Sustainable Competencies for Electronic Engineering Graduate from Industry Perspectives

[1]Agus Heri Setya Budi, [2]Noraini Kaprawi, [3]Jailani Md Yunos
[1]Universitas Pendidikan Indonesia
[2,3]Universiti Tun Hussein Onn Malaysia

Abstract

This article investigates the need of sustainable competencies of electronic engineering graduates from industry perspectives. A survey study was designed that involved 65 participants from electronic industries in the West Java. Participants completed a set 88 items questionnaire content within 13 themes of sustainable competencies using five-points Likert scales. Interview sessions were conducted that involved several key persons in the top management to support the findings. The result, a quantitative data indicated that 13 themes of sustainable competencies included were scored higher such as ethic and value, effective communication, healthy lifestyle, and integrated decision making. This was also supported by the qualitative data. Therefore, the study concludes that participants from industry perceived the respective sustainable competencies of electronic engineering graduates are strongly needed. The implication is that engineering curriculum in universities should take into consideration, which to be embedded with sustainable competencies in order to fulfill the industrial need.

Keywords; sustainable development, sustainable engineering

1. Introduction

Modern life has caused the loss of natural biodiversity such as the felling of rainforests, over consumption over nonrenewable energy, as well as the hazard of environment pollution. All these have left negative effect to the patterns on the environment and the climate. According to U.K Government, the increasing stress on resources and environmental systems are seemed unsustainable, especially when the world's population continues to increase [1]. It seems that we are doing the needs of the present generation without compromising the ability of future generation to meet their needs. It needs paradigm shift in addressing this issue for sustainable development.

In recent years, there is a concern growing over the limitation of hazardous chemicals and materials that can affect to the human health and the environment [2]. Within this, several countries have been focused on the development of environmental friendly products (green technology) to reduce the harmful effects to the earth [3]. For example, electronic product is one of the vast growing rapidly in

commercial industries. The use of electronic equipment is widespread within society. Consumer goods, from mobile phones to desktop and laptop computers, are part of daily life for many people. These products therefore have built to be friendly environment and have a very clean image compared with many other consumer goods. Unlike others, the reality, however, can be somewhat different for example in the production of detergent, food perseverance, agriculture and fertilizer etc. For that reason, in Asia as one of the fastest industrial growth has been adopt the ISO 14001 and its electronics industry has led to the ISO application [4].

When we track back the root of the issue discusses, is all related to educating engineer. The issues generally are reflected to the competencies of graduates which are the product of higher educational institution. For example, engineering graduates are not only need the knowledge base in making decisions; they also need the intellectual development to supply effective solutions on the complex technical problems [5]. To achieve the goal of Sustainable Engineering, scientists and engineers must use their best imagination, judgment and take initiative to apply science, technologies and practical experience to shape competitive processes and products [5], which is related to sustainable competencies.

Considering the current situation in Indonesia, there is an argument that the quality of Indonesia higher education institutions (HEI) in delivering such graduates is always being questioned. The graduates are presumably unable to meet the requirement of industries [6][7]. In this capacity, it is discovered that industry in Indonesia is unsatisfied with the quality of graduates in term of their competencies in facing the unpredictable and rapid change around the world. This would be a lack in the integration of sustainable competencies element in the electronic engineering program. Thus the program should be look in to and the gaps of miss match should be addressed. However, there is very few research found related to sustainable electronic engineering program that could develop sustainable graduate who could fulfill the need of the electronic industries. Thus, there is a need for the study on these issues which is to develop a sustainable electronic engineering program and to be implemented in Indonesian higher education institution.

2. Related Works

Nowadays, one of the industry requirements is the needs of sustainable competencies, which relate to SD (social, economic, and environment) and the specific performance and competencies of knowledge, skills, and attitude (KSA). Moreover the literature review reveal that the specific competencies related to KSA that required by the Indonesian workforces are failed to be identified. There is a need for sustainable competencies framework, which specifically define the competencies and attributes for Indonesian workforce. Unlike in other countries, the performance

and competencies of KSA related to SD are already established, for example in Canada and other advance countries, such as Japan, UK, United States and etc.

