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Path to SDG 2030: Fostering Sustainable Development at the School of Civil Engineering, KLE Tech - A Case Study

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Abstract

Context

The 2030 United Nations' Agenda for Sustainable Development highlights the need to integrate Education for Sustainable Development (ESD) principles across all educational levels. By equipping individuals with knowledge and skills to address environmental and social challenges, ESD contributes to achieving the Sustainable Development Goals (SDGs) and building a sustainable future.

Purpose or Goal

Current civil engineering graduates lack awareness sustainability development, resource depletion, environmental pollution, rapid population growth, and ecosystem degradation during their undergraduate studies. It is crucial to address this gap by reevaluating the curriculum and incorporating courses that specifically educate students about the importance of sustainability.

Methods

The approach of this study emphasizes understanding global perspectives on sustainability and Sustainable Development Goals (SDGs) integration especially with civil engineering curriculum. Identifying gaps in the current curriculum is essential and subsequently a four phased implementation approach is proposed to address these gaps effectively. The study further analyzes various models to determine the most suitable training program for students during their academic journey.

Outcomes

By adopting a precise and context-specific approach, current study aims to provide insights into how sustainable development goals can be systematically integrated into the existing civil engineering curriculum and make more aligned with SDGs, ensuring that graduates are well-prepared to contribute to sustainable practices in their professional careers**.**

Conclusion

Eventually instilling sustainability principles early in their education, future civil engineers will be equipped with the knowledge and skills necessary to integrate sustainable practices into their professional work, mitigating the environmental impact associated with the overuse of materials

Keywords— Sustainable development, SDG Goals, quadrant approach curriculum, curriculum matrix

I. INTRODUCTION

Sustainable development is of paramount importance as it addresses critical global challenges and ensures a better future for current and future generations. It emphases on preserving the environment, eradicating poverty, promoting social inclusivity, fostering economic resilience, and enhancing health and well-being. Sustainable development calls for global cooperation, responsible consumption, and long-term prosperity. By embracing sustainable practices, we can create a more equitable, resilient, and prosperous world where people and the planet thrive together.

In response to this, the Sustainable Development Goals (SDGs) for 2030, introduced by the United Nations (UN) in 2015, encompass an extensive and ambitious global agenda focused on addressing urgent social, economic, and environmental challenges. Consisting of 17 interconnected goals, the SDGs aim to eradicate poverty, hunger, and inequality, while ensuring universal access to quality education, healthcare, and clean water. They advocate for sustainable economic growth, decent work, and responsible industrialization, fostering resilient infrastructure and innovation. Furthermore, the SDGs underscore the importance of gender equality, climate action, and the conservation of marine and terrestrial ecosystems, striving to establish sustainable patterns of consumption and production. Collaboration among governments, civil society, and the private sector is encouraged to accomplish these transformative objectives, aiming to create a world where no one is marginalized, and our planet is safeguarded for future generations. Achieving these goals requires a collective global effort, instilling hope for a more equitable, inclusive, and sustainable world by the year 2030 (Gutierrez-Bucheli et al., 2022).

Amongst various sectors, education sector plays a vital role in promoting and encouraging to accomplish the SDGs by 2030 (Álvarez et al., 2021). It raises awareness about the interconnected global challenges and empowers individuals to contribute to sustainable development efforts. Education equips students with the knowledge and skills to adopt sustainable practices, advocate for change, and drive policy development. Every student as sustainability change agents, can upsurge mindfulness and have the potential to create impacts vis-à-vis

the SDGs at the individual, organizational and institutional levels (Hubscher et al., 2022).

Especially this is more factual in the engineering education through engineering students. Throughout the four years of innovation and problem-solving skills, engineering students can develop sustainable solutions that contribute to various SDGs, such as clean energy, sustainable infrastructure, and climate action. Their cross-disciplinary collaboration and ethical engineering practices enable comprehensive approaches to address issues related to cleaner environment, poverty, health, education, and more (Terrón-López., 2020). Engaging with communities and advocating for sustainable practices, engineering students have the potential to make a global impact and drive progress towards achieving the SDGs.

The implementation of sustainability into engineering is feasible by emphasizing analytical methods for analyzing the effects of technology, such as lifecycle evaluations of products or seeking for positive system transformation through technology and social change management and innovation (Mulder, 2017). Many writers outline learning objectives that includes broadly cognizant of global issues and changes, having the ability to comprehend competing norms and values regarding sustainability issues and to think in terms of general structures with continuous feedback, as well as being able to work across disciplinary boundaries (Dlouhá et al, 2017). In contrast, all of these approaches could fail to reach their objectives; as all engineering education needs to be refocused on confronting global concerns. Therefor national and international academic bodies have propelled the sustainable development through educational programs. (Akyazi et al., 2020). Although many universities have begun to implement sustainability into their curricula, it is still challenging to execute a systematic global approach and to assess progress and outcomes.

