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Curriculum Maturity for Sustainable Development: A Case Study from Airlangga University's Industrial Engineering Program

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ABSTRACT

Introduction: In recent years, Indonesia has made notable progress in integrating Education for Sustainable Development (ESD) across all levels of education, including higher education. Universitas Airlangga (UNAIR) demonstrates institutional support for the Sustainable Development Goals (SDGs), particularly SDGs 6, 7, 9, and 17, through various initiatives. However, the actual implementation of ESD within academic curricula—specifically in the Industrial Engineering study program—remains limited and insufficiently documented. **Methods:** This study adopts a qualitative approach supported by quantitative data to evaluate the maturity of ESD integration within the Industrial Engineering curriculum at UNAIR. Data collection focused on course assessments, student academic performance in green technology subjects, and student engagement with SDG-related topics on public knowledge-sharing platforms such as *Jurnal* Post, *Kompasiana,* and the FTMM UNAIR website. **Results:** Findings reveal that approximately 70% of Industrial Engineering students received an AB grade in green technology-related courses. However, subject evaluation indicators, including teaching methodology, yielded an average excellence score of only 69.9%. Content analysis of student-authored articles shows that SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 6 (Clean Water and Sanitation) were the most frequently addressed topics. Collectively, these articles attracted significant engagement: 1,395 views, 9 likes, and thousands of shares across social media platforms such as Facebook (1,732), X/Twitter (1,081), and LinkedIn (207). **Conclusions:** Although student participation and awareness of SDGs are evident, the current curriculum demonstrates only moderate maturity in supporting ESD. There is a clear need for curriculum enhancement, particularly in integrating SDG-specific content, pedagogical innovation, and measurable learning outcomes. Strengthening these areas will ensure that higher education institutions like UNAIR contribute more effectively to achieving sustainable development through lifelong learning.

Keywords: Curriculum Assessment, Education for Sustainable Development, Higher Education, Industrial Engineering, SDGs Integration, Student Engagement

1. INTRODUCTION

In order to implement the SDGs in Indonesia, regulations are needed to ensure that the SDGs run in accordance with the rules and agreements made in Indonesia. One of which supports SDGs 4 on education, aiming to "ensure inclusive and equitable quality

education and promote lifelong learning opportunities for all" (United Nation, 2022). The UN General Assembly proposed Education for Sustainable Development (ESD) as a 2030 goal (UNESCO, 2017). Despite financial constraints in achieving SDs 4, Indonesia has consistently made progress in its SDGs index, showing changes in both scores and global rankings (Halimatussadiah, et al., 2022). This demonstrates the Indonesian government's commitment to mobilizing nationwide support for SDG implementation, driving efforts across all sectors to ensure sustainable development for the nation. Indonesia currently holds the 6th position in Southeast Asia and ranks 97th globally in achieving the SDGs (Halimatussadiah, et al., 2022). This ranking reflects Indonesia's ongoing efforts and dedication toward sustainable development, even as it works to improve its standing both regionally and on the world stage.

Indonesia has improved access to supporting ESD in each level of education degree, such as in university level (Hawa N. N., et al., 2021). Some universities support SDGs through various research centers, such as Universitas Indonesia (UI) established SDGs Hub which works across various faculties to integrate SDGs-related topics into the curriculum, especially in public health, environmental studies, and social sciences (SDGs Hub Universitas Indonesia, 2019); Institut Teknologi Bandung (ITB) established various research centers, such as the Center for Energy Studies and the Center for Environmental Studies which are involved in academic programs and research aligned with SDGs, particularly in renewable energy and sustainable urban planning (ITB SDGs NETWORK, 2016); Universitas Gadjah Mada (UGM) also has various centers focused on sustainable development, which offer courses related to the SDGs across different faculties, including Geography, Engineering, and Public Health (SDGs Center Universitas Gadjah Mada, 2018). More universities should follow this approach, as increased contributions can lead to significantly higher outcomes. Greater involvement from academic institutions will enhance progress toward achieving these targets, amplifying impact and paving the way for measurable advancements.

One key indicator for monitoring educational quality is student performance on assessments (O. Gladushyna and R. Strietholt, 2023). Other issues which are also related to student assessments, such as teacher quality, curriculum relevance, and infrastructure, also play essential roles and require targeted improvements to support better assessment outcomes (R. Siagian and B. Artha, 2023).

