Integration of Sustainability Metrics in R&D Projects by Industrial Engineering Students

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Abstract- ***This research investigates the awareness and utilization of sustainability metrics among Industrial Engineering (IE) students in their research and development (R&D) projects. Focusing in five areas such as environmental, social, economic, SDG alignment, and governance, the research engaged 407 students from a university located in Quezon City. Findings indicated that students demonstrated a strong awareness across most areas, with the strongest in governance and policy indicators (Mean = 3.88) and social sustainability (Mean = 3.99). However, awareness of SDG alignment was relatively lower (Mean = 3.67), though it was categorized as "very aware." It was found that there were significant differences in the levels of awareness between these areas, with SDG alignment always scoring lower than the other measures (p < 0.05). The most frequent barriers reported by students were time limitations (Mean = 3.43) and unavailability of resources (Mean = 3.31). These results indicate that although students acknowledge the significance of sustainability, they require institutional assistance, more transparent direction, and resources to use such concepts practically in their academic projects.***

Indexed Terms- ***Sustainability Metrics, Industrial Engineering Students, Research and Development (R&D), Sustainable Development Goals (SDGs), Engineering Education***

I. INTRODUCTION

The call for sustainable development has never been stronger, with global issues, including climate change, resource constraints, and social inequality, redefining the way industries and educational institutions function. In response, the incorporation of sustainability metrics in R&D projects has become an important educational goal in Industrial Engineering (IE) degrees. These indicators, ranging from environmental, social, and economic to governance and adherence to the United Nations Sustainable Development Goals (SDGs), serve as standards that guide future engineers in designing solutions that not only work efficiently but also ethically and ecologically.

The academic community plays a pivotal role in shaping engineering students' awareness and competencies in sustainability. Research highlights that integrating sustainability principles into coursework and project-based learning increases students' capacity to work on actual sustainability issues (Rahman et al., 2022; Leal Filho et al., 2021), but despite increasing interest, there is inconsistent integration of sustainability metrics. Most students fail to implement these measures in educational institutions because of gaps in teaching, poor institutional support, and inadequate access to resources and guidance (Savugathali et al., 2025; Wang et al., 2020).

Emerging studies identify both progress and constant barriers. For example, Giray and Quianzon (2023) reported curriculum-based interventions that considerably enhanced students' identification of social and environmental obligations. On the other hand, Al-Shehri et al. (2021) have found that students generally view sustainability prerequisites as an additional workload because of unclear expectations and time limits. In addition, SDG awareness is often lower than awareness of more conventional sustainability areas (Zhou et al., 2023), reflecting a

difference between theoretical knowledge and real-world implementation.

Given these findings, it is important to explore the present level of awareness and difficulties for IE students in integrating sustainability metrics into their R&D projects. This research fills this gap by assessing the IE students' familiarity with sustainability standards, perceived difficulties, and the degree to which SDG alignment is integrated into academic projects.

Through exploring these dimensions, this study aims to evaluate Industrial Engineering students' awareness, challenges, and practices related to the integration of sustainability metrics in academic research and development (R&D) projects. Specifically, the study aims to:

1. To profile the demographic characteristics of Industrial Engineering students participating in the study.

2. To assess the level of awareness of sustainability metrics among students, specifically in the areas of:
a. Environmental sustainability
b. Social sustainability
c. Economic sustainability
d.Alignment with the Sustainable Development Goals (SDGs)
e. Governance and policy considerations

3.To identify the key challenges and barriers students encounter when applying sustainability metrics in academic research and project work.

4. To analyze whether there is a significant difference in students' awareness of sustainability metrics.

5. To propose actionable strategies for enhancing the integration of sustainability metrics in Industrial Engineering research and development (R&D) projects.