Civil engineering, a vital branch of engineering, assumes the responsibility of designing, constructing, and maintaining essential infrastructures such as buildings, transportation, hydraulic, and energy supply systems (Beagon., 2023). Transport infrastructures and the construction of buildings have a great impact on the environment, require a high consumption of energy and raw materials, and produce a large volume of waste. Hence it is essential to train the civil engineering graduates on order to develop the sustainable environment by introducing the reuse of materials, the manufacture of ecofriendly materials to minimize the ecological impact of newly constructed infrastructure and adopting the recycled materials, and global assessment of projects from the perspectives of social, environmental, and economic sustainability. Therefore, curriculum designed by incorporating many courses related to the environment and public policy, to elevate the focus on sustainability. By seamlessly integrating most of the Sustainable Development Goals (SDGs) into the civil engineering curriculum, this sector can play a pivotal role in addressing global challenges and creating eco-friendly infrastructures and services. Current study is dedicated to aligning the curriculum with the UN's 2030 sustainability goals, aiming to empower students to be more focused and effectively contribute to the SDGs throughout their educational journey and make a lasting positive impact on the world. The transformation of civil engineering education towards a sustainability-driven approach holds immense promise in creating a more resilient and prosperous future for all.

Current study considers Civil Engineering curriculum (2023-24 Board of Studies Approved) of KLE Technological University as case study. The approach of this study emphasizes understanding global perspectives on sustainability and Sustainable Development Goals especially integration with civil engineering curriculum. Identifying gaps in the current curriculum is essential and subsequently a four phased implementation approach is proposed to address these gaps effectively. By adopting a precise and context-specific approach, current study aims to provide insights into how sustainable development goals can be systematically integrated into the existing civil engineering curriculum and make more aligned with SDGs, ensuring that graduates are well-prepared to contribute to sustainable practices in their professional careers.

II. Understanding the SDG Landscape

The Sustainable Development Goals (SDGs) were established through a comprehensive and inclusive process initiated by the United Nations. The journey towards the SDGs began with the United Nations Conference on Sustainable Development, also known as Rio+20, held in Rio de Janeiro, Brazil, in June 2012. During Rio+20, member states recognized the need to address global challenges and promote sustainable development on a global scale. While the Millennium Development Goals (MDGs) had made significant progress since their inception in 2000, they were seen as having limitations in addressing all dimensions of sustainability and development.

In response to this, the UN General Assembly created an Open Working Group (OWG) on Sustainable Development Goals in January 2013. The OWG's objective was to develop a proposal for the post-2015 development agenda, which would include a set of sustainable development goals and targets. In September 2014, the OWG presented its final report, which contained a set of 17 proposed goals and 169 targets covering a wide range of social, economic, and environmental issues. The proposed goals were designed to be universal and applicable to all countries, recognizing the interconnectedness of global challenges and the shared responsibility for sustainable development. Subsequently, in August 2015, a UN summit was convened in New York, where world leaders formally adopted the 2030 Agenda for Sustainable Development. The 2030 Agenda outlines the 17 SDGs, each with specific targets and indicators, to be achieved by 2030. The SDGs officially came into existence on January 1, 2016 (UN; The Goals 2030 , 2017).

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The adoption of the SDGs represents a significant milestone in international cooperation, signifying a collective commitment to address the world's most pressing challenges, including poverty, hunger, inequality, climate change, environmental degradation, and social injustice. The SDGs provide a global roadmap for sustainable development, encouraging collaboration, innovation, and concerted action towards building a more equitable, inclusive, and sustainable future for all (Hák T et al., 2016). By incorporating the SDGs into the curriculum, education empowers students to understand the interconnectedness of global issues and the importance of responsible decision-making. It encourages active participation in community-based initiatives, nurturing a sense of responsibility towards society and the environment. Additionally, integrating the SDGs in education empowers teachers to serve as change agents, fostering a culture of sustainability and inspiring students to become advocates for positive change. Through education, we can create a transformative impact, equipping future generations with the knowledge and values needed to build a more sustainable and prosperous world for all (Cebrián et al., 2020). The 17 SDGs along with their purpose are as follows in the Table 1.

