the way they use and deploy their assets and also the way they present them to employers.

### 1.3 Program Standard for OSH program

The Programme Standards: Medical and Health Sciences by Malaysian Qualification Agency provide benchmarked statements pertaining to the field of medical and health sciences including OSH programme. This Programme Standard document has been developed by a panel in a consultation with various stakeholders representing public and private Higher Education Providers (HEPs), relevant government and statutory agencies, and professional bodies (Malaysia Qualifications Agency, 2016). This standard prepares guidelines to be referred by Higher Education Provider to ensure graduates acquire sufficient knowledge, understanding, skills and professionalism that underpin the education and training of safety and health professionals. However, this standard does not attempt to give specific characteristics for programmes, and allows programme providers to be innovative and to be able to customize programme based on desired niched area, producing graduates will meet the current needs of the profession and ensured their obligations to the society. A study

conducted by (Decheng et al, 2017) on the important aspects when developing curriculum have reported that, the curriculum objectives should be employment-oriented and in line with students' need for future employment and long term development and its content should be up to date and its breadth and depth of coverage are appropriate. Table 5 shows the Programme Standard proposed by MQA for Occupational Safety and Health.

**Table 5: Recommended Program Structure by MQA**

Minimum Graduating Credit= 129			
Component		Credits	Percentage
Compulsory Modules (General and HEP modules)		12-19	9-15
Core modules	Fundamentals Modules include Basic Sciences	19-37	15-29
	Professional Modules	52-62	40-48
	Industrial Training	25-28	19-21
Optional Modules		13-17	10-13

## 2.0 Methodology

### 2.1 Industrial Advisory Panel (IAP) Workshop

IAP workshop is conducted once in two years to have a thorough discussion on the journey of OSH program. For examples, in IAP workshop the participants will discuss on the offered courses whether there are still relevant until to topic that covered in the courses. Most of the times, the IAP that participated in the workshop will sharing their experiences in industry and will lead to the discussion how their expectation on OSH graduate in term of knowledge, technical skills and also soft skill. IAP workshop is important to be conducted and the requirement to engage with industry so that the approach that academia bring to the classroom is not obsolete, is undeniable. However, to have IAP workshop yearly is also requires a lot of effort to gather panel that have their own jobs in their workplace. In order to fill this limitation, the engagement with industry is still done through (1) invite OSH practitioner to become part time lecturers in OSH program every semester. At least one course is taught by OSH practitioner that defined<sup>1</sup> by DOSH, (2) invite OSH practitioner to become speaker for first year seminar and career talk, (3) invite OSH practitioner to become external examiner

<sup>1</sup>OSH practitioner is defined as industry people with OSH competency (green book holder) with minimum 5 years of industrial experience OR industry people without OSH competency (not a green book holder) with minimum 10 years of industrial experience (DOSH).

for final year project. Besides that, lecturer in the OSH program also actively collaborated with the industry people, through knowledge transfer program, consultation and many more.

## **2.2 Secondary Data**

Secondary data was obtained from the faculty for graduate employability statistics specific for OSH programme.

## **3.0 Results and discussion**

### **3.1 Continual Quality Improvement (CQI) for Occupational Safety and Health Program**

Developed programmes need to be regularly monitored, reviewed and evaluated. This includes the monitoring, reviewing and evaluating of institutional structures and processes (administrative structure, leadership and governance, planning and review mechanisms), curriculum components (syllabi, teaching methodologies, learning outcomes) as well as student progress, employability and performance. To date, 2 times of curriculum review had been done. First is when the first cohort of students is graduated in year 2013, and the second time is when the amendment had been made in the program standard (the second curriculum review is still in progress of getting alumni and employer feedback to assess PEO of program). Feedback from multiple sources – students, academic staff, employers, professional bodies (Department of Occupational Safety and Health (DOSH) Malaysia) used to assist in enhancing the quality of the programme. Feedback can also be obtained from an analysis of student performance. Student electronic feedback as known as e-PAT for student to give feedback regarding courses and lecturer who teach the course is also useful for identifying specific problems and for continual improvement of the programme (Continual Quality Improvement (CQI)). CQI can be categorized into two level which at program and course level.