II. MATERIALS AND METHODS

This research used a quantitative descriptive research design to determine the degree of awareness and perceived problems in terms of the integration of sustainability measurements in a research or scholarly project among students taking the Bachelor of Science in Industrial Engineering (BSIE) course at a university in Quezon City for the Academic Year 2024 - 2025. The primary tool employed was a structured survey questionnaire with three components: (1) demographic profile (gender, age, and year level), (2) level of awareness of sustainability metrics across five areas such as Environmental, Social, Economic, SDG Alignment, and Governance which is rated on a 5-point likert scale ranging from "Not aware at all" to "Extremely aware," and (3) perceived challenges to implementing these metrics in academic research or project work. The items in the questionnaire were drawn from the literature and international frameworks of sustainability, more so the United Nations Sustainable Development Goals (SDGs), to ensure content validity.

The study adopted simple random sampling of the 1,706 registered BSIE students. A sample size of 314 was estimated through the Raosoft Sample Size Calculator with a 95% confidence level and a 5% margin of error. To support result validity and enable potential non-responses or incomplete responses, the survey was administered to 409 students.

The data gathering process was carried out online, with the respondents providing informed consent before filling in the survey. Confidentiality and anonymity of responses were maintained. The collected data were analyzed through a blend of descriptive and inferential statistical analysis techniques for examining Industrial Engineering students' level of awareness and difficulties in incorporating sustainability metrics into R&D projects. Descriptive statistics such as frequencies, means, and standard deviations were utilized to present demographic profiles and assess awareness levels in five categories: Environmental, Social, Economic, SDG Alignment, and Governance and Policy Metrics. One-way Analysis of Variance (ANOVA) was utilized to find out if there is a significant differences in students' awareness in these domains. Moreover, post-hoc analysis by Tukey's Honest Significant Difference (HSD) test was used to determine particular differences in awareness scores between sustainability criteria. Such statistical

methods allowed determining major inconsistencies, like persistently lower awareness of SDG alignment, and offered evidence-based observations for informing more efficient strategies for integrating concepts of sustainability into student-driven academic projects in the Industrial Engineering curriculum.

III. RESULTS AND DISCUSSION

1. DEMOGRAPHIC PROFILE OF THE STUDENTS

TABLE I. DEMOGRAPHIC PROFILE OF THE STUDENTS

Demographic	Frequency (n=407)	Percent
Gender		
Male	210	51.6%
Female	191	46.9%
Prefer not to say	6	1.5%
Age		
20 and below	166	40.8%
21 to 25	235	57.7%
26 to 30	6	1.5%
Year Level		
1st Year	62	15.2%
2nd Year	103	25.3%
3rd Year	176	43.2%
4th Year	66	16.2%

Table 1 indicates the demographic breakdown of the 407 participants who had a nearly balanced split of genders, with slightly over half reporting themselves as male (n = 210, 51.6%), with female respondents following after (n = 191, 46.9%), and a very small percentage not wanting to report their gender (n = 6, 1.5%). Regarding age, most of them were aged between 21 to 25 years (n = 235, 57.7%), and a large majority were aged 20 years and less (n = 166, 40.8%). Few respondents were between 26 to 30 years (n = 6, 1.5%). In terms of academic year standing, participants were predominantly in their third year (n = 176, 43.2%), followed by second year (n = 103, 25.3%), fourth year (n = 66, 16.2%), and first year (n = 62, 15.2%). These findings indicate that the sample was primarily young adults in the early to mid-20s, with a focus of the respondents being in the middle years of the academic programs.