TABLE 1 : SUSTAINABLE DEVELOPMENT GOALS AS PER UN

	Sustainable Development Goals	Purpose
SDG1:	No Poverty	End poverty in all forms.
SDG 2:	Zero Hunger	Achieve food security and improved nutrition.
SDG 3:	Good Health and Well-being	Ensure healthy lives for all.
SDG 4:	Quality Education	Ensure inclusive and equitable education.
SDG 5:	Gender Equality	Achieve gender equality and empower women.
SDG 6:	Clean Water and Sanitation	Ensure access to clean water and sanitation.
SDG 7:	Affordable and Clean Energy	Provide sustainable energy for all.
SDG 8:	Decent Work and Economic Growth	Promote inclusive economic growth and decent work.
SDG 9:	Industry, Innovation, and Infrastructure.	Build sustainable infrastructure and foster innovation
SDG 10:	Reduced Inequalities	Reduce inequalities within and among countries.
SDG 11:	Sustainable Cities and Communities	Create sustainable cities and communities.
SDG 12:	Responsible Consumption and Production	Promote sustainable consumption and production.
SDG 13:	Climate Action	Take urgent action to combat climate change and its impacts.
SDG 14:	Life Below Water	Conserve and sustainably use marine resources.
SDG 15:	Life on Land	Protect and restore terrestrial ecosystems and biodiversity.
SDG 16:	Peace, Justice, and Strong Institutions	Promote peace, justice, and strong institutions.
SDG 17:	Partnerships for the Goals	Strengthen global partnerships for sustainable development.

III. Systematic Literature Reviews on the Integrating SDGs in Education

Current section of the article deals with literature reviews on integrating SDGs in education which have been on the rise in recent years. This section mainly serves the purpose of synthesizing existing studies and evidence related to the implementation of SDGs in educational practices and policies. Most of the studies conducted to gain a comprehensive understanding of the challenges, opportunities, and best practices involved in integrating SDGs into educational systems.

The paper by Osofero et al. (2014) examines the civil engineering program at two European universities, aiming to develop graduates with sustainability awareness and meet stakeholder aspirations. Case studies highlight efforts to integrate sustainability but underscore the need for urgent interventions to enhance students' knowledge and promote responsible actions aligned with sustainability principles.

Fenner et al. (2014) draws on 12 years of experience leading sustainability-focused engineering programs at a UK university. It highlights the essential skills young civil engineers need, such as handling complexity, uncertainty, and environmental constraints. The study explores what education is required for the next generation of civil engineers to act sustainably in their professional practice. It discusses fundamental principles, effective teaching strategies, and examples of linking sustainability to civil engineering practice. Furthermore, it reviews UK and international best practices showcasing progress towards sustainable engineering goals.

Stock et al. (2018) highlights the need to train young engineers for sustainability challenges in a dynamic global environment. It advocates for new perspectives in higher engineering education, emphasizing transnational and project-oriented teaching. The "European Engineering Team" master course exemplifies this approach, fostering sustainable start-up development and enhancing students' key competencies.

The article by Zamora-Polo et al. (2019) explores the evolving concept of sustainability, encompassing various fields like ecology, politics, ethics, and spirituality. It proposes a framework for teaching the UN's Sustainable Development Goals in Higher Education, benefiting students personally and professionally. The framework is applied in a case study for Primary Teacher Degree, aiming to build a change-maker University.

Mansell et al. (2019) emphasizes linking project sustainability to the UN's 2030 goals. It identifies a "golden thread" between sustainability reporting at project and organizational levels, allowing for embedding sustainable development goals into infrastructure project design. This strengthens investment appraisal and promotes success across economic, social, and environmental outcomes. Critical questions raised need resolution within the infrastructure sector for better alignment with global sustainability objectives.

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Perpignan et al. (2020) addresses the lack of sustainable engineering teaching in French schools. It proposes a skill crossover matrix derived from a literature review and a survey to aid in eco-design skill development. The matrix guides teachers in creating sustainable engineering curricula and helps students monitor their skill growth. Companies seek engineers with eco-design skills to align with their evolving strategies.

The study by Cebrián et al. (2020), highlights the urgency of embedding Education for Sustainable Development (ESD) principles into all educational levels. The Special Issue titled "Competencies in Education for Sustainable Development" presents recent developments in ESD competencies, including curriculum developments, evaluation tools, and conceptual models. The study also emphasizes the growing importance of sustainability competencies and the need for further research on operationalizing and evaluating competency development among students and educators.

