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Research Article

Occupational Competency Profile for Workers in Mechanical Industry Towards Sustainable Development

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Abstract

The encouragement of technology application in environmental protection is one of the major challenges faced by most industries. Human activities that harm the environment must be tackled wisely so that all efforts in maintaining a safe environment can be continued. This situation leads us to the need for preparing individuals with adequate skills and knowledge related to green skills before entering the industry. This research is conducted to identify the occupational competency profile for mechanical industry towards sustainable development. The Fuzzy Delphi Method (FDM) was utilized in this research. The FDM is a structured investigation process aimed at reaching a consensus among a group of experts on a particular topic. Five experts were involved in the first phase and eleven experts were involved in the validation process in the second phase. The lowest items score based on the expert's consensus were rejected. Three items were rejected because of the score less than 75 per cent. The final competency profile consisting of Skill, Knowledge, and Attitude domains with 14 sub domains was constructed. The current scenario shows that people entering the industrial world lack relevant skills to work on sustainable development. These workers are classified as low-skilled workers, which means they need to be trained before entering the labor market. This study can support the development of training towards sustainability for future workers in the mechanical industry towards sustainability. Therefore, specific training related to their professional skills, especially green skills, needs to be carried out to improve their skills.

***Keywords**:* Mechanical Workers; Sustainable Development; Skill, Knowledge; Attitude

1. Introduction

The current progressive demands in the 21st century have pushed different sectors, especially education and industry, to improve the quality of individual competencies. As a developing country, Malaysia has employees trained to have competent skills to be competitive in this era of globalization (Ismail & Kasman, 2018). These proficient skills include green skills as one of the important skills to foster. Environmental literacy is another set of skills that promotes an individual's awareness of nature conservation. Promoting green technologies to protect the environment is a particularly major challenge in today's world. Human activities that harm the environment must be properly managed to ensure that efforts to maintain such best practices are successful (Abdullah & Ahmad, 2014; Ismail et al., 2016; Rahman, 2017). Specifically, green skills are skills related to the design, management, supervision, and production aspect of technology. Therefore, there is an evolving need for green skills development among workers, which is increasing in line with industry demands for worker's skills (Vona et al., 2016; Makhbul, Hasun, & Latif, 2018; Ghani, 2018).

Sustainable development is not a modest issue as it involves a combination of economic, social, and environmental skills. Sustainable development can be designed from a balance between economic, environmental, and social aspects. These three aspects must be balanced to achieve sustainable development and must be consistent with the demands of technological and industrial progress (Ciegis, Ramanauskiene & Martinkus, 2009; Barbier & Markandya, 2012; Suhaimi et al., 2018). However, there are no specific guidelines outlining how to balance implementation to create sustainable development. For example, I.A. Pierantoni (2004) stated that the importance of the concept of sustainable development depends on the specific area (Pierantoni, 2004; Barbier & Markandya, 2012; Samsudin, Hassan & Hasan, 2013). It is crucial to specifically identify the sustainable skills needed in the areas.

A previous study by Dlimbetova et al., (2016) found that employers lacked knowledge and awareness of the importance of green skills. This is due to insufficient skills and inadequate training provided before entering the labour market. Initiatives such as conducting specific training for them need to be planned and appropriate training provided to improve their skills (Hanafi, 2015; Dlimbetova et al., 2016; Hamdan et al., 2018). To get a better picture of the type of training to be offered to workers, research needs to be done on the key skills of workers in specific sectors. Therefore, this research aims to explore the competency profile for workers in the mechanical industry in terms of sustainable development.

2. Research Questions

This research aims to identify the competency profile for workers in the mechanical industry that includes the green skills. The specific questions are:

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i) What are the elements of green skills for workers in the mechanical industry?
ii) What are the appropriate and required green skills for workers in the mechanical industry?

3. Literature Review

Green skills have always been an important issue in recent times and even their meaning has been defined by multiple sources and experts in the field. Green Skill is an important skill and an asset for all individuals before exploring all areas of employment in today's industries. Green skills are also referred to as skills required for sustainable development. According to McDonald, Condon & Riordan (2012), green skills are considered sustainability skills that refer to the technical skills, knowledge, values, and attitudes required in the workforce to achieve sustainable social, economic, and environmental outcomes in business and communities, to develop and support industry and society. Similarly, green skills are also defined as the knowledge, skills, values and attitudes required to survive, develop, and support a society that reduces the impact of human activities on the environment (Ismail et al., 2019).