2. TO ASSESS THE LEVEL OF AWARENESS OF SUSTAINABILITY METRICS AMONG IE STUDENTS IN TERMS OF THE FOLLOWING: TABLE

II. ENVIRONMENTAL SUSTAINABILITY METRICS

Metrics	Mean	Std. Dev.	Interpretation
I am aware that our project can contribute to environmental impact, such as carbon emissions.	3.63	0.94	Very aware
I understand how energy and resource use in our project affect environmental sustainability.	3.80	0.88	Very aware
I am aware that a life cycle perspective can be used to assess our project's environmental footprint.	3.80	0.90	Very aware
I know that choosing sustainable or recyclable materials is important in our project.	4.04	0.95	Very aware
I understand the importance of minimizing waste and pollution during project development.	4.10	0.94	Very aware
Overall Mean	3.87	0.92	Very aware

Table 2 indicates that Industrial Engineering students show an elevated degree of environmental sustainability indicators awareness (M = 3.87, SD = 0.92), this is consistent with the current study of Leal Filho et al. (2021) that integrating environmental topics like pollution management, waste minimization, and carbon footprint consideration into engineering programs significantly enhances

students' ability to assess environmental effects. Out of the five indicators reviewed, students indicated the highest level of recognition regarding the need to reduce waste and pollution when designing projects (M = 4.10, SD = 0.94), followed by the incorporation of recyclable or sustainable materials (M = 4.04, SD = 0.95). The findings also indicate that issues of sustainability are highly embedded in students' academic awareness, especially in contexts that resemble real-world concerns of engineering design and execution.

In addition, consideration of how resource and energy consumption impact sustainability (M = 3.80, SD = 0.88) and the use of a life cycle approach (M = 3.80, SD = 0.90) also suggests that the students appreciate the general environmental impact of their projects. Rahman et al. (2022) confirm that such appreciation is typically nurtured by project-based learning, as theoretical theory is practiced in real-world situations, hence actualizing sustainability principles. While consciousness of particular matters like carbon footprint (M = 3.63, SD = 0.94) was relatively lower, it was still in the "very aware" category, reflecting a solid foundation. Zhou et al. (2023) affirm the idea that where sustainability education is interdisciplinary, the chances of incorporating such principles effectively are higher. The intersection of present results with current literature confirms that IE students not only have environmental sustainability awareness but are also able to integrate it into scholarly research, which is a good sign for institutions that seek to raise environmentally responsible engineers.

TABLE III. SOCIAL SUSTAINABILITY METRICS

Metrics	Mean	Std. Dev.	Interpretation
I am aware that hearing different opinions can help improve our project.	4.09	0.96	Very aware
I understand how our project can contribute to solving social issues like education, health, or accessibility.	3.97	0.91	Very aware
I know that our project should consider ethical implications for people and communities.	3.95	0.93	Very aware
I am aware that consulting with community stakeholders can improve the social relevance of our project.	3.98	0.90	Very aware
I understand how our project's outcomes could impact public well-being.	3.98	0.90	Very aware
Overall Mean	3.99	0.92	Very aware

The above outcomes showed that Industrial Engineering students were highly aware of social sustainability indicators with a general mean score of 3.99 (SD = 0.92), indicating being "very aware." The most significant awareness was seen in identifying the importance of hearing different opinions to enhance the outcome of projects (M = 4.09, SD = 0.96). This result is consistent with the findings of Rahman et al. (2022), who reported that teamwork and integration are crucial elements of socially sustainable project design, particularly in multidisciplinary learning settings.

Students in the study also indicated high consciousness of ways in which their projects could resolve more general societal issues like education, health, and accessibility (M = 3.97, SD = 0.91), and how results from projects can influence public welfare (M = 3.98, SD = 0.90). Zhou et al. (2023) argue that those students who are educated to think about the social implications of what they do in class are likely to come up with solutions that are inclusive and responsible. Moreover, the large mean scores for stakeholder involvement (M = 3.98, SD = 0.90) and ethical accountability (M = 3.95, SD = 0.93) support evidence by Al-Shehri et al. (2021), who highlighted that social sustainability awareness is directly linked with students' appreciation of accountability and

fairness in engineering activity. These findings indicate that IE students have a high level of social sustainability awareness, an indicator of a trend towards more ethically based and people-sensitive engineering education.

