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ANALYSIS OF DEFUZZIFICATION FOR DETERMINING THE RANKING OF GREEN SKILLS

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Abstract: Apart from technical and generic skills, employers start looking for manpower with green skills which are much needed for promoting sustainable development in social, economic as well as environment. This article aimed at finding out the ranking of element of green skills demanded by the green industry based on the experts perspective. A total of 11 experts have been invited to express their experience and knowledge regarding to the green aspects. The Delphi technique has been conducted and comprised three rounds of data collection following a pilot. The fuzzy Delphi analysis method has beenused for analysing the data obtained from the third round of data collection. The defuzzification process has been conducted to measure the score and ranking of green skills. The result shows that the energy and water skill is the most prominent skill within the skill dimension as compared to other green skills. For knowledge and attitude dimensions, the most critical elements are waste management knowledge and awareness respectively.

Keywords: climate change, green skills, fuzzy Delphi method

1.0 Introduction

During the Covid-19 pandemic, most of the countries have implemented lockdowns and movement restriction in order to contain the Covid-19 outbreak. The lockdowns is effective to curb the virus spread, however, it also adversely affects manufacturing operations, business services, and social activities throughout this period. From other perspective, the closure of industrial, business and social activities has also contributed to the reduction of greenhouse gases emission [1]. When the lockdown and movement restriction were lifted, all economic and social activities are back to normal, the level of pollution and greenhouse gas emissions are also exponentially increased.

There are numerous negative impacts of greenhouse gases and pollution such as climate change and rising sea level. Specifically, there are four factors that contribute hugely to the climate change and pollution, namely industrial activities, transportation, logging, and urbanization [2]. The waste from the industry is the most significant contributor on climate change and pollution, and the amount of the waste is increasing every year [3]. For example,

the tragedy of Kim Kim River that happened in 2019 in Malaysia was caused by the illegal dumping of toxic chemical waste into the river by the irresponsible and unethical industry. In that tragedy, many people who live around the affected area were hospitalized due to chemical poisoning and more than 100 schools were forced to close down [4].

In the context of Malaysia, the government pledged to reduce the greenhouse gas emissions by 45% by 2030 [5]. In order to achieve this noble goal, pragmatic actions must be taken, such as formulating environment-oriented policy, strengthening enforcement, and promoting public awarement towards environment protection. In order to response to the environmental issues, the industry is required to adapt and adopt eco-friendly processes in their operations [6]. In general, the industries/companies that apply environmental friendly manufacturing operations and services can be regarded as green industry [7]. Some examples of green industry are recycling companies, solar panel manufacturing companies and hotel that practices energy and water saving policy [8]. Green industry generates green jobs [9] and the green jobs need workers who are equipped with green skills in order to allow them to accomplish the given tasks [10].

To date, green skills needed by industry have not yet been fully researched. It is not known what type of green skills are really relevant to industrial sectors. However, in this research, we have already identified some important green skills demanded by the industry through Delphi technique involving experts from both industrial and academic sectors. The green skills were determined based on three dimensions, namely knowledge, skill, and attitude dimensions. Specifically, in this article, we focused on determining the prominent green skills by ranking the identified green skills using fuzzy Delphi method.

2.0 Literature review

The term "green skill" is sometimes used interchangeably with other tems, such as low carbon skills and generic green skills [11, 12]. Although the terminology differs, they share the common goal, which is to contribute to the environmental protection and natural resources conservation [13]. In general, green skills can be defined as technical skills, knowledge, value, and attitude needed by green worker to perform tasks that contribute to sustainable environment, economy, and social development [14]. Similarly, CEDEFOP [15] describes green skills as knowledge, ability, values and attitude required by people to minimize the impact of human activity on the environment within social context. In short, green skill can be conceptualised as the skill that comprises three dimensions, namely knowledge, skill, and attitude/value dimensions that prormote sustainable social, economy and environment.

There are many types of green skills, such as green commucation skill, design skill, energy skill and so on. In specific, Sern, Zaime, Foong [16] have provided a list of green skills that are significantly relevant to green industry. See Table 1.

Table 1. the elements of green skills

No.	Element
1	Design skills
2	Energy skills
3	Communication skills
4	Procurement skills
5	Leadership skills
6	City planning skills
7	Waste management skills

8	Financial skills
9	Management skills
10	Landscaping skills

(Source: Sern, Zaime, and Foong, 2018)

Likewise, Essex and Hirst [11] have also discovered 13 green skills that are relavent to green industry. The importance of those green skills were ranked accordingly as presented in Table 2.

