Curriculum Innovation in Engineering: Integrating SDG and ESG for Future-Ready Technologists

*Mahanijah Md Kamal

Faculty of Electrical Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

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ABSTRACT

Since technical advancement in electrical and electronics engineering must strike a balance between social responsibility, economic viability, and environmental preservation, sustainability management has emerged as an essential component in today's engineering education. The fourth (SDG 4) of the 17 Sustainable Development Goals is to ensure high-quality education and promote opportunities for lifelong learning, which is an essential component of sustainable development. The innovative integration of sustainability management concepts into engineering curricula, with an emphasis on the environmental, social, governance, and economic aspects, is presented in this paper. In this regard, the Sustainability Management course is one of the courses offered in the Bachelor of Electrical and Electronics Engineering Technology with Honours programme. It is seen as added value and at the same time raises awareness of the critical role of the younger generation in improving environmental sustainability. These days, the industry seeks graduates who can contribute to the long-term viability of their company's operations in addition to having technological expertise. Thus, the course adds value for UiTM graduates as they can catalyze shaping the future of sustainable management in Malaysia and throughout the world in addition to pursuing careers in the energy and technology sectors.

Keywords: Sustainability, Management, Course, Technologist

INTRODUCTION

Sustainability has emerged as a critical component in addressing global challenges such as climate change, resource depletion, and social inequality. As future technologists are expected to lead the design and development of sustainability technologies and systems, integrating sustainability into engineering education has become not only relevant but essential. Engineering undergraduates must be equipped with the knowledge, skills, values, and integrity necessary to understand complex scenarios and to propose innovative solutions aligned with global sustainability goals. One common problem in engineering studies is that, although design is a fundamental part of engineering sciences, sometimes it may be excluded from the teaching curriculum. Hence, future engineers may lack creativity and have a narrow problem-solving focus, with too much emphasis on mastering mathematical equations (Pineda et. al. 2024).

In response, higher education institutions (HEIs) worldwide are reforming curricula to embed sustainability principles across disciplines. The integration of sustainability into engineering curricula has emerged as both a global and national priority. Globally, universities are aligning their teaching and learning with the United Nations' Sustainable Development Goals (SDGs) to prepare future-ready graduates capable of addressing complex societal and environmental challenges, which serve as a global blueprint for achieving a more sustainable and equitable future by 2030. Nationally, the Malaysian Qualifications Agency (MQA) underscores this priority by mandating the integration of SDGs into higher education programme standards. This integration extends to curriculum design, learner learning assessment, academic staff development, and governance structures, ensuring that higher education contributes directly to sustainable development. Consequently, university curricula should be adapted to raise student awareness on the concepts of sustainability and sustainable development. In addition, it is essential to introduce methodological changes aimed at making students more active in their learning processes (Calvo et. al, 2024). In this scenario, the following research questions arise:

RQ1: What pedagogical strategies are most effective in embedding sustainability management into engineering education?

RQ2: How does the course design address industry and societal needs for future technologist graduates?

Therefore, this paper proposed a structured approach to curriculum development for a sustainability-focused subject in engineering programme. This paper aims to present a curriculum innovation in engineering by integrating SDG and ESG principles and introducing them in the Sustainability Management course to prepare future-ready technologists.

LITERATURE REVIEW

A growing body of research underlines the necessity for engineering education to move beyond purely technical skills. Studies show that integration of the SDGs into engineering curricula fosters more holistic education, combining ethics, social, and environmental awareness, and systems thinking with technical learning (Risti et. al, 2026). The authors highlight that recent years have seen increasing attention to SDG themes in engineering education globally, emphasizing that students develop core competencies required for sustainability and that institutions face both structural barriers and opportunities in integrating these into curricula. Consequently, various frameworks have been developed to guide the incorporation of sustainability into higher education, notably the UNESCO Education for Sustainable Development (ESD) framework and the ABET Engineering Criteria.

In Malaysia, particularly, studies demonstrate that in the electrical and electronics manufacturing sectors, green management and green technology have measured positive impacts on performance and business sustainability (Mohd Yazid Md Talib et. Al, 2024). These findings suggest that graduates in electronic engineering require not only technical knowledge but also management capability and awareness of sustainability to align with industry and national sustainable ambitions. The 2030 Agenda for Sustainable Development clearly reflects the urgency to embed the principles of education for sustainable development (ESD) into all levels of education. ESD, understood as an integral part of quality education and all educational institutions, from preschool to higher education and in nonformal and informal education, can and should foster the development of sustainability competencies (Cebrian et. Al, 2020).