Not only must these skills be present in all employees, but employers must inculcate them themselves and ensure that the organization practices these skills while working to create sustainable development. According to Arunkumar (2012), in most cases, the new jobs created by green industries will require a mix of traditional green skills and new green skills. For example, construction companies undertaking construction and housing projects need workers with traditional construction skills and appropriate training in energy efficiency. Another study by Buntat & Othman (2012), categorized the green skills as one of the soft skills required by all graduates in general and VET graduates in particular. However, these skills are complementary to green jobs and green careers. Another soft skill such as communication skills is one of the critical skills for a mechanical worker. Their marketability is assessed through their effectiveness and competence in communication skills, leadership skills, high-level thinking skills (HLTS), and entrepreneurial skills to produce high quality social, economic, environmental, industrial, community and national development.

Green skills generally consist of three dimensions namely knowledge (cognitive dimension), skills/abilities (psychomotor dimension), and attitudes/values (affective dimension) needed by employees to promote sustainable development from the social, economic, and environmental facets. From the cognitive dimension, knowledge of environmental protection can be considered as an element of green skills. From the psychomotor perspective, green skills refer to abilities such as minimising energy consumption or reducing greenhouse gases. Green skills also refer to affective aspects such as the motivation of individuals to conserve natural resources (Hamid et al., 2016; M.Said et al., 2015; Pavlova, 2019; Vona et al., 2018).

In addition, green skills are also defined as skills that include reliability, initiative, and interpersonal skills that should be present in each of us. In other words, the competencies and skills that individuals possess can drive the production of quality work capable of achieving an organisation's goals (The Conference Board of Canada, 1996; Strachan & Laing, 2010). It is also a generic skill that helps to conserve and reduce the use of various resources such as environmental resources and energy, and reduce greenhouse gas emissions as well as increase recycling, use of environmentally friendly products, etc. In general, it can be said that for low to medium employment, there is a need for traditional skills, supplemented by green skills, which are usually offered through company training programs. Higher skilled jobs, such as those found in eco-consulting, require a broader and more specific range of new green skills. Such new skills are well imparted through educational and in-depth programs that involve higher-order thinking skills. Areas of employment in business, manufacturing, construction, transportation, agriculture and livestock are seen to have the potential to save natural environmental resources through green skills which are the main criteria towards sustainable national development (Ismail et al., 2019; Ismail,R. & Jajri.I, 2008; Arunkumar, J. (2012).

The Ministry of Education, Malaysia has identified seven elements of soft skills that universities should focus on to produce a competent workforce. These include effective communication skills, critical thinking and problem-solving skills, teamwork skills, continuous learning and information management, entrepreneurial skills, professional ethics and morals, and leadership skills. Employers believe that good communication skills are important to adapt to new situations and improve performance, especially for engineering graduates. Critical thinking is essential to solving problems in the workplace, while teamwork is important to overall success. Continuous learning and information management can help students improve their learning and use of technology. Entrepreneurial skills are seen as critical to productivity and development, and professional ethics and morals are important to the well-being of society. Finally, leadership skills are important for developing competent leaders (Manshoor et al., 2011; Vijaya Lakshmi, 2016; Roselainy et al., 2012; Jaghannath, 2016).

4. Methodology

The research methodology of this research is based on the qualitative method includes a document analysis and structured interviews with experts, to explore the competencies of worker in the mechanical industry. A qualitative method study is a study conducted with verbatim description and reporting (sentence by sentence) without any statistical observations (Darusalam & Hussin, 2018). The data obtained through qualitative methods will be used to explore and validate specific technical green skill elements.