TABLE IV. ECONOMIC SUSTAINABILITY METRICS

Metrics	Mean	Std. Dev.	Interpretation
I am aware that our project can contribute to cost-efficient solutions for users or communities.	3.76	0.92	Very aware
I understand how to use resources wisely to make our project economically sustainable.	3.81	0.90	Very aware
I know that sustainable designs in our project can create value or potential business opportunities.	3.87	0.90	Very aware
I am aware that our project could support job creation or livelihood improvement in the future.	3.87	0.90	Very aware
I understand that economic feasibility should consider long-term sustainability, not just short-term cost.	3.95	0.90	Very aware
Overall Mean	3.85	0.90	Very aware

Table 4 indicates that the students were extremely aware of the financial implications of their academic projects. The greatest agreement was with the value placed on prioritizing long-term sustainability over short-term expenses (M = 3.95, SD = 0.90), which indicates an appreciation of sustainable economic planning. Students also appreciated that their projects could create employment or improve livelihoods (M = 3.87, SD = 0.90) and create business opportunities through sustainable design (M = 3.87, SD = 0.90). This supports Giray and Quianzon's (2023) discovery that incorporating sustainability into engineering education enhances student awareness of responsible, value-based design and long-term economic sustainability. Knowledge of cost-effective remedies (M = 3.76, SD = 0.92) and optimizing resources (M = 3.81, SD = 0.90) also highlights students' awareness of where sustainability overlaps with economic efficiency.

These findings are in line with the general trend in engineering education towards integrating sustainability into technical decision-making, as highlighted by Savugathali et al. (2025), who indicated that even with challenges of limited guidelines and resources, students show good conceptual understanding of economic sustainability. The total mean score (M = 3.85, SD = 0.90) attests to a good grasp among IE students of the long-term financial and social benefits that sustainable project planning can offer. Such high awareness warrants ongoing institutional interventions in making available practical tools, mentorship, and policy integration to make students better equipped to apply economic sustainability practices in academic and real-world settings.

TABLE V. SDG ALIGNMENT METRICS

Metrics	Mean	Std. Dev.	Interpretation
I am aware of the United Nations Sustainable Development Goals (SDGs) and their relevance to student projects.	3.57	1.01	Very aware
I understand how our project can align with specific SDGs, such as clean energy, innovation, or climate action.	3.65	0.95	Very aware

I know that contributing to SDGs can increase the value and impact of our project.	3.69	0.95	Very aware
I am aware that mapping our project to SDG targets helps clarify its broader purpose.	3.67	0.95	Very aware
I understand that sustainability-aligned projects are encouraged by academic institutions and industry.	3.78	0.92	Very aware
Overall Mean	3.67	0.96	Very aware

The table above indicates that the students tended to be highly aware of how their projects could be aligned with and contribute to the international SDG agenda. The highest mean score was obtained for awareness that sustainability-focused projects have the backing of academic institutions and industry (M = 3.78, SD = 0.92), followed by perception that SDG integration adds value and impact to projects (M = 3.69, SD = 0.95). This degree of awareness was supported by recent research by Villanueva et al. (2022), who highlighted the increased focus in tertiary education on matching student projects with worldwide objectives as a means of enhanced real-world applicability and stakeholder engagement. Lee and Chen (2021) also established in their research that students are made more aware and feel more responsible for sustainability when presented with project-based learning linked to the SDGs.

In addition, the students showed sound comprehension of how connecting their projects to a particular SDG target could make larger goals clearer (M = 3.67, SD = 0.95), and recognized the significance of aligning with global priorities such as clean energy, innovation, or climate action (M = 3.65, SD = 0.95). While overall awareness of SDGs and their applicability to academic work was somewhat lower (M = 3.57, SD = 1.01), the overall mean score (M = 3.67, SD = 0.96) indicates a strong level of engagement. This echoes wider academic trends, as reported by UNESCO (2023), which call for engineering curricula to include SDG-based frameworks to produce globally aware, socially conscious graduates. Yet, as noted by Savugathali et al. (2025), even if awareness is robust, effective alignment will likely need more definitive curricular guidance and institutional support, an area that still lacks improvement to guarantee greater student engagement with the SDGs.