#### **3.1.1 Continual Quality Improvement (CQI) in Program Level (Industrial Advisory Panel (IAP) Workshop)**

IAP workshop is conducted once in two years to have a thorough discussion on the journey of OSH program. For examples, in IAP workshop the participants will discuss on the offered courses whether there are still relevant until to topic that covered in the courses. Most of the times, the IAP that participated in the workshop will sharing their experiences in industry and will lead to the discussion how their expectation on OSH graduate in term of knowledge, technical skills and also soft skill. IAP workshop is important to be conducted and the requirement to engage with industry so that the approach that academia bring to the classroom is not obsolete, is undeniable. However, to have IAP workshop yearly is also requires a lot of effort to gather panel that have their own jobs in

their workplace. In order to fill this limitation, the engagement with industry is still done through (1) invite OSH practitioner to become part time lecturers (in OSH program every semester at least one course which is taught by OSH practitioner that defined<sup>2</sup> by DOSH), (2) invite OSH practitioner to become speaker for first year seminar and career talk, (3) invite OSH practitioner to become external examiner for final year project. Besides that, lecturer in the OSH program also actively collaborated with the industry people, through knowledge transfer program, consultation and many more.

### **3.1.2 Finding on survey regarding the curriculum**

In 2018 one IAP workshop was conducted on Mac. The workshop was attended by six (6) IAP from various industry (construction industry, oil and gas industry, service industry and consultancy industry). At the beginning of the workshop, program standard for medical and health science (MQA), document from DOSH for OSH in higher education were shared and reviewed. In overall, all participated IAP agreed and strongly agreed with the proposed new curriculum specifically with the total graduating hours (129 credit hours). The duration to complete the proposed program also appropriate as per required by the established program standard. Referring to the whole curriculum structure that had been proposed, the IAPs also agreed that the curriculum in line with the requirement by industry since the elements of psychomotor clearly reflect in the proposed subjects (courses). Several subject such as Industrial Hygiene is developed based on the requirement of DOSH competency course in Malaysia.

Program Educational Objectives (PEO) and Program Learning Outcomes (PLO) were also shared and IAPs have a consensus that the developed PEO and PLI are attainable and measureable. OSH disciplines were successfully trained in a multidisciplinary approach, ultimately oriented on prevention of workplace exposure (Van Dijk, Bubas, & Smits, 2015). For OSH program in UMP, IAP also agreed that the proposed courses show its multidisciplinary. Table 6 shows the result of IAP feedback in the distributed questionnaire.

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<sup>2</sup>OSH practitioner is defined as industry people with OSH competency (green book holder) with minimum 5 years of industrial experience OR industry people without OSH competency (not a green book holder) with minimum 10 years of industrial experience (DOSH).

**Table 6**

	Numbers of graduating credit hour is appropriate	Educational duration is appropriate	Industrial training duration is in line with the program standard	PEO are attainable and measureable	PLO are attainable and measureable	The developed curriculum covers all aspect in the field of occupational safety and health	The proposed courses shows its multidisciplinary	Industrial needs clearly shown in the propose curriculum	The proposed curriculum support the need of industry	It is expected that the graduate from this program marketable	AVERAGE ANSWER
IAP 1	7	7	7	7	7	7	7	7	6	6	6.8
IAP 2	7	7	7	6	6	6	7	7	7	7	6.7
IAP 3	6	6	6	6	5	5	6	5	5	6	5.6
IAP 4	7	7	7	7	7	7	7	7	7	7	7
IAP 5	6	6	6	6	5	7	5	6	6	6	5.9
IAP 6	6	7	7	6	6	7	6	6	7	6	6.4
<b>AVERAGE ANSWER</b>	<b>6.5</b>	<b>6.7</b>	<b>6.7</b>	<b>6.3</b>	<b>6.0</b>	<b>6.5</b>	<b>6.3</b>	<b>6.3</b>	<b>6.3</b>	<b>6.3</b>	<b>6.4</b>
7 likert scale is used for answering the questionnaire related to the curriculum and the industry needs.											
Number 1 represent “Strongly disagree” while number 7 represent “Strongly agree”											

The finding from open-ended question from distributed questionnaire are presented in Table 7. From the finding, it is clearly seen that the soft skill of students such as communication skills and proper time management are the crucial elements that need to be improved among students. This issue

requires all lecturers to work together so that students can be educated and monitored in every courses thorough the educational years.