Amidst the climate emergency, organizations globally integrate sustainability and SDGs in their actions. In education, steps have been taken to include sustainability at all levels, including universities. However, challenges like rigid structures and time constraints hinder integration. Civil engineering's role in creating environmentally impactful infrastructures makes it vital for promoting sustainability. Álvarez et al. (2021) presents a multidisciplinary approach utilizing problem-based and project-based learning to foster sustainability in civil engineering education. Positive outcomes and increased SDG integration in final projects indicate potential adoption in other disciplines.

Study by Gutierrez-Bucheli et al. (2022) focuses on sustainability-initiatives in engineering education to achieve the UN's SDGs. It utilizes a realist scoping review to analyze approaches since the 1990s, identifying gaps in learning outcomes. While there is a desire for integrative sustainability education, it requires additional administrative resources. The study emphasizes re-evaluating the engineer's role and social responsibilities to empower students as change agents. Implications for practice and curriculum development are highlighted.

Beagon et al. (2023) examines key competences for engineering students to address sustainability challenges and achieve SDGs. Stakeholders' views (Academics, Employers, and Students) from four countries are compared. Normative, strategic, and systems thinking competences are prioritized, but anticipatory competence, crucial for future-oriented sustainability, is lacking. Educators can use the findings to develop programs and provide opportunities for students to acquire the necessary competences for supporting sustainable development and SDGs.

In conclusion, the rise of literature reviews on integrating SDGs in education reflects the growing awareness of sustainability's importance in various academic fields. However, there is a need to address the gaps in the civil engineering curriculum to effectively prepare students for sustainability challenges. While the existing civil engineering curriculum includes many courses related to the environment or sustainability, they often lack integration with the specific goals outlined in the SDGs. Hence, there is urgent interventions are required to enhance civil engineering students' knowledge and promote responsible actions aligned with sustainability principles. Emphasizing anticipatory competence is crucial for a future-oriented perspective in achieving sustainable development in the construction industry. By incorporating these insights into civil engineering education, we can also bridge the gap and equip the next generation of engineers to contribute meaningfully to the global pursuit of sustainable development and SDGs. With this current study emphasizes understanding global perspectives on sustainability and Sustainable Development Goals (SDGs) integration with existing civil engineering curriculum through a four phased implementation approach.

IV. SDGs Embedding Methodology for Curriculum of Civil Engineering Program

To proactively address the crucial task of integrating a global approach to sustainability, particularly the SDGs, into the existing civil engineering curriculum, a strategic adoption approach based on four distinct phases or quadrants has been devised as shown in the Figure 1.The proposed curriculum focuses on the demand that initiatives are required to integrate a global practical approach to sustainability for current civil engineering degrees at KLE Technological university, Hubballi. This structured method serves as a preliminary step, allowing educators to thoroughly examine and evaluate the opportunities for effectively embedding SDGs in the curriculum. By employing this systematic and comprehensive approach, civil engineering programs can align their educational objectives more cohesively with the broader goals of sustainable development. This empowers future engineers to tackle real-world challenges with a more holistic and responsible approach, contributing to a sustainable and prosperous global future.

Planned strategic four quadrant approach for integrating a global approach to sustainability into the existing civil engineering curriculum encompasses four key quadrants such as courses, laboratories, student projects, and internships. In theoretical courses, sustainability concepts, ethical considerations, and best practices aligned with SDGs are introduced. This fosters critical thinking and analytical skills, essential for sustainable engineering practices. Laboratory courses offer hands-on experience in implementing sustainable solutions, exploring renewable energy, and sustainable materials. Through practical projects, students develop innovative design solutions, promoting creativity and problem-solving abilities.

Student projects offer a unique opportunity to connect classroom learning with real-world applications. By encouraging projects aligned with specific SDGs, students can directly contribute to sustainability goals, fostering a sense of

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responsibility and impact. Moreover, internships with sustainability-focused companies provide students with practical exposure to sustainable engineering in a professional setting. Working on SDG-related projects during internships enhances their understanding and experience in sustainable practices, while mentorship supports their professional growth.