The document analysis method was used to analyze previous studies related to sustainable development, while the interview method was used to obtain the technical skills elements and the consensus of the experts. In this research, a group of five experts with more than 10 years

of experience in the mechanical industry and sustainable development were interviewed. The interviews were conducted to gain an insight into the current status and future competency of workers in the mechanical industry.
The interviews were conducted in a structured and systematic manner, with a set of semi-structured questions to guide the discussion. Findings from the interviews were analyzed using the FDM method to obtain expert consensus. The Delphi method is an exercise in group communication among a panel of geographically dispersed experts. The process is followed by the respondent selection procedure, data collection process, data analysis, model development study matrix, and conclusion with a summary (Adler and Ziglio, 1996).
In this research, the Delphi technique involved three rounds of data collection. However, only the last round of data collection involving the fuzzy Delphi methodology and will be clarified in this study. There is a total of six steps in the fuzzy Delphi method.

Step 1: Determination of experts
The population of this study are experts in green industries and mechanical academics. The green industry sector involved in this study comprises environmental, construction, manufacturing, and telecommunication industries; while mechanical academics are made up of a few departments, such as environmental and civil engineering, electrical engineering, and mechanical engineering. The purposive sampling technique was used in this research. A total of 11 experts were selected in this research, supported by Adler and Ziglio (1996), who specified the total number of participants in the Delphi Technique as 10 to 15. The selection of experts was based on characteristics such as skills, job position, work experience, and knowledge in green practices.

Step 2: Linguistic scale selection
The research instrument was developed according to the results of the second round of Delphi. As a result, a set of questionnaires was developed and administered with a fuzzy scale of seven points. The experts are required to rate the items.

Step 3: Average value
The Excel template was used to calculate the average value (*Fave*). The formula is 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.

Step 4: Threshold value (*d*)
The threshold value (*d*) formula is as follows.

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

If the *d* value is equal to or less than 0.2, it indicates that there is a consensus reached by all experts. However, if the *d* value is greater than 0.2 the item must be eliminated, or the next round of Delphi must be conducted.

Step 5: Percentage of expert consensus
In this step, a calculation of the percentage of expert consensus is carried out. If the expert consensus is equal to or greater than 75%, it indicates that the consensus of all experts is reached. However, if the expert consensus is less than 75%, the item needs to be eliminated or the next round of Delphi needs to be conducted.

Step 6: Defuzzification process
The formula of the defuzzification process to determine the rank and score of each element is as follows.

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

Meanwhile, there are three requirements were used to indicate whether to accept or reject the item.

1. Threshold value (*d*);

$$d\,(\tilde{m}, \tilde{n}) = \sqrt{[\frac{1}{3}(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2]}$$
$d \leq 0.2$ = *accepted*
$d \geq 0.2$ = *rejected*

2. Using the traditional Delphi method (percentage of expert consensus);

expert group consensus $> 75\%$ = *accepted*
expert group consensus $< 75\%$ = *rejected*

3. $a - cut$ value. The $a - cut$ value refers to the median which is the fuzzy number within 0 – 1. Thus, the $a - cut$ value is equal to 0.5.

$a - cut\ value > 0.5$ = *accepted*
$a - cut\ value < 0.5$ = *rejected*

In this analysis, however, only the second criterion of the traditional Delphi method was used which is only expert consensus was applied to evaluate the elements. A total of three main dimensions in are constructed namely: 1) knowledge 2) skill, and 3) attitude were evaluated using the Fuzzy Delphi method. These dimensions are defined based on the literature review.

5. Findings and Discussion

The competency for the mechanical workers towards sustainable development was explored using the interview and literature analysis on the specific theme as in Table 1.