**Table 7**

<b>List of IAP</b>	<b>Proposal of improvement in the BOSH curriculum</b>
IAP 1	<ul style="list-style-type: none"> <li>✓ Always ensure that the BOSH curriculum is in line with the industry needs ad catch up to the technology enhancement.</li> <li>✓ Empower the education with the existence of Occupational Safety and Health Act (1994) and Factory Machinery Act (1979).</li> </ul>
IAP 2	<ul style="list-style-type: none"> <li>✓ Develop a rubric to be shared with the potential industry supervisor before sending students to enrol industrial training.</li> <li>✓ In relation to industrial training, university supervisor and industry supervisor need to have a medium to communicate effectively throughout the duration of student's attachment.</li> </ul>
IAP 3	<ul style="list-style-type: none"> <li>✓ <i>Softskill</i> empowerment among graduate specifically in term of effective time management, communication skills, and the ability of the students or graduate to produce good product of work (report, slide presentation and many more) using Bahasa Melayu and English properly.</li> <li>✓ Every lecturer should have the ability or knowledge to select certain topic the teaching subject that is important and give extra focus so that students not wasting their time in learning any topic that less important in the current needs for occupational safety and health field.</li> </ul>
IAP 4	<ul style="list-style-type: none"> <li>✓ For industrial training, it is good if all the courses can be classified based on the type of industry so that students can refer as a guideline which topic need to study to self- equip themselves before start their industrial training.</li> </ul>
IAP 5	<ul style="list-style-type: none"> <li>✓ A workshop related to career need to be conducted whereby the speaker should be the person from industry that has knowledge in occupational safety and health.</li> </ul>

✓ Soft skill empowerment starting from early study (such as in Seminar Tahun Pertama – currently provide by Faculty of Engineering Technolgy , UMP).

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IAP 6 ✓ Provide medium for students to have public speaking, participate in any local or international exhibition. This is important as an exercise for them to develop or improve self-esteem and communication skills

✓ Frequently invite industry partner to share knowledge and current implementation in industry that is related to occupational safety and health field.

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### **3.1.3 Continual Quality Improvement (CQI) in Program Level with External Examiner**

Academic External Examiner (EE) workshop is conducted among program or representative of program with appointed EE to discuss thoroughly about the matter regarding the development of curriculum. EE was appointed among academicians who have robust experience in developing occupational safety and health curriculum in higher educational providers. For this program there are Two (2) experienced EE were appointed to verify the proposed curriculum. In the workshop program, PEO and PLO were shared and discussed.

### **3.1.4 The Program Educational Objectives (PEO) and Programme Outcomes (PO) for Bachelor of Occupational Safety and Health**

Program Educational Outcomes (PEO) for Bachelor of Occupational Safety and Health as the following:

1. PEO 1 - Employable graduates with the knowledge and competency in Occupational Safety and Health
2. PEO 2 – Graduate having professional attitude in fulfilling their role their role in Occupational Safety and Health
3. PEO 3 – Graduate engage in lifelong learning activity in their organisation.

From the discussion with EE, PEO must be measurable, reliable and attainable. The proposed PEO is appropriate. Since the first cohort of OSH program had been graduated more than 5 years ago, the method to measure programme's PEO also had been discussed. This is because of each program's PEO should be assessed after 4 or 5 years students graduated (Nor Amanina Izyan, 2013).

Focus group discussion methodology was used to obtain the consensus on the programme's PEO attainment. In the focus group discussion, minimum 3 alumni and their employers are gathered and discussed on the PEO whether they are achieved or improvement (if any) need to be done.

**Program Outcomes (PO) for Bachelor of Occupational Safety and Health as the following:**

- PO1 - Describe, interpret and apply knowledge of science and engineering in occupational safety and health.
- PO2 - Assess and analyse issues of occupational safety and health in workplace and community.
- PO3 - Interpret, analyse, synthesis and recommend preventive and corrective measures in occupational safety and health.
- PO4 - Identify and analyse critically occupational safety and health problems to provide solutions based on evidence
- PO5 - Educate and train employees, employers and the community on occupational safety and health
- PO6 - Apply evidence based scientific principles in discussing ideas of improvement in occupational safety and health
- PO7 - Demonstrate sensitivities and responsibilities towards the community, culture, religion and environment
- PO8 - Adhere to the legal, ethical principles and the professional code of conduct in occupational safety and health
- PO9 - Adhere to the legal, ethical principles and the professional code of conduct in occupational safety and health
- PO10 - Demonstrate leadership, interpersonal and social skills
- PO11 - Collaborate with other skills professionals
- PO12 - Conduct research related to occupational safety and health under supervision
- PO13 - Utilise ICT and information management system to enhance their occupational safety and health practices
- PO14 - Apply skills and principles of lifelong learning in career development
- PO15 - Apply broad business and real world perspectives in workplace and demonstrate entrepreneurial skills