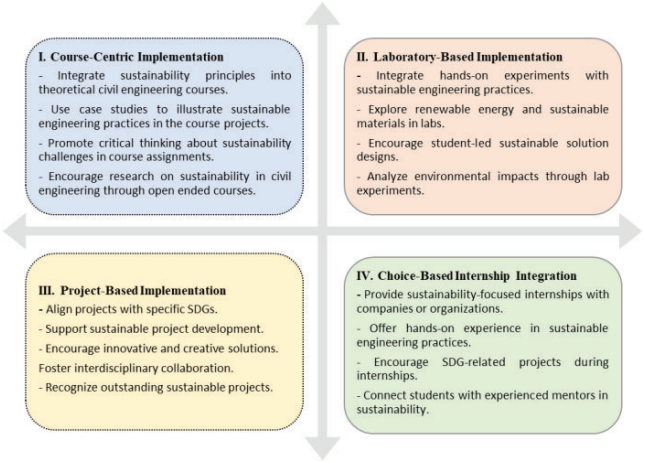

Fig.1: Strategic four quadrant approach for integrating a global approach to sustainability into the existing civil engineering curriculum

A. Integration of curriculum with SDGs

Based on strategic four-quadrant approach for integrating Sustainable Development Goals (SDGs) in the civil engineering curriculum involves a meticulous selection of subjects, semester-wise, based on their impact on the final degree. A comprehensive matrix is formulated, encompassing all courses chosen, including theory, design, laboratory, projects, and internship training. The courses in the matrix are then color-coded according to the SDGs (as per Table 1) that has all the possibility to directly integrated with it. This matrix serves as a roadmap in upcoming days to guide the curriculum design and delivery trajectory, ensuring the seamless implementation of sustainability principles throughout the civil engineering degree. The curriculum matrix for the SDG roadmap is shown in the Figure 2.

Subsequently in-depth discussions are conducted to explore the potential and possibilities of integrating possible SDGs with identified courses is made. The aim is to identify innovative ways to embed sustainability principles, making the curriculum more effective and impactful. This process allows educators to develop a holistic approach to sustainability education, preparing civil engineering students to tackle real-world sustainability challenges.

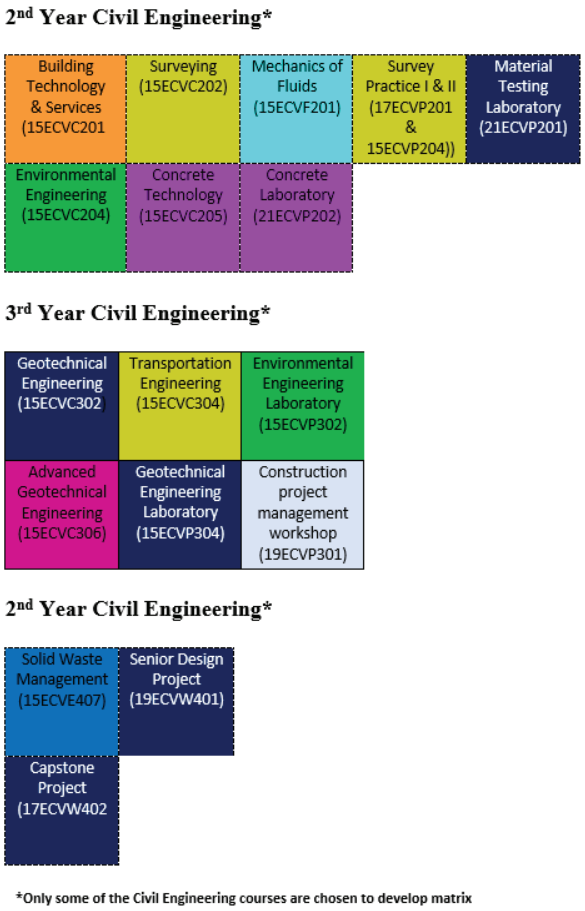

Fig. 2: The curriculum matrix for the SDG roadmap

As shown in the Figure 2, Civil Engineering curriculum has Building Technology & Services during 2nd year of curriculum as one of the basic theory courses but yet important one. This course has predominant opportunity to integrate some of the SDG's goals in the syllabus where it detailed with fundamental of buildings such as categories of buildings, building components, building materials etc. SDG 12 (Responsible Consumption and Production) can be incorporated by focusing on sustainable building materials and construction methods with lower environmental impacts. Concepts such as waste reduction strategies can be taught effectively to promote responsible consumption and production in building projects.