TABLE VI. GOVERNANCE & POLICY METRICS

Metrics	Mean	Std. Dev.	Interpretation
I am aware of school policies or guidelines that promote sustainability in student projects.	3.87	0.92	Very aware
I understand that documenting sustainability aspects is important in our final project report.	3.87	0.92	Very aware
I know that involving stakeholders in project decisions can improve its sustainability outcomes.	3.84	0.95	Very aware
I am aware of legal or ethical standards our project should comply with.	3.87	0.92	Very aware
I understand the importance of transparency and accountability in how we manage our project.	3.97	0.94	Very aware
Overall Mean	3.88	0.93	Very aware

Table 6 shows a strong level of awareness on all criteria measured. Maximum score was obtained for awareness among students regarding the importance of transparency and accountability in project

management (M = 3.97, SD = 0.94), which shows that they know about their ethical responsibility in engineering practice. Similarly strong scores were reported for knowing school sustainability policies, the necessity to report on sustainability factors in final reports, and complying with ethical and legal requirements (M = 3.87, SD = 0.92 for all). The results are consistent with Alnabhan and Qasem (2021), who highlighted that governance education in engineering programs enhances students' capacity for ethical and policy-influenced decision-making. In addition, increasing the incorporation of institutional sustainability models in educational institutions, as noted by Gómez et al. (2023), complements students' exposure to and familiarity with these governance systems.

Participants also indicated high recognition of the importance of stakeholder engagement in enhancing sustainability performance (M = 3.84, SD = 0.95), reflecting appreciation of participatory forms of governance. Such awareness is in line with advice by Mulder et al. (2020), who claim that stakeholder engagement is vital in developing responsible innovation and socially responsible engineering practices. The total mean score (M = 3.88, SD = 0.93) indicates that IE students have a balanced idea of governance and policy measures, which can be explained by growing institutional initiatives aimed at integrating sustainability guidelines into academic project work. These results lend weight to the argument for ongoing emphasis on governance principles in engineering instruction to prepare graduates to manage legal, institutional, and ethical aspects of sustainability.

3. CHALLENGES AND BARRIERS STUDENTS FACE IN APPLYING THESE METRICS

TABLE VII. BARRIERS IN APPLYING

Barriers	Mean	Std. Dev.	Interpretation
I find it difficult to apply sustainability concepts because they are not clearly explained in our coursework.	2.98	0.94	Neutral
Our group lacks the knowledge or training needed to integrate sustainability into our project.	3.02	0.95	Neutral
There are limited resources (e.g., data, tools, mentors) to help us evaluate our project's sustainability.	3.31	0.90	Neutral
Time constraints make it hard for us to include sustainability considerations in our project.	3.43	0.90	Agree
I am unsure how to measure or track sustainability impacts in our work.	3.17	0.92	Neutral
I find it challenging to align our project with the UN Sustainable Development Goals (SDGs).	3.16	0.95	Neutral
Our project guidelines do not require or emphasize sustainability, so we tend to overlook it.	3.02	0.98	Neutral
I feel that focusing on sustainability makes our project more complicated or harder to complete.	3.10	0.98	Neutral
I struggle to balance sustainability goals with technical or financial feasibility.	3.22	0.94	Neutral
There is little support or encouragement from faculty when it comes to integrating sustainability into student projects.	3.15	1.01	Neutral
Overall Mean	3.16	0.95	Neutral

The table above shows that the general mean score (M = 3.16, SD = 0.95) results are in a neutral position, meaning that the students are aware of some issues, but these are not perceivably seen as significant burdens. Based on the barriers listed, the most universally accepted was the time constraint, with students suggesting that there is not enough time to make sustainability considerations in their projects (M = 3.43, SD = 0.90). They also had concerns regarding having insufficient resources like data, equipment, or guidance (M = 3.31, SD = 0.90) and the challenge of reconciling sustainability objectives with financial or technical viability (M = 3.22, SD = 0.94).