Table 2. the ranking of green skills required by industries

Element	Ranking
Design skills	1
Energy skills	2
Client skills	3
Leadership and management skills	4
Community skills	5
Construction skills	6
Town and country planning skills	7
Waste skills	8
Procurement skills	9
Landscape and environmental skills	10
Building management skills	11
Financial skills	12
Transport infrastructure skills	13

(Source: Essex and Hirst, 2011)

Many of the green skills are commonly presumed as conventional skills. For example, design skills is usually considered a basic skill that must be possessed by designer of all fields, such as mechanical machine designer, electronic circuit designer, fashion designer and so on. However, it is nowadays regarded as green skill because designers need design skills that enables them to integrate green elements into the design. A machine designer should be able to design a machine that requires less energy consumption, and produce less green gassess. A building designer should be able to design a building that fully ultilise natural resources, such as natural ventilation system that uses the force of wind to deliver fresh air into bulding and natural light or daylighting that brings sunlight directly into the building. All these eco-friendly design concepts only can be achieved with green design skills. Similarly, procurement skills and financial skills are also recognised as green skills because these skills are needed in purchasing materials for manurafcturing operation. Individuals who have green procurement skills tend to purchace materials that are friendly to environment with reasonable price. In short, we could argue that green skills are actually the conventional skills that embedded with green elements in order to contribute to the sustainability of envionement, social and economy development.

3.0 Methodology

At the initial phase of this research, the Delphi technique was used to identify green skills needed by industrial sectors. The Delphi technique comprised three rounds of data collection

by involving 11 experts from the industrial and academic sectors. In the first round, semi-structured interview was conducted. The data has been analysed using thematic analysis to find out the green skills. In second round, the checklist items among the experts was conducted. The data has been analysed using mean and standard deviations to verify level of agreement.

In the third round, which is the essence of this article, the fuzzy Delphi method and deffuzification analysis were used to determine the rank of green skills identified in the second round of data collection. In detail, the fuzzy Delphi method was composed of six steps presented as follows [17];

Step 1: Determination of expert

A total of 11 experts were involved in third round of data collection. According to Adler and Ziglio [18], the minimum number of respondents should be 10 or 15 participants. The selected experts were either attached to TVET instituons or green industries. The experts were chosen based on four characteristics, namely: 1) qualification, 2) job position, 3) working experience, and 4) knowledge in green practice. The expert should have at least a bachelor degree major in engineering or environmental and more than five years of working experience. In terms of position, the expert should be at least holding the position of executive. Last but not least, the expert must be well versed in green practice in the green industry.

Step 2: Linguistic scale selection

In the second step, a set of questionnaire with seven-point fuzzy scale was developed based on the findings obtained in the second round. Table 3 shows the seven-point fuzzy scale used in this study.

Table 3. the seven-point fuzzy scale

Linguistic Variables	Fuzzy Scales
Strongly agree	0.9, 1.0, 1.0
Agree	0.7, 0.9, 1.0
Agree somewhat	0.5, 0.7, 0.9
Neither agree nor disagree	0.3, 0.5, 0.7
Disagree somewhat	0.1, 0.3, 0.5
Disagree	0.0, 0.1, 0.3
Strongly disagree	0.0, 0.0, 0.1

Step 3: Average value
In the third step, the average value was calculated using the formula as follows;

$$Fave = \frac{\sum m1}{n}, \frac{\sum m2}{n}, \frac{\sum m3}{n}$$

Where; $\sum m_1$, $\sum m_2$, $\sum m_3$ = *total of fuzzy scales*
n = *number of experts*.

The average value (F_{AVE}) was used to determine ranking and score of items.

Step 4: Threshold value (*d*)
In fourth step, the Threshold value (d) was determined using the formula as follows:

$$d\ (\tilde{m}, \tilde{n}) = \sqrt{[\frac{1}{3}(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2]}$$

m_1 = *smallest value*
m_2 = *most plausible value*
m_3 = *maximum value*
n = *number of experts*

If the d value is equal to or smaller than 0.2, it indicates that the consensus of agreement from all the experts is achieved. On the contrary, if the d value is larger than 0.2, the item needs to be eliminated or else additional round of Delphi needs to be conducted.

Step 5: Percentage of expert consensus
The fifth step is for obtaining percentage of experts' consensus. If the experts' consensus percentange is equals to or more than 75%, it indicates that the consensus of agreement from all experts is at an acceptable level. However, if the experts consensus percentage is lower than 75%, the item needs to be eliminated, otherwise another round of Delphi needs to be additionally conducted.