Universitas Airlangga (UNAIR) also supports SDGs through Decree of the Chancellor of Universitas Airlangga Number 253/UN3/2022 which concerning Establishment of the Sustainable Development Goals (SDGs) Center (SDGs Center Universitas Airlangga, 2022). Universitas Airlangga has implemented several SDGs in its university environment such as in Faculty of Advanced Technology and Multidiscipline (FTMM), they supported SDGs 6, where they developed clean water treatment after the earthquake in Turkey. FTMM Universitas Airlangga also supports SDGs 7 by conducting various activities such as analyzing renewable energy potential, talk shows to increase awareness of renewable technology, designing electric bicycles, electric motorbikes, and charging stations (FTMM, 2024). Unfortunately, although Universitas Airlangga fully supports SDGs, the implementation of ESD in UNAIR itself is not very prominent.

The lack of studies that identify whether Universitas Airlangga, specifically Industrial Engineering study program, have supported ESD encourages researchers to conduct research analysis. This research can help both universities and government in making decisions whether the implementation of ESD has been carried out as expected or not. It can also indicate whether students have actively participated in simple research and projects to improve their understanding, attitudes and behavior towards the success of ESD (Karyanto, 2019). The researchers aimed to gain a better understanding of ESD implementation at Universitas Airlangga.

ESD is also implemented through Green Technology subject, which involves student's active participation to propagate 17SDGs by publishing articles through several media. The effectiveness of this strategy should be measured to know how to enhance the contribution of students to broaden Indonesian knowledge about SDGs. Measurement can be conducted by evaluating the score proportions, the media influence rate and also the fidelity of the topic chosen for the task.

2. MATERIALS AND METHODS

2.1. Data Collection

The data for this research is gathered from the curriculum of the green technology subject offered in the years 2022 and 2023. This data includes both the academic performance of students and the teaching performance of instructors. Student performance data, including final grades and assessments, will be collected and organized using Ms. Excel. Similarly, teaching performance will be recorded and stored in Ms. Excel for further analysis. Ms. Excel will be used to create tables and charts to visually represent the data and simplify the analysis process.

2.2. Descriptive Statistics

In this section, a descriptive analysis is performed on the data collected from the green technology subject. The analysis includes the distribution of student grades, which will be presented in terms of means to highlight general

trends in academic performance. Furthermore, teaching performance will be analyzed based on evaluation reports. The data will be summarized using frequency distributions and visualized through charts to provide a clear overview (Triola, 2021) of both student outcomes and teaching effectiveness across the 2022 and 2023 academic years. Ms. Excel will be used to create tables and charts to visually represent the data and simplify the analysis process.

2.3. Mapping Analysis

This subject learns about technology efficiency and management, planning and design of environmentally friendly technology, utilization of sustainable technology, environmental impacts concerning biological, physical and socio-cultural aspects that may occur in relation to technological engineering activities. Soft skill attributes which must be received from this subject include integrity, professionalism, responsibility, work ethic, and critical thinking.

The final assessment for students in the green technology subject was based on their ability to produce a journal article related to topics covered during the semester. This journal article served as a capstone project, requiring students to apply theoretical knowledge to practical problems within the realm of sustainable engineering. The mapping of these final assignments involves identifying the key topics addressed in the student journals, such as renewable energy, waste management, and sustainable manufacturing processes.

These topics will then be analyzed to assess how well students integrated subject material into their final work and to measure the depth of understanding demonstrated in their submissions. Ms. Excel will be used to map and categorize these journal submissions. Each journal will be tagged according to its primary topic (e.g., renewable energy, waste management, sustainable manufacturing) and entered into Ms. Excel sheet for tracking. Ms. Excel will then be used to create visual representations, such as pie charts and tables, to show the distribution of topics and assess the alignment of student work with subject objectives.

3. RESULTS

This chapter presents the findings from the analysis of data collected in the green technology subject during 2022 and 2023. The results are divided into three main sections: student performance, teaching effectiveness, and the mapping of final assignments. The goal of this chapter is to provide a clear and structured overview of the key outcomes of the study.

The distribution of grades in the green technology subject over the past three years reveals a notable trend. A majority of students, approximately 70%, received a grade of AB, indicating that while they performed well, they did not achieve the highest level of mastery. In contrast, fewer students attained the maximum grade of A, suggesting that while many students are grasping the core concepts, only a smaller portion are excelling to the fullest extent. This pattern could point to challenges in mastering certain advanced topics or variations in assessment methods. Figure 1 provides a visual representation of this distribution, highlighting the gap between those achieving an AB versus those earning an A.