Students also felt unsure of how to quantify or monitor sustainability effects (M = 3.17, SD = 0.92) and difficulty in making their projects align with the UN Sustainable Development Goals (SDGs) (M = 3.16, SD = 0.95). Additionally, the absence of priority on sustainability within the guidelines for projects (M = 3.02, SD = 0.98) and minimal faculty encouragement (M = 3.15, SD = 1.01) were noted. Despite these challenges, the majority of the answers were clustered around the midpoint, showing that although students do face some challenges, these are not highly prohibitive. This leaves a chance for educational institutions to further develop support mechanisms, such as incorporating more explicit sustainability education, offering assistance, and increasing faculty engagement, to further prepare students in the integration of sustainability into projects.

4. SIGNIFICANT DIFFERENCES IN STUDENTS' AWARENESS OF SUSTAINABILITY METRICS

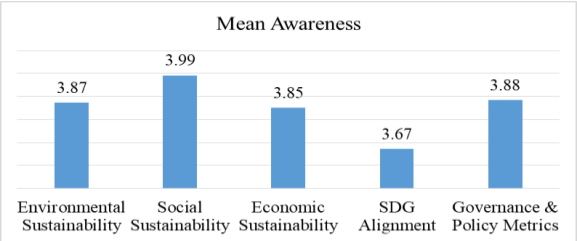

FIGURE 1: AWARENESS LEVELS ACROSS SUSTAINABILITY METRICS

Figure 1 shows the bar chart of Industrial Engineering (IE) students' mean awareness scores on five sustainability areas. Social Sustainability had the highest (M = 3.99), which means students are most aware of social aspects like ethics, stakeholder engagement, and public welfare in project planning. Governance & Policy Metrics (M = 3.88), Environmental Sustainability (M = 3.87), and Economic Sustainability (M = 3.85) ranked just behind, indicating a relatively high awareness level across these areas. The lowest was found in SDG Alignment (M = 3.67), indicating students are relatively less confident when connecting their projects to particular Sustainable Development Goals (SDGs), although they still fall into the "very aware" range.

This alignment is also supported by findings of Gómez et al. (2023), who observed that governance and institutional policies to a certain degree find their way into academic routines, but practice in linking student projects to international objectives like the SDGs is not widespread. Likewise, Lee and Chen (2021) stressed that incorporating project-based learning aligned with SDGs has the potential to enhance students' understanding of concepts but should be intentional and well-planned to produce results.

TABLE VIII. DIFFERENCES IN STUDENTS' AWARENESS IN TERMS OF THE FIVE SUSTAINABILITY INDICATORS

Sources	*SS*	*df*	*MS*	*F*	*P value*	*Remarks*
Between Groups	21.876	4	5.469	8.032	0.000	Significant
Within Groups	1382.305	2030	0.681			
Total	1404.182	2034	0.690			

To statistically analyze whether there are differences in students' awareness in terms of the five sustainability indicators, a one-way ANOVA was used. The findings ($F = 8.032$, $p < .001$) reveal a statistically significant difference among groups, meaning the student awareness is significantly different depending on the specific sustainability criteria. This implies that some areas of sustainability, like Social and Governance indicators, are better grasped or emphasized in the curriculum, while others, most notably SDG Alignment, are less profoundly covered.

These results align with Savugathali et al. (2025), where they discovered that the learners sometimes find it challenging to apply concepts relating to SDGs because of limited exposure and inappropriate curricular direction. The greater variation shown by the ANOVA emphasizes that learning institutions need to take steps to balance and integrate all areas of sustainability more evenly, particularly in aligning projects with international agendas for sustainability.