The SC can be defined in a collective manner. According to Schmidt and Kunzmann [8], competencies refer to abstractions of the works relevant to human behavior, which emerge as promising concepts for making human skills, knowledge, and abilities manageable and addressable in a wide range of application areas. Norman [9] suggests five levels of competencies for graduates, which include principles, skills, behaviors, process, and technique.

According to Brundtland [10], commission's definition of sustainable development as behavior that "meets the needs of the present without compromising the ability of future generations to meet their own needs" was left purposefully. While according to Barth et al [11], the key competencies for sustainable is based on non-cognitive dispositions and ask for multiple contexts. It is through combining formal an informal learning setting in higher education.

However, when comes to align competency to sustainable concept, the term of sustainable competency can be defined as the abstraction of human behavior, either cognitive or non cognitive dispositions, which relevant to preserve in the theme of social, economic, and environment that gain from the process of learning. The generic competencies comprises of eight main attributes, namely ethics and values, integrated decision making, critical thinking and problem solving, effective communications, responsible use of resources, healthy life style, valuing diversity, and continual improvement [12][13][14][15][16][17][18][19]. While, the subject specific competencies were developed according to five main attributes which were preparation for advanced graduate level, electrical and electronic engineering technical expertise, electrical and electronic engineering laboratory expertise, preparation for National industrial development and preparation for the professional [20][21][22][23][24].

Based on this list of competencies, sustainable competencies graduates might capable to anticipate future developments, or quickly adapt to changing times in terms of economy, social and environment without compromising the ability of future generation to meet their needs.

3. Methodology

3.1 Design and sampling

A survey study was designed to investigate the sustainable competencies of electronic Engineering Graduate from industrial's perspective. This study involved the sample of 65 participants from electronic engineering in the West Java. Several interview sessions were also conducted that involved key persons from top management.

3.2 Instruments

Questionnaire

A set of questionnaire consisted of 88 items was used to collect the respondet response on the needed for sustainable competencies in the electrical engineering course seen from industry perspective. Items of sustainable competencies were developed and adapted based on existing literature, which were classified into 13 themes [12][13][14][15][16][17][18][19]. The respondent indicated their agreement or disagreements on the items according to five-point Likert scale, anchored at 5, strongly agree to 1 strongly disagree. Data were analyzed using SPSS, in order to determine descriptive statistic value for items according to subscales. This was determining the value of the mean score, mode, and median, as well as to explain the samples' demographic.

The instruments reliability was 0.820 indicated by Cronbach's Alpha. According to Fornell and Bookstein [25], the reliability was in a good internal consistency if the value above 0.6. The details of items reliability according to each subscale were indicated in **table 1**:

Table 1: The Cronbach' Alpha for each subscale

No		Items	(Alpha) Cronbach
1	Ethics and Values	7	0.777
2	Integrated Decision Making	9	0.820
3	Critical Thinking and Problem Solving	7	0.746
4	Effective Communications	6	0.702
5	Responsible Use of Resources	6	0.863

6	Healthy Lifestyle	9	0.842
7	Valuing Diversity	5	0.884
8	Continual Improvement	5	0.781
9	Preparation for advanced graduate level	6	0.839
10	Electrical and Electronic Engineering Technical Expertise	12	0.929
11	Electrical and Electronic Engineering Laboratory Expertise	5	0.751
12	Preparation for National Industrial Development	5	0.882
13	Preparation for the Professional	6	0.850

Interview

Informal interview sessions were conducted that involved two heads of department in two companies in the west java. The first company A; is a partner manager of human resources and the second company B; is a manager of Innovation and Product Development Division. Questions were based on several key issues regarding the need of sustainable competencies graduate in the electronic industries. An interview was recorded using tape recorder. The data were transcribed immediately and analyzed.

4.0 Result

4.1 Quantitative data

Data analysis indicated that the samples were amongst males' respondent represent 63% (41), while females represent 37% (24). The majority of the respondents have been involved in the industry and have experienced approximately 5 to15 years. Response rate were high since the questionnaire were self-administered by the researcher.