Evaluating indicators: Explaining of learning contract at the beginning of lectures; Explaining of library information used in learning (reference books/ teaching materials/ handouts/ modules); Implementation of learning in accordance with the study contract; Suitability of the material delivery method with the Course Learning Outcomes; The assessment weight is in accordance with

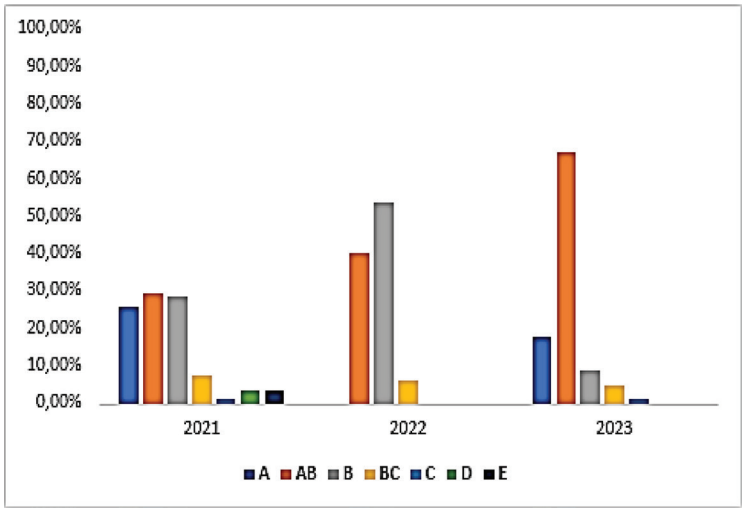

Figure 1. Grades Distribution of Green Technology Subject.

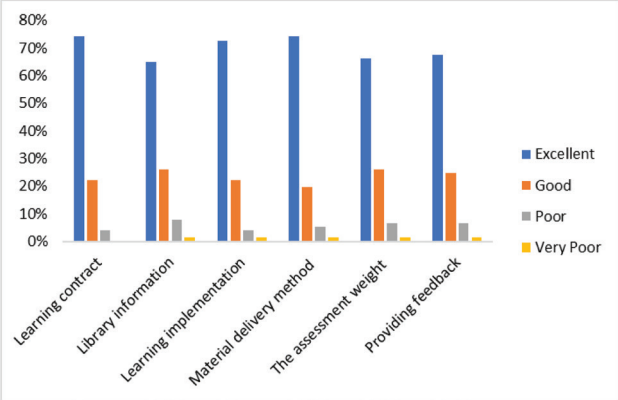

Figure 2. Lecturer Performance in Teaching Green Technology Subject.

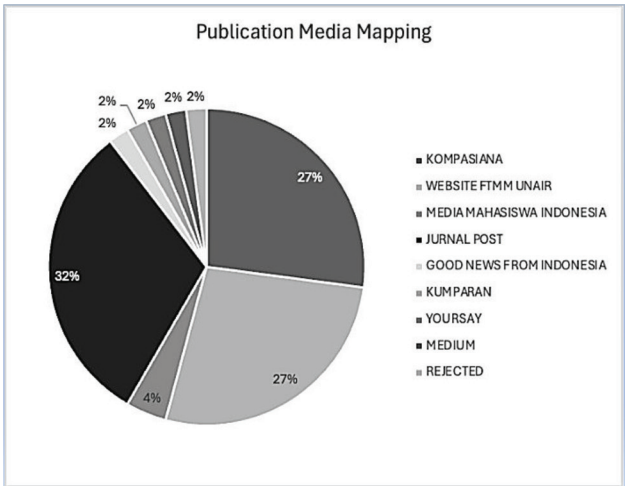

Figure 3. Mapping of the Publication Media Type.

the workload given (assignment/ quiz/ exam (midterm exam/ final exam)); Providing feedback on student learning outcomes (assignment/ quiz/ exam). The average scores of excellent, good, poor, and very poor are 69,9%, 23,4%, 5,6% and 1,1%, respectively (refer to Figure 2).