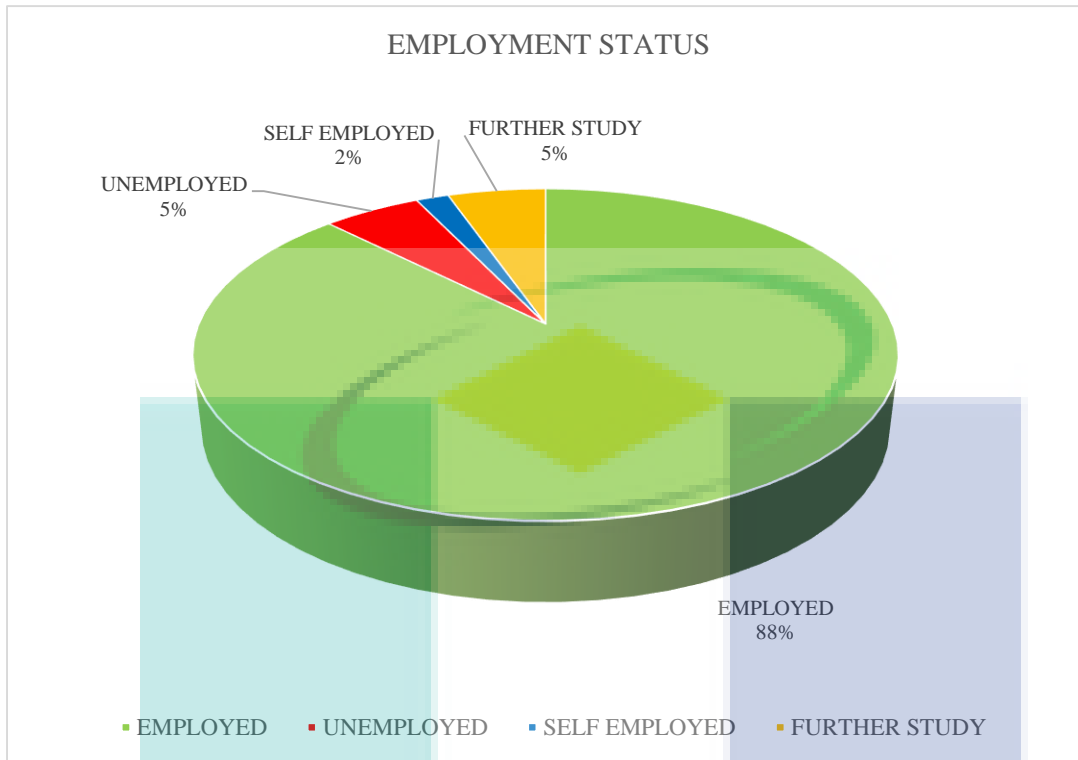
### 3.1.5 Graduate employability for OSH programme for 2017

There are fifty-six students of Batch 6 able to complete their studies in Bachelor of Occupational Safety and Health and graduates on November 2016. The employment status of these graduates is shown in Figure 2. More than half of the graduates (28) able to secure an employment upon graduation while another 21 has been employed on the period after the convocation. The distribution of employment timing can be seen in Figure 3. Figure 4 shows, 49 has secured a job in various sectors including services, construction, oil and gas, utility and logistics

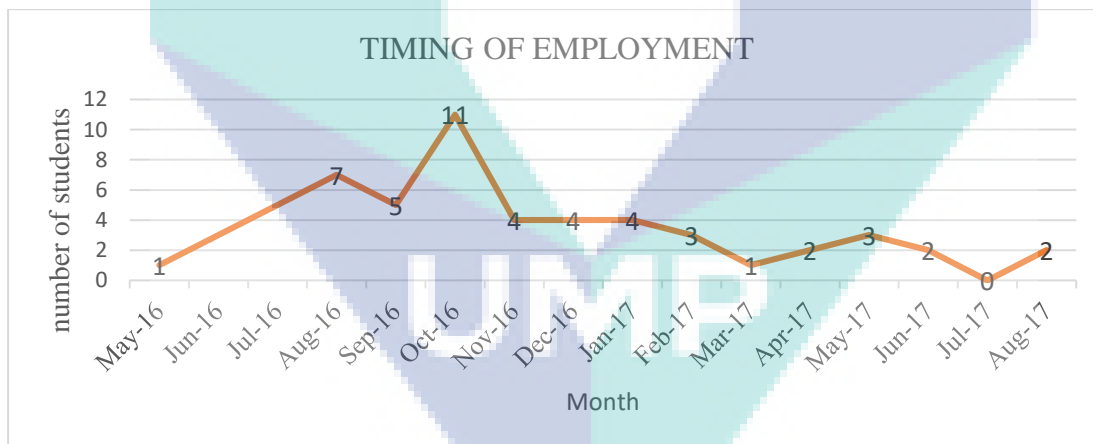
Employability in higher education range from the use of simple measures, such as whether or not graduate has secured a job by using graduate first destination surveys. Measuring employability using this simplistic terms or whether or not a graduate has managed to secure a job within six months of graduating, provides a very vague and imprecise indication of what the student has gained (Pool & Sewell, 2007). Interestingly, graduate employability for OSH programme in UMP is high for every intake. This shows a good relationship between the quality of graduates produced with the current industrial needs. The overall response by IAP and EE was very positive towards the overall curriculum.

