



Comparative Analysis on Green Skills Framework for Sustainable Development

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Abstract: *The Green Technology or clean technology is the application of one or more of environmental science, green chemistry, environmental monitoring and electronic devices to monitor, model and conserve the natural environment and resources, and to curb the negative impacts of human involvement. Although it has been adopted as an important component for Sustainable Development, it has not been sufficiently tackled to this date. This literature review study presents a comprehensive comparative analysis and gives an insight into existing green skills frameworks to transform skills development for sustainable development. Moreover, to make this comparative analysis more in-depth, a matrix on existing green frameworks in chronological order is presented. It presents the main conceptual models on greening Technical Vocational Education and Training (TVET) institutions to support green technology industry requirements with the support of the TVET sector. Despite this, the key characteristics of the existing frameworks also discussed and stated. Furthermore, the proposed matrix encourages TVET stakeholders and green industries to work together to produce skilled workers in green sectors. In addition to this, another matrix on the empirical research on Green Skills/Technology is depicted which provides several evidences on the workplace skills most relevant in the transition toward environmentally sustainable economies. These empirical research articles fulfill the demand of the training providers, green sector organizations, industry associations and unions etc. The purpose of the matrixes is to compare the existing work done by the different researchers on green skills.*

Key Words: Green Technology, Green Skills, Green Skills Framework, Green Matrix

INTRODUCTION

Nowadays, there are many discussions of green generation, green economy, green homes, green jobs and all things related to the phrase green. Though what does green really mean? Green can be an element that is described as a natural occurrence such as trees and forest, life, stability, peace and natural. Clearly there is no precise description to describe the concept of green skills. However, the definition of green skills from the viewpoint of researchers for this experiment is a concept that emphasizes on environmental element in lives and how individuals that will be produced can ensure a preserved development through economy, community and country.

Green skills are professional and vocational skills, generic skills (sustainability approaches, problem solving, and innovation) where green skills are needed in all

industrial sectors as a response towards climate change and sustainable imperatives (DoE, n.d). Green jobs mean “green collared jobs”, which are individuals who contribute towards a better environment or to increase sustainability (ACF, 2021).

The Council of Australian Governments (COAG, 2008) stated that green skills is a form of skills that is on the path towards a sustainable preserved development from a technical aspect, value and attitude knowledge. All these skills are needed in the work force to develop and support the social, economic and environmental outcome that is established in business, industry and community. (Pavlova, 2011) has also listed down a few elements of green skills:

Table 1: Green Skills (as defined by Pavlova, 2011)

S.No	Definition
1	Environmental awareness, attitude and readiness to study about sustainable development, issues as well as challenges.
2	Innovation skills to identify chances and create new strategies to respond towards green challenges.
3	Coordination and management of holistically approached skills towards the designated solution to fulfill economical, social and ecological objectives.
4	Entrepreneurship skills to grab the chance from low carbon technology
5	Analytical thinking skills: As a business and industrial step towards a model that is truly sustainable, there will be a need to understand the logic behind a rapid growing economy and how this is different from traditional model linear economic development.
6	STEM skills: general knowledge about the role of science, technology, engineering and mathematics to contribute to the process of a greener economy and community.

Green skills are deeply needed by all sectors no matter in the education sector, construction, industry and in all levels of workforce. While Vona, et al (2015) in their research found out that green skills is a set from the efficiency that is related to design, output, management and technology monitoring. In the research findings, they discovered that the rules of the environment sparked a change in technology and organization that increases the demand for a higher analytical and technical skills.

This research reviews the relevant literature on Green Skills, existing frameworks on green skills especially in construction and energy sectors for skilled workers. This investigates green skilled framework among TVET educators and green industry stakeholders. The paper provides previous studies related to the topic of the study namely green skills framework in education and training sector. The old research and studies are important to show the knowledge gap in the literature. Moreover, the objective of the paper is to compare and contrast the literature pertaining to Green Skills framework.

GREEN SKILLS FOR RENEWABLE ENERGY SECTOR

The economic movement towards a green economy creates opportunities for technology, investment, and new jobs. At the same time, environmental changes and especially climate change have a detrimental effect on specific economic sectors and can cause loss of some jobs. Lack of professionals with cutting-edge skills in energy efficiency, green engineering, and green construction have been identified in some countries as the main obstacles in implementing national strategies to reduce greenhouse gas emissions or address environmental change.