Table 1
Findings from interview and literature

Occupational Competency Profile	Interview Findings	Literature Findings
Determining the Employee Competency Profile	* Make plans and give green initial exposure to employees about the training's topic and the content	* Employees need to make an initial plan about the tasks that need to be done for the next task.
Job components ***** Knowledge dimension	Employees need to master green knowledge. Master the science of green skills Plan for green practices at work * Make a job plan so that work planning will be greener, perfect, and thorough and have good values in line with the understanding of job duties in the automotive industry. Inserting pure green values into the work * a green job plan and everything related to work will be given early through the WhatsApp messaging system so that employees can make preparations and assignments take place more perfectly * Planning jobs that consider green needs from various aspects according to current needs that can save the environment such as providing recycling bins so that objectives and goals are achieved because work objectives are very important for an employee.	Topics need to be described in advance so that employees are prepared or able to make preparations (Akyuz et al., 2013). Give green exposure to automotive design. * With a job plan or work preparation, employers will think about goals or objectives clearly, selection of important content, selection and arrangement of work methods, activity planning, and assessment preparation according to the set time (Ling, 2015). Determine the green skills that are appropriate for the job * Work materials need to be disclosed early to employees to set work goals to prepare for the tasks that will take place (Nik, 2015). Set goals with green awareness. * Workers must not run away from real objectives and follow the requirements of the current environmentally friendly's knowledge, skills, and attitudes (Witt & Orvis, 2010).
Analyse the working time situation ***** Skill dimension	* Employees position themselves as employees and try to explain and nurture positive attitudes and spirits in themselves as motivation. Develop skills so that cleanliness and air circulation are given priority. Ensure good air circulation. Practise green practices as motivation. *Before the working day starts, the boss reminds the employee what he needs to do; for example, if the boss says that the employee has to come at such a time, so he has to come and wear suitable clothes.	* Good use of language while explaining and cultivating a positive spirit is important to attract employees to work. Bilateral interaction will assist in the process of working effectively (Norasmah & Shuki, 2010). Fertilise a positive spirit. * Leaders in the workplace need to know how to manage employees well. Instructions need to be given wisely so that the task runs smoothly and effectively (Ishak, Jamil, Razak & Ahmad, 2013). Give instructions perfectly so that no problems occur
Works Planning *****Attitude dimension	* First order the representative or all the employees to ensure that the workroom is tidy and then clean the rubbish; all the rubbish must be cleared. Make sure the doors are all open, the fan exhaust will be open for ventilation in case of a workshop class. Fertilise the spirit of being responsible for global issues. Responsibility for global issues * Before starting work, employees should be wise to associate the current situation with green practices and show a positive attitude towards the environment to create a cheerful and harmonious atmosphere to facilitate work assignments from all parties. Relate the current situation to green practices. Pure values that are positive for the environment * Before start working, employees should look around and ensure that the rules related to safety aspects should be followed by themselves. The initial aspect that needs to be emphasised is ethics and the way the employee practice safety at the workplace to prevent any accidents.	* The boss needs to train employees with high leadership qualities such as giving early instructions to employee representatives to help manage a task. If other employees listen to instructions, then the leadership values are considered successful. The nature of high leadership * Employees need to know how to manage all task equipment to suit what is being taught and look cheerful and conducive. How to control the situation so that the job can run smoothly and effectively. * Accidents and injuries cannot be completely avoided but can be reduced and prevented if all parties involved in work management work together in performing their duties and responsibilities so that safety rules in the workshop are provided and practised.

The data from the interview and literature review were then being mapped to construct the item for expert's consensus. The items were analysed through a thematic analysis based on the three dimensions (Knowledge, Skill, and Attitude).

A. Knowledge dimension

In the knowledge dimension, a total of three elements and eleven sub-elements were analysed. The results show that three sub-elements obtained less than 75% consensus in the group of experts which are: 1) the knowledge of environmental protection; 2) the knowledge of decision-making by considering the environmental aspect; and 3) the knowledge of critical thinking for decision-making. The three of these will be withdrawn from the knowledge dimension, and the problem-solving and critical thinking elements were removed.

Table 2
Knowledge dimension

Item	Threshold value, d	Fuzzy score (A)	Result
K1 Green Technology Knowledge	0.162	100.00%	Accepted
K1.1 The knowledge of renewable energy	0.136	100.00%	Accepted
K1.2 The knowledge of green transportation	0.153	90.90%	Accepted
K1.3 The knowledge of green technology	0.092	100.00%	Accepted
K2 Waste Management Knowledge	0.098	100.00%	Accepted
K2.1 The 4Rs (reduce, reuse, recycle, and recovery) knowledge	0.092	100.00%	Accepted
K2.2 The knowledge of waste material sorting	0.057	100.00%	Accepted
K2.3 The knowledge of water consumption	0.098	100.00%	Accepted
K2.4 The knowledge of electricity usage	0.155	100.00%	Accepted
K2.5 The manufacturing material usage	0.162	90.91%	Accepted
K3 Problem Solving and Critical Thinking	0.153	81.80%	Accepted
K3.1 The knowledge of environmental protection	0.212	**36.40%**	**Rejected**
K3.2 The knowledge of decision making by considering the environmental aspect	0.238	**54.50%**	**Rejected**
K3.3 The knowledge of critical thinking for decision making	0.248	**54.55%**	**Rejected**

B. Skill dimension

A total of nine elements were analysed, namely: waste skills, design skills, planning, procurement and material skills, energy and water skills, communication skills, management skills, leadership and teamwork skills, problem-solving and critical thinking skills, and protection skills. The results show that all items obtained more than 75% consensus in the expert group. Thus, in the skill dimension, all items were acceptable.