Further analysis indicated that the mean score for overall subscales was higher at 4.00. This was clearly showed that majority of respondents were in agreement of the items regarding the sustainable competencies in electrical engineering course. The highest mean score for the subscale was indicated by ethic and value with 4.413, which mean that industry were generally in agreement with the items regarding the

ethic and value items. However, the lowest value was indicated by the valuing diversity with mean score of 4.003. Although this particular subscale indicated lower score, but the mean score value were still in the acceptance range. The result of the analysis such as mean score, standard deviation, and data interpretation were indicated in table 2:

Table 2: Mean score for the sustainable competencies items

No		Mean	Std Deviation	Mean Interpretation
1	Ethics and Values	4.413	0.431	High
2	Integrated Decision Making	4.362	0.420	High
3	Critical Thinking and Problem Solving	4.347	0.422	High
4	Effective Communications	4.377	0.434	High
5	Responsible Use of Resources	4.121	0.563	High
6	Healthy Lifestyle	4.371	0.457	High
7	Valuing Diversity	4.003	0.649	High
8	Continual Improvement	4.311	0.499	High
9	Preparation for advanced graduate level	4.208	0.557	High
10	Electrical and Electronic Engineering Technical Expertise	4.349	0.522	High
11	Electrical and Electronic Engineering Laboratory Expertise	4.305	0.468	High
12	Preparation for National Industrial Development	4.148	0.599	High
13	Preparation for the Professional	4.095	0.501	High

4.2 Qualitative data

Based on qualitative data, several themes appeared in the transcript that supports some of 13 themes of sustainable competencies as in the questionnaire. For example, participants expressed their agreement on the needs of the themes, such as ethic and culture, responsibility use of resources, healthy lifestyle, integrated decision making, continual improvement, and etc.

Specifically, participants had mentioned the ethical and cultural theme, which is similarly defined in the themes of ethic and values. For that reason, we maintain the themes "ethic and values" to avoid confusion. Generally, ethic and values have been one of the important themes of sustainable electronic engineering competencies needed among participants in the electronic engineering field. This is clearly expressed by the participant, for example, the participant from company A mentioned that:

"…ethical value must the first to be concerned during working…"

The notion also supported by the participant from company B:

"…A good worker should be trustworthiness, loyal and honest…"

Furthermore, healthy lifestyle has also appeared as another theme that has been mentioned by the participants. For example:

"…awareness and unhealthy behavior will consequence a high operating cost …" Participant from company A.

The notion also supported by the participant from company B:

"…there is a standard operating procedures and work safety procedures, however workers are also encouraged to have awareness and responsibilities to prevent any accident in the workplace…"

This indicated that healthy lifestyle is among important theme of sustainable competencies of electronic engineering graduates.

Another theme also appeared in the data transcribed was "integrated decision making" that has been mentioned by the participant from company A. The statements like:

"…to support human sustainable life, workers should have awareness on their current decision made, which has an impact in the future…"

The notion also supported by the participant from company B:

"…therefore workers should capable of evaluating the impact of their decision …"

Based on the data transcribed, several other themes have also clearly emphasized by both participants that is beyond the space to be included in this paper. However, the qualitative data generally supports the quantitative findings.

5. Findings and Discussion

Based on the quantitative result, 13 themes included in the questionnaire were rated higher by participants from industries. This indicated the need of sustainable competencies that highly needed by industries, relevant to the current need. This result reaffirmed previous studies [12][13][14][15][16][17][18][19]. The implication is that the engineering education providers must consider their existing curriculum, which should be embedded with these respective sustainable competencies.

The finding was supported by the qualitative data, in which players from industries were in light with some of the 13 themes of sustainable competencies that included in this study. For instance, a front line in the industries concerned more on the ethical and cultural that often mentioned by those participants interviewed. Other themes that were highlighted including integrated decision making; responsible use of resources; valuing diversity; healthy life style; continual improvement; preparation for advanced graduate level; electrical and electronic engineering technical expertise; electrical and electronic engineering laboratory expertise; preparation for National industrial development and preparation for the professional. Therefore, the qualitative data from participants in the electronic engineering industries in Indonesian case, support the important of these sustainable competencies to be acquired by graduates before entering the job market.

6. Conclusion

This research paper investigates the need of sustainable competencies in the electronic engineering program, specifically for Indonesian case. The result indicated that the sustainable competencies were highly rated by participants from industries, which imply the need of these competencies relevant to industrial needs. The findings also supported by the qualitative data, which collected from an interview session with several key persons from industries' top management. Future research should evaluate existing electronic engineering curriculum, whether these sustainable competencies are already embedded in.

7. References

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