In the energy sector, rapid growth in renewable energy, progress in energy efficiency and better access to energy can lead to major gains in employment opportunities and income as well as significant environmental benefits. Fossil energy generation is likely to see job losses, calling for policies to ensure a just transition for workers and their communities (ILO, 2015).

The challenge of involving the private sector is particularly important in the energy sector, particularly in Africa. Only 30% of the African population have access to electricity, 80% rely on the use of biomass for cooking (mainly firewood and coal), 600,000 children die each year from indoor smoke pollution. Still, by 2014, Africa attracted less than 10% of global investment in renewable energy (about 80 billion USD) despite a significant potential (AFD, 2017).

L. Energy (2021) stated that different types of green sector jobs required different types of skills that are in demand of the industry. Although there are many skills that are important for this type of work, the five below are those that will give you the edge over other candidates.

- Technical Skills
- An Inquiring Mind
- Ingenuity
- Communication
- Motivation

GREEN SKILLS FOR CONSTRUCTION SECTORS

The construction sector is responsible for one-third of all global carbon emissions and one-third of global resource consumption. Curtailing the environmental impact of this sector is, therefore, an urgent task for ensuring the survival of future generations. One of the major challenges in greening the construction sector is that as an industry, it is fragmented and disjointed. A single construction project can involve hundreds or even thousands of different organizations in a supply chain.

The construction supply chain is highly complex diverse, and fragmented. On a large construction project, the number of organizations involved in the supply chain can run into the thousands.

- Green building design
- Green purchasing
- Green Transportation
- Green Construction/Manufacturing
- End of life Management

The term sustainable or green supply chain refers to the idea of integrating sustainable environmental processes into the traditional supply chain. This can include processes such as supplier selection and purchasing material, product design, product manufacturing and assembling, distribution and end-of-life management. Instead of mitigating harmful impact of business and supply chain operations, green supply chain involves value addition and/or value creation through the operations of whole chain.

RELATED EXISTING FRAMEWORKS AND RESEARCH

Industry is striving to support economy through green economy. The Green economy is very complex construction regarding efforts to integrate economic, environmental, and social problem, which involve various figures and forms of government needed to regulate the process of green environment. Furthermore, among the conceivable areas where these creations and growth are expected to come from involve organic farming, green energy, green building construction, eco-textiles, and manufacturing of relevant products and materials to support green business because it is new to the industries (Abolfazal et al, 2017). The following section will help to understand the existing frameworks and their contribution towards green technologies and skills.

Skills Framework for Environment – Singapore

The Skills Framework is a SkillsFuture initiative developed for the Singapore workforce to promote skills mastery and lifelong learning, and is an integral component of the Environmental Services Industry Manpower Plan (SFS, 2020). This framework was jointly developed by SkillsFuture Singapore (SSG), Workforce Singapore (WSG), and the National Environment Agency (NEA), together with industry associations, training providers, organisations and unions, the Skills Framework for Environmental Services provides useful information on:

- Sector information;
- Career pathways;
- Occupations and job roles;
- Existing and emerging skills; and
- Training programmes for skills upgrading and mastery.

This framework addresses the needs of the individual (students, researcher etc), employers, and training providers. It is systematic framework which contains information on trends, career pathways, occupations, job roles, skills and competencies and training programmes. This framework more focused on environmental services instead of specific sector such as Energy and construction sectors.

Greening TVET Framework

The focus of Greening TVET framework is to transform TVET institutions into becoming green. It is a proposed international framework for TVET organization to transform TVET institutions. Majumdar (2010) elaborated a three-tier approach, consisting 1) development of a framework to transform and orient TVET institutions into becoming 'green', 2) support transformation through a national-level Green Policy; and 3) develop an international cooperation model that support formation of a network of green-bound institutions. It also defined five dimensions:

- Green campus
- Green technology
- Green community
- Green culture

The author focuses on thematically oriented suggestions for actions towards greening TVET. In this paper, no detailed analysis is present which can help to understand the overall greening practices in TVET institutions. Since Majumdar's proposal for greening TVET institutions is being spread all over the world by UNESCO-UNEVOC, it seems to be worthwhile to discuss the approach and get the idea for perfect green skills framework for future skilled workers.