Table 3
Skill dimension

Item	Threshold value 'd'	Fuzzy score (A)	Result
S1 Waste skills	0.129	90.90%	Accepted
S1.1 The skill related to 4R practice	0.112	90.90%	Accepted
S1.2 The skill related to waste management	0.174	90.90%	Accepted
S1.3 The skill to minimise/reduce waste	0.168	100.00%	Accepted
S2 Design Skills	0.168	90.90%	Accepted
S2.1 The design skill that involves environmental elements	0.174	81.80%	Accepted
S2.2 The design skill to increase the efficiency of machinery	0.092	90.90%	Accepted
S3. Planning, Procurement, and Material Skills	0.068	81.80%	Accepted
S3.1 The planning skill that considers the environmental aspect	0.088	81.80%	Accepted
S3.2 The skill to choose eco-material product	0.084	90.90%	Accepted
S3.3 The skill to manage material inventory	0.168	81.82%	Accepted
S3.4 The procurement skill-related material/product/service	0.167	90.91%	Accepted
S4 Energy and water skills	0.090	90.90%	Accepted
S4.1 The skill to optimise energy usage	0.132	100.00%	Accepted
S4.2 The skill to minimise water consumption	0.116	100.00%	Accepted
S5 Communication Skills	0.096	81.80%	Accepted
S5.1 The communication skill through the environment-friendly method	0.096	81.80%	Accepted
S5.2 The communication skill using green IoT (Internet of Things)	0.096	81.80%	Accepted
S6 Management Skills	0.141	90.90%	Accepted
S6.1 The skill to reduce air pollution risk	0.092	90.90%	Accepted
S6.2 The skill to reduce water pollution risk	0.176	100.00%	Accepted
S6.3 The skill to follow the SOP (standard of operation) in handling waste material	0.095	90.91%	Accepted
S7 Leadership and Teamwork Skills	0.080	81.80%	Accepted
S7.1 The leadership skill	0.082	81.80%	Accepted
S7.2 The teamwork skill	0.080	81.80%	Accepted
S8 Problem Solving and Critical Thinking Skills	0.140	90.90%	Accepted
S8.1 The problem-solving skill related to the environment	0.092	81.80%	Accepted
S8.2 The critical thinking skill related to the	0.081	81.80%	Accepted

environment			
S9 Protection Skills	0.079	81.80%	Accepted
S9.1 The skill to protect the environment by using relevant equipment	0.089	81.80%	Accepted
S9.2 The skill to conserve biodiversity	0.076	81.8%	Accepted
S9.3 The skill to conserve the landscape	0.089	81.82%	Accepted
S9.4 The skill to conserve the ecosystem	0.089	81.82%	Accepted

C. Attitude dimension

A total of two elements and 11 sub-elements of the attitude dimension were analysed. The results show that all items obtained more than 75% consensus in the expert group, and three of them obtained 100% agreement, which are: 1) behaviour, 2) the attitude of 4R practice at the workplace, and 3) the attitude of waste management and minimising the use of natural resources. In this dimension, all the items have been accepted.