Step 6: Defuzzification process
The defuzzification process is performed in the sixth step to determine the rank and score of the item, and the formulas used are provided as follows:

$$i.\ Amax = \frac{1}{3} \times (m1 + m2 + m3)$$
$$ii.\ Amax = \frac{1}{4} \times (m1 + m2 + m3)$$
$$iii.\ Amax = \frac{1}{6} \times (m1 + m2 + m3)$$

A_{max}= *defuzzification*
m_1 = *smallest value*
m_2 = *most plausible value*
m_3 = *maximum value*

The purpose of ranking the items through defuzzification process is to determine level of need, level of important, and level of variable or sub-variable needed.

4.0 Findings and Discussion

The rank of items was determine based on three main dimensions in green skills namely knowledge, skills, and attitude through fuzzy Delphi method. Table 4. shows the outcomes of items' score and rank of defuzzification.

Table 4. Scores and ranks of green skills based on dimensions

Knowledge dimension		
Item	**Score**	**Rank**
Green technology knowledge	0.872	2
Waste management knowledge	0.914	1
Problem solving and critical thinking	0.762	3
Skill dimension		
Item	**Score**	**Rank**
Waste skills	0.918	2
Design skills	0.913	3
Planning, procurement, and material skills	0.838	5
Energy and water skills	0.959	1
Communication skills	0.806	7
Management skills	0.902	4
Leadership and Teamwork skills	0.761	9
Problem solving and critical thinking skills	0.778	8
Protection skills	0.821	6
Attitude dimension		
Item	**Score**	**Rank**
Motivation	0.924	2
Awareness	0.931	1

In the dimension of knowledge, waste management knowledge was ranked as first and followed by green technology knowledge, and problem solving and critical thinking. Waste management knowledge is considered the most important knowledge for industrial workers because one of the major environment pollution factors is due to mishandling of industrial waste [19]. Improper industrial waste disposal may cause water pollution [20], air pollution [21], and soil pollution [22]. These pollutions will adversely impact people well-being and jeapordise the sustainability of social, economy and environment. Therefore, waste management is the most significant knowledge that must be acquired by workers compared to other knowledge.

In the skill dimension, most of experts strongly agreed that energy and water skills is the most important skill and needed to be at the top of the list and followed by waste skills, design skills, management skills, planning, procrument, and material skills, protection skills, communication skills, problem solving and critical thinking skills, and leadership and teamwork skills. The possible reason to explain why energy and water skill is considered the most critical skill for industry could be that water is needed by people to live and energy is required for all industrial activities. In fact, energy and water are closely connected each other. Water is needed to produce all sorts of energy. For instance, to produce biofuel energy,

water is needed for the cultivation of crops; to produce solar energy, water is needed in the cooling of thermal process. Likewise, the water infrastructures also require energy in order to allow it to be operational. For example, the processes of water collection, water treatment and water distribution require energy, otherwise it does not work [23].

For the attitude dimension, there are only two items (awareness and motivation). The awareness is ranked on first place followed by the motivation. The score of both elementss are very high and can be concluded that the experts are very concerned about the attitude dimension. According to Chin, De Pretto, Thippil and Ashfold [24], environment awareness is the most important element to ensure the success of activities related to environmental protection and natural resources conservation. Therefore, it is imperative to instill environmental awareness among people from very young age. In this sense, primary school should play a proactive role in cultivating younger generation who are more environmentally concious, commited and responsible for the environmental protection. This also can be integrated in final year project of diploma or degree level [25]. Industries are looking for a competence workforce in various aspect [26], which includes green skill.

5.0 Suggestion and Conclusion

In conclusion, we have discovered that waste management knowledge, energy and water skill, and environment awareness are particularly important for the green industry. Nevertheless, the findings also indicate that other knowledge, skill, and attitude elements are no less important. Forn instance, in skill dimension, although the leadership and teamwork skill is not ranked on top of the list, it is still considered important to ensure the green practices are implemented and excersied within organization.

In relation to the findings, this study puts forward several suggestions to enhance green skills acquisition among graduates.Firstly, all TVET institutions need to revise the existing training curricula in order to fulfil the demand of green industries . Green skills should be integrated into training curricula framework to cultivate more manpower equipped with green skills. Secondly, government agencies, such Ministry of Higher Education and Ministry of Environment and Water, should formulate a more holistic policies to encourage the transformation of conventional industry into green industry. In addition, incentive can be provided to the companies that train green workers. Thirdly, government agencies, industry, and society should work together in terms of curriculum design, provision of training facilities, and environment awareness improvement. The cooperation and partnership from multiple quarters will ensure the quality of graduates, sufficient supply of green workers, and thereby generating society well-being.

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7.0 References

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