Current civil curriculum of civil engineering one theory course and two laboratory course related surveying practices in infrastructure industry. As SDG 11 clearly address on (Sustainable Cities and Communities), hence in these course and laboratory students can learn about the critical role of accurate land surveys in urban planning and development. Even they can made to understand how Geographic Information Systems (GIS) can be utilized to analyze spatial data for sustainable city planning. Surveying plays a crucial role in

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assessing land use, infrastructure development, and resource management within cities. By integrating SDG 11 into the course, students recognize the importance of promoting inclusive and sustainable cities through their surveying work. They also explore how their expertise can contribute to improving urban living conditions, enhancing accessibility, and ensuring environmental sustainability in urban areas

The Mechanics of Fluids one important course during 2nd year of the curriculum, also presents an opportunity to address SDG 13 (Climate Action), which focuses on taking urgent action to combat climate change and its impacts. Students can learn about fluid dynamics in the context of environmental applications, such as studying the behavior of air and water currents, ocean circulation patterns, and weather systems. They explore how climate change can influence fluid behaviors, leading to extreme weather events, sea-level rise, and other climate-related challenges. By integrating SDG 13, civil engineering students become more aware of their role in mitigating the effects of climate change through sustainable engineering practices.

In the Material Testing Laboratory course, civil engineering students are exposed to various testing methods for materials, particularly steel, which is a crucial component in building infrastructure. By integrating SDG 9 (Industry, Innovation, and Infrastructure), students explore how innovations in material testing techniques can enhance the quality and durability of infrastructure projects. They learn about non-destructive testing methods, advanced technologies, and automation in material testing, enabling them to contribute to the development of safer and more efficient construction practices.

Environmental Engineering course during 2nd year and Environmental Engineering Laboratory during 3rd year of the curriculum are significant course those can unswervingly integrate with SDG 6 (Clean Water and Sanitation) by emphasizing the importance of providing clean and safe water to communities and managing wastewater effectively. Students here learn about various water treatment processes, including filtration, disinfection, and desalination, to ensure access to clean drinking water. Additionally, they explore techniques for treating and reusing wastewater, reducing water pollution, and protecting water resources. By understanding the principles of sustainable water management, civil engineering students can efficiently contribute to achieving SDG 6 and ensuring that all individuals have access to clean water and adequate sanitation, which is essential for human health and well-being.

In the Concrete Technology theory and subsequent laboratory course of civil engineering curriculum, the integration of SDG 15 (Life on Land) can be made essential to promote sustainable land use and biodiversity conservation. Concrete production is associated with significant environmental impacts, including land degradation and habitat loss. By focusing on eco-friendly concrete production techniques, such as using recycled aggregates and supplementary cementitious materials, students can reduce the demand for natural resources and minimize the environmental footprint.

In the Geotechnical Theory and Lab Course of civil engineering, the integration of SDG 9 (Industry, Innovation, and Infrastructure) is play essential role to ensure the development of resilient and sustainable infrastructure. Geotechnical engineering plays a crucial role in the design and construction of foundations, retaining walls, and underground structures. By incorporating innovative techniques in the syllabus integrating with SDG 9, such as geosynthetics and soil stabilization methods etc, students can contribute to the advancement of infrastructure that withstands natural hazards and environmental challenges. Where as in the case of advance geotechnical course along with conventional aspects by integrating SDG 14 (Life Below Water), the course can also focus on the significance of geotechnical investigations for marine environments and the protection of marine ecosystems. Students can learn about sustainable solutions for coastal engineering, which involve preserving marine habitats and mitigating potential impacts on marine life. Emphasizing SDG 14 course can raise awareness about the need for advanced geotechnical practices that safeguard life below water and contribute to ocean conservation efforts.

Again, Transportation Engineering course can integrate with SDG 11 (Sustainable Cities and Communities) very effectively by focusing on the development of sustainable and efficient transportation systems in urban areas. Students can learn about innovative transportation planning and design practices that prioritize public transport, non-motorized modes, and integrated mobility solutions. Emphasis can be placed on creating pedestrian-friendly streets, dedicated cycling lanes, and efficient public transit networks. By integrating SDG 11, the course can highlight the role of transportation engineers in promoting sustainable urban development, reducing congestion, and enhancing accessibility for all residents.

The Solid Waste Management course can contribute to SDG 8 (Decent Work and Economic Growth) by focusing on the economic aspects of waste management. Students can be trained in the course to explore waste-to-resource opportunities, such as recycling and composting, which can create employment and contribute to economic growth. The course can also examine the role of civil engineers in designing cost-effective waste management systems that benefit local economies and communities.