Table 4
Attitude dimension

Item	Fuzzy score (A)	Fuzzy score (A)	Result
A1 Behaviour	0.163	100.0%	Accepted
A1.1 The attitude towards environmental protection	0.163	90.90%	Accepted
A1.2. The attitude regarding environmental consciousness at the workplace	0.163	90.90%	Accepted
A1.3 The attitude of following the regulation at the workplace	0.119	81.82%	Accepted
A1.4 The attitude of 4R practice at the workplace	0.163	100.00%	Accepted
A1.5 The attitude of green practice	0.147	90.91%	Accepted
A1.6 The attitude of waste management and minimising the use of natural resources	0.068	100.00%	Accepted
A1.7 The attitude of being patient in green practice at the workplace	0.122	81.82%	Accepted
A2 Awareness	0.185	90.90%	Accepted
A2.1 The awareness of environmental protection at the workplace	0.098	81.80%	Accepted
A2.2 The awareness of green policies at the workplace	0.170	90.90%	Accepted
A2.3 The awareness on waste reduction at the workplace	0.141	81.82%	Accepted
A2.4 The awareness of green concept at the workplace	0.112	81.82%	Accepted

As for further discussion, knowledge dimension which consist of three main elements and 11 sub-elements has been derived. Three items were rejected due to their low percentage of consensus. The knowledge elements are consistent with the study by Pavlova, (2016) which identified cognitive competencies as a strategies for sustainability. The knowledge in green technology, waste management, problem-solving and critical thinking needs to be acquired by worker in the mechanical industry to respond to the green challenge.

In the skill dimension, all experts accepted nine main elements and 24 sub-elements listed. The elements were design skills, waste skills, design, planning, procurement and material skills, energy and water skills, communication skills, management skills, leadership and teamwork skills, problem solving skills and protection skills, which are important because they enable the process of greening the economy in area of mechanical industry. All this elements are similar to the interpersonal skills and technological skills by Pavlova, (2018) as it is complement to the existing skills to complete the work in mechanical industry.

For the attitude dimensions, there were two main items, namely behaviour and awareness, and 11 elements were accepted by the experts. Awareness is important in the workplace as suggested by Mustapha et al., (2019). It is an important element to ensure the success of activities related to the environmental protection. Awareness need to be supported by behaviours to ensure workers in the mechanical industry are engaged in their work and responsible for protecting the environment. It will also support the green industries that open green job opportunities and fill vacancies for jobs that require workers competent in green skills (Mohd Zubir et al., 2021). These findings may also be helpful in developing green skills training programs for workers in the mechanical industry towards sustainable development.

6. Conclusion

In conclusion, this research has uncovered elements of green skills for workers in the mechanical industry based on three dimensions, namely knowledge, skills and attitudes. Green skills have become a major concern for a sustainable environment and the industry is currently looking for competent personnel who can perform tasks effectively, including the competencies in green skills. Therefore, these elements in this study are important for the sustainable development and need to be integrated into existing work skills in the mechanical industry.

In terms of finding, industry feedback is important to produce quality human resources. As current industry practices slowly go green, more studies involving the government in green careers and vocational training need to be conducted. One of the many actions that the government can take is to stimulate the demand for green skills by emphasizing green curricula in institutions and disseminating them across industry. For example, the Ministry of Higher Education and Ministry of Human Resources can collaborate with the industry on the design of curricula and training facilities to ensure an adequate supply of green workers. These initiatives will close the green skills gap for student before entering the job market and also for existing workers looking to reskill in the industry. Therefore, this collaboration can support the sustainability in social, economic, and environmental terms.

References

Abdullah, K. & Ahmad, J (2014). Impak Pemerkasaan Teknologi Hijau terhadap Amalan Pengamal Perhubungan Awam Hijau di Malaysian Green

Technology Corporation (GreenTech Malaysia). *AKADEMIKA, 84(3)*, ms.29-39.

Adler, M., & Ziglio, E. (1996). Gazing into the oracle. Jessica Kingsley Publishers: Bristol, PA.

Adriansyah. (2015). *Manajemen Transportasi dalam Kajian dan Teori.* Jakarta, Indonesia: Publisher Kompak.

Akyuz, I., Guasch, T., & Espasa, A. (2013). *University teacher roles and competencies in online learning environments: A theoretical analysis of teaching and learning practices*. European Journal of Teacher Education, 32(3), 321-336.

Arunkumar, J. (2012). A study on assessment of environmental awareness among teacher trainees in teacher training institutes. *International Journal of Research in Social Sciences*, 2(3), 312.

Baharom, J.K. (2013). Wasatiyyah Menurut AlQuran dan Sunnah: Aplikasinya di Arab Saudi dan Malaysia.

Barbier, E.B. & Markandya, A. (2012). *A New Blueprint for a Green Economy*. London: Routledge/Taylor & Francis.