TABLE VIIII. DIFFERENCES IN AWARENESS OF SUSTAINABILITY METRICS AMONG STUDENTS USING TUKEY'S HONEST SIGNIFICANT DIFFERENCE (HSD) TEST

Group 1	*Group 2*	*Mean*	*p-value*	*Decision*
Environmental Sustainability	Social Sustainability	0.118	0.244	Not Significant
Environmental Sustainability	Economic Sustainability	0.023	0.995	Not Significant
Environmental Sustainability	SDG Alignment	0.202	0.004	*Significant*
Environmental Sustainability	Governance & Policy Metrics	0.010	1.000	Not Significant
Social Sustainability	Economic Sustainability	0.142	0.104	Not Significant
Social Sustainability	SDG Alignment	0.321	0.000	*Significant*
Social Sustainability	Governance & Policy Metrics	0.109	0.330	Not Significant
Economic Sustainability	SDG Alignment	0.179	0.017	*Significant*
Economic Sustainability	Governance & Policy Metrics	0.033	0.980	Not Significant
SDG Alignment	Governance & Policy Metrics	0.212	0.002	*Significant*

To further investigate the notable differences in awareness of sustainability metrics among students, post hoc comparisons were made. Comparisons were found to be statistically significant for some pairwise comparisons. In particular, awareness of Environmental Sustainability was significantly greater than awareness of SDG Alignment metrics (mean difference = 0.202, p = .004). In the same way, Social Sustainability awareness was much greater than SDG Alignment awareness (mean difference = 0.321, p < .001), and Economic Sustainability awareness was greater than SDG Alignment awareness (mean difference = 0.179, p = .017). Finally, Governance & Policy Metrics awareness was greater than SDG Alignment (mean difference = 0.212, p = .002).

All other pair-wise comparisons were not statistically different (p > .05), which means students' awareness levels were fairly uniform across Environmental, Social, Economic, and Governance & Policy measures of sustainability. In general, the findings indicate students are overall very aware of sustainability principles but are comparatively less aware of how these apply to the United Nations Sustainable Development Goals (SDGs), specifically, an area that can be a subject to instructional enhancement.

CONCLUSION

This research concludes that Industrial Engineering (IE) students exhibit a very good level of sensitivity across various sustainability areas, such as environmental, social, economic, governance, and SDG alignment, through their university-level research work and projects. Out of these areas, the highest sensitivity was exhibited by the students in social sustainability, followed very closely by governance and policy aspects. Although environmental and economic sustainability awareness was also high, the incorporation of Sustainable Development Goals (SDGs) into projects was significantly less prevalent. This indicates that students appreciate the general idea of sustainability but struggle with implementing these principles, specifically, relating their projects to international frameworks of sustainability.

To bridge this gap and improve the integration of sustainability in engineering education, several suggestions are made. First, institutions should update and improve the curriculum to incorporate specialized modules or course elements in

sustainability metrics, with a focus on actual application and adaptation to worldwide agendas like the SDGs. The modules should apply case studies, simulations, and practical projects in reinforcing learning.

Second, institutions should provide targeted training for faculty members regarding sustainability education so that they can educate students on incorporating sustainability into their studies. This can be achieved through workshops, seminars, and interdisciplinary collaboration with sustainability professionals.

Third, scholarly project guidelines should be revised to specifically mandate that research and design outputs should include sustainability metrics. Detailed rubrics and assessment criteria appropriate to environmental, economic, and social impact must be established and standardized for all levels of student projects.

Fourth, colleges and universities should invest in allowing access to resources such as data repositories, assessment tools, and sustainability assessment frameworks that students can leverage to enhance their analysis of project impacts. Furthermore, opportunities for mentorship with industry partners or alumni who are experienced in sustainability initiatives can serve to bridge the theoretical-to-practical gap.

By these efforts, Industrial Engineering programs can develop a new breed of engineers who will not only possess technical competence but also the mindset to make valuable contributions to sustainable development..

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