An ESD Pedagogical Model

It is an interesting paper which abstracted an education for sustainable development (ESD) pedagogical model relevant for the TVET context based on the pilot study and literature review (Pavlova, 2019). This study explores and identified the differences between pedagogical approaches used in TVET to teach SD issues and approaches suggested in the literature (although they are proposed for universities and other education institutions). Furthermore, this paper advices how four elements of the framework can be translated into learning objectives, pedagogical strategies and learning activities and which specific generic green skills can be addressed through the different components. The Problem-Oriented and Project-Based Learning Plus model (POPBL+) is proposed here to facilitate the effective delivery of the generic green module to enhance students' generic green skills. Bringing the world into the classroom is an important component of this model, as the current reality of the TVET

institution involved in this study would not allow students to go outside campus during the module.

Framework for Green Skills for Environment Industries

This article proposed a green skills framework for environment industries based on analysis of trends in Hong Kong, China, India, and Malaysia. A detailed analysis report on existing government policies of these countries were discussed. The article also identified that development of these industries, resulting in new employment opportunities for young people and new skills requirements. Based on evidences, a holistic framework to support the development of road maps relevant to different contexts that extend beyond TVET to all levels of education, and which involves close partnerships between governments, industry, civil society, and education (Pavlova, 2019). The article presented a framework for green skills to help TVET meet the skills needs of environment industries.

MATRIX ON EXISTING GREEN FRAMEWORK

These framework/models of green skills represent the main conceptual models on greening TVET institutions to support green technology industry requirements with the support of the TVET sector. The key characteristics of these models are summarized in Table 5. These frameworks encourages TVET stakeholders and green industries to work together to produce skilled workers in green sectors. This is further elaborated in Table 2.

Table 2: Matrix on Green Frameworks - Chronological order

Title of the work	Year Published	Authors	Characteristics
United Nations Decade of Education for Sustainable Development (an special framework)	2005	United Nations	The main aim to make sustainable development central to all education and training in all sectors by refining and promoting the transition to a sustainable future through all forms of education, public awareness and training.
Education as sustainability: An action research study of the burns model of sustainability pedagogy	2009	Burns, H.	This model is comprised of five key dimensions: (1) Content; (2) Perspectives; (3) Process; (4) Context; and (5) Design.

International Framework for Greening TVET for Green Society : a three-tier approach	2010	Majumdar, S.	In visualizing a common framework, three tiers need to be established. 1. Transforming TVET Institutions 2. Formulating National Policies 3. Forming International Alliance
A strategy for green skills? A study on skill needs and training has wider lessons for successful transition to a green economy.	2012	CEDEFOP	A study on skill needs and training has wider lessons for successful transition to a green economy.
Facilitating the development of students' generic green skills in TVET: an ESD pedagogical model	2019	Pavlova, M. and Christy Shimin Chen	This paper considers pedagogy for education for sustainable development (ESD) as a broad framework that can enhance the development of generic green skills. It examines current theories and a selection of practices related to ESD pedagogy and analyses pedagogical approaches commonly used in ESD curricula.
Emerging environmental industries: impact on required skills and TVET systems	2019	Pavlova, M.	This article analyzes recent trends in Hong Kong, China; India; and Malaysia where government policies in the last two decades have paved the way for the rapid development of these industries, resulting in new employment opportunities for young people and new skills requirements. It suggests an evidence-based, holistic framework to support the development of road maps relevant to different contexts that extend beyond TVET to all levels of education, and which

			involves close partnerships between governments, industry, civil society, and education.
Skills Framework for Environmental Services	2020	SkillsFuture, Singapore	The Skills Framework is a SkillsFuture initiative developed for the Singapore workforce to promote skills mastery and lifelong learning, and is an integral component of the Environmental Services Industry Manpower Plan.

MATRIX ON THE EMPIRICAL RESEARCH ON GREEN SKILLS/TECHNOLOGY

These empirical researches provided several evidences on the workplace skills most relevant in the transition toward environmentally sustainable economies. These articles fulfill the demand of the training providers, organizations, industry associations and unions etc. The key summaries of these researches are depicted in Table 3.