Buntat, Y., & Othman, M. (2012). Penerapan kemahiran insaniah "Hijau" (Green Soft Skill), Pendidikan Teknik dan Vokasional di Sekolah Menengah Teknik, Malaysia. In Malay. *Journal of Social Science*, 5, 32-41.

Ciegis, R., J. Ramanauskiene & B. Martinkus. (2009). The Concept of Sustainable Development and its Use for Sustainability Scenarios in Inzinerine. *Ekonomika: Engineering Economics*, 2, pp.28-37.

Dlimbetova, G. et al. (2016). Green Skills for Green Economy: Case of the Environmental Education Role in Kazakhstan's Economy. *International Journal of Environmental & Science Education*, Volume 11(8), pp.1735-1742.

DoSM (Department of Statistics Malaysia) (2006). *Compendium of Environment Statistics: Malaysia*. Putrajaya, Malaysia: Percetakan Nasional Malaysia, Bhd.

Ghani, Mohd Shahril bin Mohd Hassan@Abdul (2018). *Model Konsep Kemahiran Hijau Politeknik Malaysia*. Unpublished PhD Thesis. Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia.

Hamdan, Abdul Rahim et al. (2018). Tahap Minat, Pengetahuan dan Kemahiran, Latihan Guru, dan Beban Tugas Guru Program Pemulihan Khas Sekolah Kebangsaan Daerah Pontian, Johor.

Ishak, A., Jamil, K., Razak, F. & Ahmad, S. M. (2013). Pembangunan Kompetensi Kerja Bagi Pekerja Teknikal Berkemahiran Terhadap Kemahiran Hijau Untuk Pembangunan Kelestarian: Sebuah Kajian Dalam Industri Pengangkutan Malaysia. International Journal of GEOMATE, Month, Year Vol.00, Issue 00, pp.000-000 Geotec., Const. Mat. & Env., DOI: https://doi.org/10.21660/Year.Issue.PaperID ISSN: 2186-2982 (Print), 2186-2990 (Online), Japan.

Ismail, A., Kasman, Z., Sri Sumarwati, Nur Yunus, F. A. and Abd Samad, N. (2019). The Development of Job Competency for Skilled Technical Worker Towards Green Technology, International Journal of Geomate, Geomate International Society, 2, 216, ISSN:21862990.

Ismail, A. and Kasman, Z. (2018). Pembangunan Kompetensi Kemahiran Teknika bagi Sektor Pengangkutan di Malaysia. *Jurnal Kajian Pendidikan*, 10(1).

Ismail, A., Hassan, R., Masek, A., Hamzah, N., Ismail, I. M., & Subramaniam, T. S. (2017). Implementation of vocational training into TVET's teacher program for national core standard. *IEEE 8th International Conference on Engineering Education: Enhancing Engineering Education through Academia-Industry Collaboration*, ICEED 2016, 28-31. doi:10.1109/ICEED.2016.7856088

Ismail, R. & Jajri. I. (2008). Analysis of Technical Efficiency Changes, Change of Technology, Productivity Growth Overput Factors, and Growth in Transport Equipment Industry in Malaysia. *Journal of Technology*, 49(E), pp.31-48.

Jaghannath, K. (2016). Ethics and values: The Need for Student Awareness of Workplace Value Systems. *International Journal of Engineering Research and General Science*, Vol. 4, Issue 3, May-June, 2016. Ethics.

Ling, K. S. & Lay, Y. F. (2015). Perbandingan pola pembelajaran kontekstual dan tahap pemahaman konsep sains pelajar sekolah menengah rendah di Malaysia dan Singapura. Jurnal Teknologi (Social Sciences), 63(2), 91-96.

Makhbul, Zafir Mohd, Mohamad Hasun F. & Abd Latif M.N. (2018). Pengurusan Sumber Manusia Hijau Mendepani Industri 4.0. *Proceedings of the 5th ICoMM (International Conference on Management and Muamalah)*.

Manshoor, H. A., Attiya, S., and Rahatul, A. A. (2011). Role of Effective Communications for Enhancing Leadership and Entrepreneurial Skills in University Students. *International Journal of Business and Social Science*, Vol. 2 No. 10; June 2011.