However, the measurement of PEO is necessary in order to measure the total outcome based education approach that being adapted in the curriculum. Questions need to be asked either graduates' current job used the skills, knowledge and understanding gained during their studies. There is so much to employability than gaining employment. First destination statistic do not take into account the fact that some graduates may have taken lower job levels in order to deal with financial pressures.

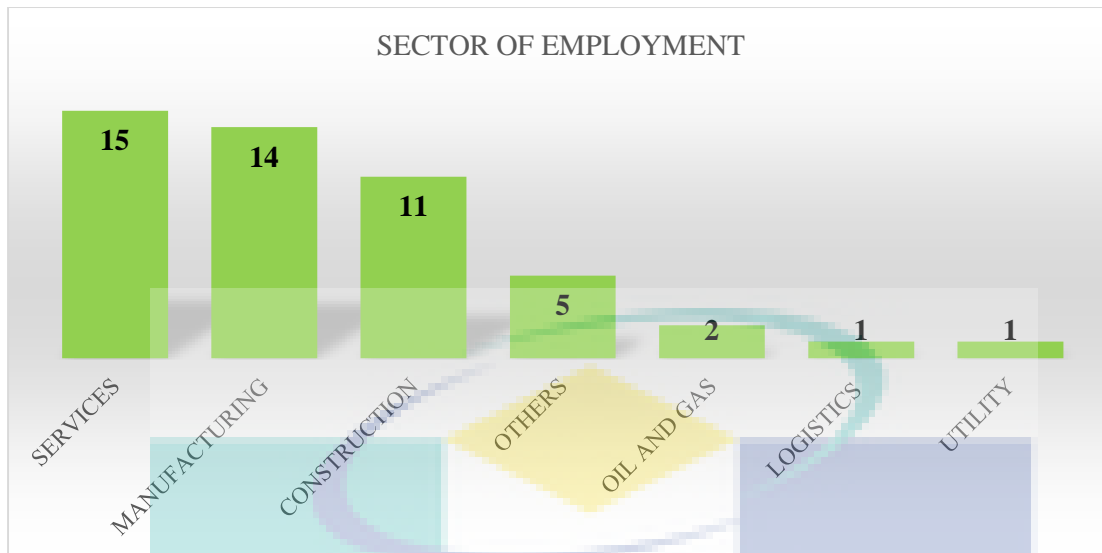
The logo of Universiti Malaysia Perlis (UMP) is a large, stylized letter 'U' composed of several overlapping triangles in shades of blue, teal, and yellow. The letters 'UMP' are printed in white, bold, sans-serif font across the bottom portion of the 'U'.



**Figure 2: Employment status of Bachelor of Occupational safety and Health in 2016.**



**Figure 3: Timing of employment of Bachelor of Occupational safety and Health in 2016**



**Figure 4: Employment sectors distribution between Bachelor of Occupational safety and Health in 2016**

#### **4.0 Conclusion**

Outcome based education approach is crucial part to be emphasized during curriculum development and its implementation. It is undeniable that employability skills or soft skills reflects graduate employability and significance of the existence and sustainable of a program at the university. For OSH programme in UMP, the developed curriculum had been complied the MQA standard and aligned with OBE approach. The graduate employability is high among OSH graduates but a proper and thorough measurement need to be conducted few years after graduation (3-5 years). This is to ensure student-centered learning philosophy of OBE based on student performance measurement is reliable, which mean the develop PEO is achievable through curriculum that being implemented. Feedback from the industry remain important as it can be seen as bridging the gap between academic and industrial needs.

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