During final year of curriculum students will experience the long-term projects. Most of the projects are either field or laboratory based. Ultimately most of the projects try to address the current industry needs. Hence in the Project Courses, SDG 9 (Industry, Innovation, and Infrastructure) can be integrated by focusing on sustainable and innovative infrastructure development. Some of the student teams can work on projects that promote energy-efficient technologies, smart solutions, and inclusive infrastructure. By considering environmental impact and social inclusion, they contribute to SDG 9 goal of promoting sustainable industrialization and resilient

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infrastructure. Through this integration, civil engineering students gain valuable skills in designing projects that align with global sustainability objectives, fostering economic growth, and supporting sustainable development.

V. SDGs Implementation Through Pedagogical Approaches

A. Research-Based Learning

A significant flaw in higher education has been noted as being excessively theoretical instruction with little practical application and inadequate research preparation. Thus, it requires the new holistic paradigm approach of sustainability compels science to become more inclusive and receptive to taking a holistic perspective to society. There are various ways of integrating teaching with research; in some of these ways, students play a more passive part, while in others, they play a more active role. RBL, or research-based learning, is the strategy that is most widely used in higher education. The present curriculum proposed the Research investigation-based course project in 4th semester to enhance students research skills and critical thinking. Research projects are carried out in material testing laboratory and concrete technology laboratory course. Students make attempt to develop the sustainable and ecofriendly cement composite by using cement-based demolition waste, industrial waste, granite waste and recycled aggregate for and municipal solid waste incineration fly ash to produce eco-friendly binders for building construction. The samples prepared using above materials and evaluate the mechanical behavior of cement. The strategy presented by RBL aims to achieving the SDG 9 and SDG 12 objectives through the revaluation and reuse of industrial waste and municipal solid waste incineration and concrete debris produced during construction. The outcomes of research projects promote waste management and reduces the impact on environmental. Additionally, this new strategy would enable the industrial sector to strengthen its production infrastructure through the development of new, cutting-edge manufacturing processes built on eco-friendly models and utilizing resources more effectively.

B. Project Based Learning

PBL aids in the development of students problem-solving abilities. Students typically excel at closely specified textbook problems but have lack of knowledge with poorly structured, open-ended problems, which they frequently face in the real world. This is particularly true for concerns about sustainability, which seek for multidisciplinary, integrative, flexible problem-solving methods rather than closed approach. Students often learn that dealing with problems frequently entails more than just a cognitive training. Implementing solutions to problems is necessary, however, there may be difficulties in the way of progress. Through PBL, students acquire new skills along with social and political awareness which is required for implementing solutions into actions. Hence, In the Fifth Sem, the 2-credit course titled “Construction project management workshop” is introduced where students are exposed to methodology to construct projects from the initial design to the detailed construction project. In this subject, students apply all the knowledge acquired during the degree in the development of a project, and it is the prelude to the Final Degree Project. This course serves as a prerequisite for the real time construction project and requires students to apply all of the knowledge they have learned from academic curriculum. In the proposed work, students carry out case study of complex real problem related to structural, geotechnical and transportation field. The objective of the course is understanding the multiple stages involved in execution. The students collect the data regarding structural conditions, performance and environmental aspect which impact the different criteria such as sustainability, economy, and society. Students are groups into 6 numbers, and they have analyzed the above data and prepare the report about methodology adopted to solve of the case study problem which helps them understand the reality of large civil engineering projects. In addition, it has been helpful to have a better understanding of how decision-making is carried out in complex environments, the usefulness of multi criteria evaluation, and the need to consider sustainability criteria in this type of large-scale work. It has also been beneficial to gain a deeper comprehension of the way of decision-making is carried out in complicated situations, the value of multi-criteria evaluation, and the necessity of taking sustainability criteria into account in this kind of large-scale activity. As a result, this kind of work appears to be enabling civil engineering students to consider additional criteria (sustainability, society, and economy) in projects that are related to their own profession, beyond the simple application of technical and functional criteria.

VI. Discussion and Conclusions

The integration of Sustainable Development Goals (SDGs) in the Civil Engineering curriculum is of utmost importance to prepare future engineers to address global sustainability challenges. Through systematic literature review, the current study has emphasized understanding the global perspectives on sustainability and identified gaps in the existing curriculum. By adopting a strategic four-quadrant approach, the study has provided insights into how SDGs can be systematically integrated into the Civil Engineering curriculum at KLE Technological University through some of courses.

The study has highlighted the opportunities to link SDGs in theoretical courses, laboratory work, student projects, and internships. By incorporating SDGs into theoretical courses such as Building Technology & Services, Mechanics of Fluids, Environmental Engineering, etc students gain a deep understanding of how civil engineering practices can contribute to sustainability. Laboratory courses in Surveying, Material Testing, and Environmental Engineering etc provide hands-on

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experience in implementing sustainable solutions and exploring innovative technologies.