McDonald, G., Condon, L., & Riordan, M. (2012). *The Australian green skills agreement policy and industry context, institutional response and green skills delivery*. Broadway, Australia: TAFE Directors Australia.

MIDA (Malaysian Investment Development Authority) (2019). *Laporan Prestasi Tahunan Malaysia 2018: Menginspirasikan Transformasi Teknologi. Putrajaya: Penerbit MIDA*.

Mohd Zubir, M. Z., Lai, C. S., Zaime, A. F., Lee, M. F., Ibrahim, B. and Ismail, A. (2021). Dimension of Green Skills: Perspectives from the Industry Experts. *Journal of Technical Education and Training*, Vol. 13 No. 1 (2021) p. 160-166

Mustapha, R., Mat Nashir, I., & Ma'arof, N. N. (2019). Awareness of green technology among engineering technology students. *Journal of Engineering Science and Technology Special Issue on ICEES2018*, 1(3), 1–8.

Nik, A. (2015). *Pengetahuan murid dan perkaitan ibu bapa terhadap kesedaran alam sekitar: Satu kajian awal*. Jurnal Teknologi 64(1): 51-57.

Norasmah, M.Y. & Shukri S. 2010. *Pendidikan alam sekitar dalam Pendidikan Islam: Peranan guru*. In The 4th International Conference on Teacher Education, 839-851. Bandung, Indonesia.

Onga, H.C., Mahlia T.M.I & Masjuki. H.H.A (2012). Review on Energy Pattern and Policy for Transportation Sector in Malaysia. *Renewable and Sustainable Energy Reviews*, pp.532-542.

Pavlova, M. (2016). Greening skills: Research and pratices from Asia and Pacific region to cover. *EESA 2016, South Africa.*

Pavlova, M. (2018). Fostering inclusive, sustainable economic growth and "green" skills development in learning cities through partnerships. International Review of Education, 1–16. https://doi.org/10.1007/s11159-018-9718-x

Pierantoni, I.A. (2004). *Few Remarks on Methodological Aspects Related to Sustainable Development in Measuring Sustainable Development: Integrated Economic, Environmental, and Social Frameworks*. USA: OECD Publications.

PPM (Perbadanan Produktiviti Malaysia) (2016). *MPC: Laporan Produktiviti 2015/2016 ke-23.* Petaling Jaya, Selangor Darul Ehsan. Publisher: Perbadanan Produktiviti Malaysia.

Razak, N. (2017). *Laporan Ekonomi 2017/2018*. Putrajaya. Publisher: Kementerian Kewangan Malaysia.

Rahman, Abdul H. (2017). Usaha dan Cabaran dalam Mengaplikasikan Pendidikan Alam Sekitar dalam Sistem Persekolahan di Malaysia. *Asian Journal of Environment, History, and Heritage, 1(2),* ms.61-70.

Roselainy, A. R., Yudariah, M. Y., Hamidreza, K. and Sabariah, B. (2012). Developing Mathematical Communication Skills of Engineering Students. *Procedia-Social and Behavioral Sciences*, 46, 5541 – 5547.

Samsudin Z., Hassan R. & Hasan A. (2013). Melestari Program TVET Berdasarkan Kreativiti Guru. This paper has been presented. *CiE-TVET (Conference in Education Technical Vocational Education & Technology)*.

Suhaimi, N. et al. (2018). *Pelestarian Kurikulum Pendidikan Teknik dan Vokasional (PTV)*.

SPAD (Suruhanjaya Pengangkutan Awam Barat) Malaysia (2018). *Rancangan Induk Pengangkutan Awam Darat Negara*.

Vijaya Lakshmi D. (2016). Significance of language labs in engineering education. *International Journal of Humanities in Technical Education*. Institute of Technology, Bhimavaram, (Andhra Pradesh).

Vona, F. et al. (2016). *"Green Skills" in NBER Working*. Paper Series, No.21116. Cambridge, MA: National Bureau of Economic Research.

Witt Z. & Orvis A. C., (2010) *Reduce, reuse, recycle: Green technologies and practices at work*. Beyond the Numbers, 2(7). Washington, DC: Bureau of Labor Statistics. Accessed from http://digitalcommons.ilr.cornell.edu

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