METHODOLOGY

The methodology comprises five key stages: Curriculum Development, Instructional Design and Delivery, Learning Assessment, Feedback and Survey, and Review and Continuous Improvement. Figure 1 shows the flow chart of the curricula development for the Bachelor of Electrical and Electronics Engineering Technology with Honours at the Faculty of Electrical Engineering, Universiti Teknologi MARA, Shah Alam.

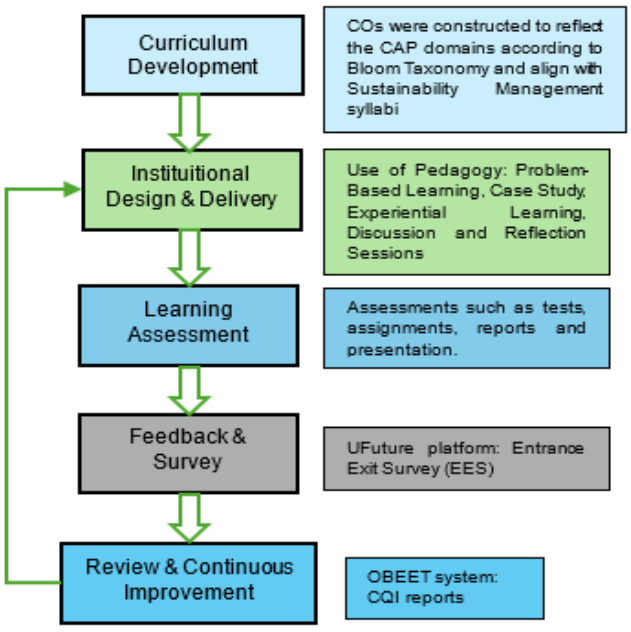

Figure 1 The flow chart of the Sustainability Management development course

Bloom's Taxonomy

Bloom's Taxonomy, created by Benjamin Bloom in 1956, classifies educational learning objectives into six levels of complexity (Chandio et. al, 2021). The six levels of Bloom's Taxonomy are divided into three domains (Armstrong, 2010) to promote higher-order thinking skills as tabulated in Table 1.

It employs the CAP (Cognitive, Affective, and Psychomotor) learning domains to ensure a holistic development of learner competencies, encompassing critical thinking, personalised values formation and practical skills. The integration of CAP domains in the Sustainability Management course enables the creation of meaningful learning experiences that go beyond theoretical knowledge to include ethical reasoning, emotional engagement, and real-world scenarios. Table 1 tabulates the level of Bloom's Taxonomy used in the CAP domains.

Table 1 Bloom's Taxonomy

Domain	Focus	Levels
Cognitive	Thinking & Knowledge	Remember, Understand, Apply, Analyze, Evaluate, Create
Affective	Feelings & Attitudes	Receive, Respond, Value, Organize, Characterize
Psychomotor	Physical Skills	Imitate, Manipulate, Precise, Articulate, Neutralize

RESULTS AND DISCUSSION

Curriculum Innovation

The rapid industrialization and digital transformation of the 21st century have brought both opportunities and challenges for engineering graduates. Beyond technical expertise, technologists today are expected to demonstrate awareness of global sustainability issues, ethical decision-making, and the capacity to design solutions that integrate environmental, social, and economic considerations. Sustainability Management, course code: EEE510, is a new course being offered by Universiti Teknologi MARA (UiTM) as part of the course of study for the Bachelor of Electrical and Electronics Engineering Technology with Honours (CEEE260) programme in response to this changing need.