Furthermore, the study recognizes the significance of student projects and internships in promoting sustainability. By encouraging projects aligned with specific SDGs, students can actively contribute to sustainable development goals and understand the broader impact of their work. Internships with sustainability-focused companies offer practical exposure to sustainable engineering practices and mentorship to support professional growth.

In conclusion, the integration of SDGs in the Civil Engineering curriculum is a critical step towards producing responsible and future-oriented engineers. The strategic approach outlined in this study enables educators to develop a holistic approach to sustainability education, preparing students to tackle real-world sustainability challenges.

Current study acts as a base for the SDGs integration planning in the curriculum considering only few courses. For future work, it is essential to evaluate the actual effectiveness through integrating SDGs in the curriculum using innovative teaching methods and continuously monitoring and taking feedback from students, if required by industry professionals to as third party.

Overall, by adopting a comprehensive approach to integrate SDGs in the curriculum, civil engineering programs can play a vital role in achieving sustainable development goals and shaping a sustainable and prosperous future for generations to come.

REFERENCES

Hubscher, C., Hensel-Borner, S., & Henseler, J. (2022). Social marketing and higher education: partnering to achieve sustainable development goals. Journal of Social Marketing, 12(1), 76-104.

Terrón-López, M. J., Velasco-Quintana, P. J., Lavado-Anguera, S., & Espinosa-Elvira, M. D. C. (2020). Preparing sustainable engineers: A project-based learning experience in logistics with refugee camps. Sustainability, 12(12), 4817.

Álvarez, I., Etxeberria, P., Alberdi, E., Pérez-Acebo, H., Eguia, I., & García, M. J. (2021). Sustainable civil engineering: Incorporating sustainable development goals in higher education curricula. Sustainability, 13(16), 8967.

Beagon, U., Kövesi, K., Tabas, B., Nørgaard, B., Lehtinen, R., Bowe, B., ... & Spliid, C. M. (2023). Preparing engineering students for the challenges of the SDGs: what competences are required?. European Journal of Engineering Education, 48(1), 1-23.

Cebrián, G., Junyent, M., & Mulà, I. (2020). Competencies in education for sustainable development: Emerging teaching and research developments. Sustainability, 12(2), 579.

Fenner, R. A., Cruickshank, H. J., & Ainger, C. (2014, October). Sustainability in civil engineering education: why, what, when, where and how. In Proceedings of the Institution of Civil Engineers Engineering Sustainability (Vol. 167, No. 5, pp. 228-237). Thomas Telford Ltd.

Gutierrez-Bucheli, L., Kidman, G., & Reid, A. (2022). Sustainability in engineering education: A review of learning outcomes. Journal of Cleaner Production, 330, 129734.

Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable Development Goals: A need for relevant indicators. Ecological indicators, 60, 565-573.

Mansell, P., Philbin, S. P., Broyd, T., & Nicholson, I. (2019). Assessing the impact of infrastructure projects on global sustainable development goals. In Proceedings of the Institution of Civil Engineers-Engineering Sustainability (Vol. 173, No. 4, pp. 196-212). Thomas Telford Ltd.

Osofero, A. I., Udeaja, C., Corradi, M., & Vo, T. (2014). Sustainability Challenges in Civil Engineering Education. In Computing in Civil and Building Engineering (2014) (pp. 2047-2054).

Perpignan, C., Baouch, Y., Robin, V., & Eynard, B. (2020). Engineering education perspective for sustainable development: A maturity assessment of cross-disciplinary and advanced technical skills in eco-design. Procedia CIRP, 90, 748-753.

R. Bali Swain & F. Yang-Wallentin (2020) Achieving sustainable development goals: predicaments and strategies, International Journal of Sustainable Development & World Ecology, 27:2, 96-106.

Stock, T., & Kohl, H. (2018). Perspectives for international engineering education: Sustainable-oriented and transnational teaching and learning. Procedia Manufacturing, 21, 10-17.

United Nations (n.d.). Sustainable development goals. THE 17 GOALS | Transforming Our World: The 2030 Agenda for Sustainable Development. UN General Assembly, 21 October 2015. Retrieved August 3, 2023, from

Zamora-Polo, F., & Sánchez-Martín, J. (2019). Teaching for a better world. Sustainability and sustainable development goals in the construction of a change-maker university. Sustainability, 11(15), 4224.

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