Table 3: Matrix on the Empirical Research on Green Skills/Technology

Title of the work	Year Published	Authors	Characteristics
The status of environment education in the Mediterranean countries within formal and informal education system.	2004	Perikleous, E.	The education on the importance of the environment is essential to increase the level of individuals' self-awareness. Environmental education has the potential to assist the future generation to manage life and to establish a prosperous future.
Assessing knowledge, attitudes, and behavior toward charismatic megafauna: The case of dolphins.	2005	Erin C. Barney, Joel J. Mintzes, and Chiung-Fen Yen	It is a cross-age study which assessed public knowledge, attitudes, and behaviors toward bottlenose dolphins.
Environmental management and environmental education in two schools in the Klang Valley	2005	Lim, S.F.	The study explored Environmental management and education into two school of Malaysia.

Factors Associated With K–12 Teachers' Use of Environment-Based Education. The Journal of Environmental Education	2007	Julie Ernst	The author used analysis of variance and discriminant function analyses, and results suggest that environmental literacy knowledge and skills and environmental sensitivity are important in teachers' decisions to use and their abilities to implement environment-based education.
Impact of Global Recession on Sustainable Development and Poverty Linkages	2010	ADB	Paper discusses consequences of global financial crisis for energy use, pollution prevention, and land use in Asia and associated greenhouse gas emissions and their linkage with poverty.
Skills for green jobs: A global view	2011		
Skills for a Green Economy: Practice, Possibilities, and Prospects	2013	John Fien and Jose Roberto Guevara	Achievement of 'green economy' will require existing education and vocational training systems to be capable of equipping future workers with the requisite breadth of competencies needed to take full advantage of the employment opportunities being generated by the 'green economy'.
Green and sustainable development for TVET in Asia	2016	Ramlee Mustapha	The aim of this paper is to map the sustainable development in terms of green mindset, lifestyle, economy, education, training, employability and sustainability in selected Asian countries.
Informal and Formal Environmental Education Infusion: Actions of Malaysian Teachers and Parents Among Students in a Polluted Area	2017	Baniah Mustam, Esther Sarojini DANIEL	The study explored Environmental Education infusion among students by teachers and parents in two schools located in a highly polluted area.
Exploring green skills: a study on the	2018	A. Kamis, R. Rus, Mohd	The aim of this research is to explore the views of teachers

implementation of green skills among secondary school students		Bekri Rahim, F. Yunus, Normah Zakaria, H. M. Affandi	regarding the instilling of green skills in students and the types of green skills applicable in schools. This research is a qualitative investigation using the method of in-depth interview to collect information from the teachers who handle the subject of Living Skill Integration in secondary schools.
Awareness of green technology among engineering technology students	2019	Ramlee Mustapha, Irdayanti Mat Nashir, & Nurul Nazirah, Mohd Imam Ma'arof	The purpose of the research is to find out the green awareness among engineering technology students. The study found that even though the majority of the respondents claim that their awareness of green technology is relatively high, the daily application of green technology in their lives is only moderate.
Development of Secondary School Students' Green Skills for Sustainable Development	2020	Sarsvathy Thirupathy, R. Mustapha	This concept paper discusses about the implementation of green skills in the learning process for secondary school students. Activities which contribute toward the preservation of the environment and the conservation of energy are considered as part of generic green skills.
A Structural Model of Green Technology Practices among Primary School Teachers at Northern Region Malaysia	2021	Talirkodi Vinathan and Arumugam Raman2	This study aimed to examine the level and influence of primary school teachers' awareness and motivation in accepting green technology practices. Besides, this study aimed to examine the moderation effect of knowledge and gender on the relationship between awareness and motivation with the acceptance of green technology practices.

CONCLUSION

The paper discusses about the frameworks, models, and empirical researches related to green skills and technologies. The overall purpose of paper is to do the literature review on existing research. There are two green sector are focused in this study i.e. energy and construction. Furthermore, the researcher also explains the concept of green skills and sustainable development. In addition to this green skills related to proposed sectors are explained. Based on international studies there are different green skills framework described and write a narration on these. Two matrixes are also prepared and developed on green skills framework and empirical research on green skills & technology. The purpose of the matrixes is to compare the existing work done by different researcher on green skills.

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