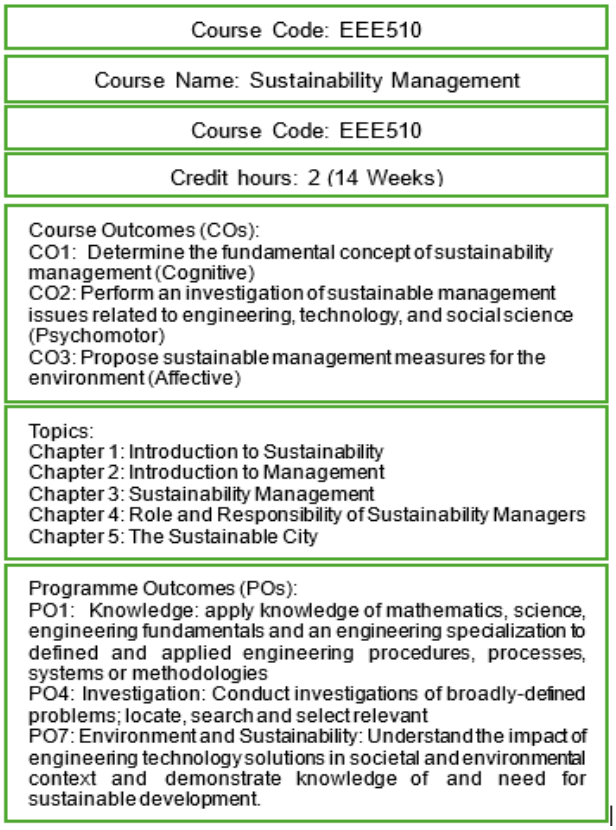

Figure 2 EEE510 Course syllabus

The innovation of curriculum design of the Sustainability Management course in the CEEE260 programme reflects UiTM's commitment to producing future-ready graduates who are both technically competent and socially responsible. This course, offered in Semester 3 with 2 credit hours, is designed to provide learners with a foundational understanding of sustainability concepts and their relevance to engineering practice. The course integrates experiential learning through assignments and case studies that link learners with the stakeholders. By aligning with the Malaysian Qualifications Agency (MQA) standards, accreditation requirements, and the United Nations Sustainable Development Goals (SDGs), the curriculum ensures both national and international relevance. The course syllabus, including the COs, POs, and topics studied in EEE510, is outlined in Figure 2. The mission of the FKE is to create multi-skilled engineering graduates who can be entrusted to spearhead nation-building, especially to support the demand of the workforce in the green economy sector. To graduate from the CEEE260 programme, the learners must undertake courses divided into several categories/components as depicted in Table 2, which shows the component attributes of this program. The course, offered in different components, is designed to enhance learner skills and abilities in various areas.

Table 2 The Program of EEE260 Courses

Component	Percentage (%)
University	27.9%
Faculty	46.5%
Program	16.3%
Elective	9.3%

Feedback and Survey

Using the uFuture platform, an entrance and exit survey (EES) was produced and conducted to assess students' understanding as well as experience in the Sustainability Management course.

Table 3 Entrance Exit Survey Questions

No	Question & Domain Keyword
1.	I am **familiar** with the concept of sustainability management (Cognitive)
2	I have a strong **knowledge** of sustainability management (Cognitive)
3	Sustainability management has become a **culture** of my **lifestyle**. (Affective)
4	Sustainability management is one **essential** component of engineering studies (Affective)
5	I can **perform** an investigation of sustainable management issues related to engineering, technology and social science. (Psychomotor)
6	I can **propose** suitable sustainable management measures for the environment. (Cognitive)
7	I can **discuss** the necessary tools and mechanisms for sustainable management. (Cognitive/ Affective)
8	I can **contribute** to the university, community and global sustainable agenda. (Psychomotor/ Affective)

At the beginning of the semester, an entrance survey was given to students to determine their prior understanding, views, and expectations about sustainability principles and how they relate to engineering. The exit survey, conducted at the end of the course, measured the extent of knowledge gained, skills developed, and changes in attitudes towards SDG and ESG integration in engineering practice. This method gave comparative insights into how learners progressed and how well the course design worked to achieve the desired learning objectives. Table 3 shows how the EES questions were distributed. Here, the CAP domains are shown using Bloom's Taxonomy, which is reflected in the keywords.

This curriculum innovation applies aspects of sustainable management in accordance with national and international objectives, exposing students to creative and inventive thinking abilities. In addition to giving students a coursework learning experience that integrates sustainable concepts into governance practices, policies, work culture, engineering, and technology, it exposes them to how their role emphasizes a strategic approach to sustainable management and investigates how ethical decisions impact organizational development.

CONCLUSION

This requirement translates into the necessity for specialist courses in Electrical and Electronics Engineering that not only educate technical knowledge but also raise awareness of environmental, social, and governance (ESG) concepts. This gap is filled by the proposed Sustainability Management course, which gives learners the skills they need to analyze sustainability issues critically, look into social and engineering problems, and suggest solutions that support the shift to a green economy. This puts learners in a position to become morally pure and creative technologists who can make a big difference in the sustainable future of Malaysia and the entire globe. To prepare technologists for the needs of the green economy, the CEEE260 program needs to include knowledge of sustainability management. This knowledge empowers technologists to suggest environmentally friendly solutions, create ecologically conscious goods, and put management plans into action that strike a balance between technical innovation and economic and ecological factors. This subject's inclusion ensures that graduates are not only technically competent but also prepared to make a significant contribution to both national sustainability priorities and global development goals, thereby meeting MQA's requirements to incorporate SDG aspects.

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