Based on the mapping (refer to Figure 3), Jurnal Post is the most popular platform among students for sharing knowledge about the SDGs. Other frequently used platforms include Kompasiana and the Website of FTMM UNAIR (the faculty's media). In addition, students have access to five other national-level platforms. This development is a positive step toward expanding their market reach for sharing knowledge about the SDGs. About 2 percent of the student's articles are rejected to be published.

Not all students explicitly mention the SDGs key topics their articles support, but some do. The most commonly chosen key topic is SDG 7, which focuses on affordable and clean energy. The second most popular topic is SDG 9, which covers industry, innovation and infrastructure, followed by SDG 6, which addresses clean water and sanitation. Other key topics that attract student interest include SDG 2 (zero hunger), SDG 11 (sustainable

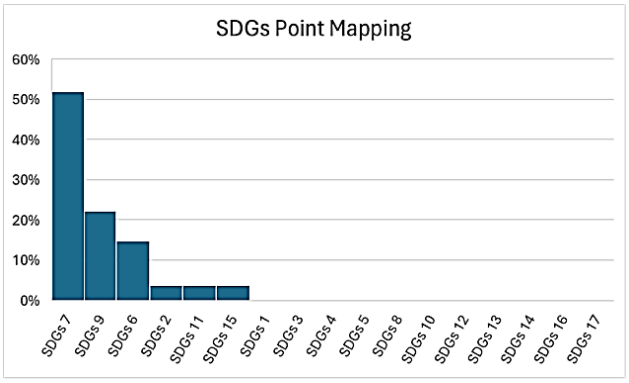

Figure 4. Mapping of the SDGs Key Topics.

cities and communities), and SDG 15 (life on land). The remaining key topics are not clearly identified as being supported by students in their articles.

About 23% of the students' published articles actively track their social engagement with the public, gauged through views, likes, and shares across various platforms such as Facebook, X (formerly Twitter), and LinkedIn. However, the majority of the articles have yet to be evaluated for their social media reach and impact (refer to Table 1).

The published articles have garnered a total of 1,395 views, received 9 likes, and have been shared 1,732 times on Facebook, 1,081 times on X, and 207 times on LinkedIn (refer to Table 2). While these numbers signal a positive impact in spreading SDG knowledge, there's a clear opportunity to amplify this influence even further.

4. DISCUSSION

Not all publication platforms track their influence on audiences, yet this metric is crucial for evaluating the subject's success in expanding knowledge to a broader public, particularly those not pursuing higher education but actively engaged with social media. This gap can be addressed by opting for platforms that provide detailed audience engagement metrics, such as views, likes, and shares. However, platform reputation and familiarity must also be considered. For instance, FTMM UNAIR's website, as the faculty's official media, should enhance its capabilities to track at least views and likes, enabling a more accurate assessment of the impact of published articles. This data driven approach could also serve as the foundation for content improvement strategies, providing insights for better content management.

The data suggests that one student assignment can reach around 1,395 viewers, demonstrating that increasing the number of publications or assignments could significantly expand reach. This strategy proves effective for disseminating SDGs knowledge, and it's vital to raise public awareness of the 17 SDG topics before 2030. Ideally, this awareness will inspire individuals

Table 1. Comparative Social Engagement Measurement

SOCIAL ENGAGEMENT						
	VIEWS	LIKE	SHARE FB	SHARE X	SHARE LINKEDIN	Average
BLANK	75%	83%	73%	73%	81%	77%
RECORDED	25%	17%	27%	27%	19%	23%

Source: *Authors, 2024.*

Table 2. Engagement Footprint of Social Platforms.

SOCIAL ENGAGEMENT				
VIEWS	LIKE	SHARE FB	SHARE X	SHARE LINKEDIN
1395	9	1732	1081	207

Source: *Authors, 2024.*

to contribute to achieving the goals by the 2030 deadline, as SDG success hinges on widespread global participation. With an average of approximately 1,395 viewers per assignment, these publications demonstrate a tangible impact on public engagement with sustainability issues. ESD emphasizes the importance of active learning, where students are not just consumers of information but also contributors to wider societal discourse on sustainability (J. Boeve-de, et. al., 2015) The outreach achieved through student publications exemplifies this active engagement, bridging academic achievement with real-world impact.

One potential strategy is to revise the subject curriculum, either by increasing the weight of publication assignments or the volume of required publications. This aligns with recent study in Education for Sustainable Development (ESD), which emphasizes the integration of practical, outcome-based learning into academic programs (Therese F., et al., 2022). By raising the assignment weight from 30% to 50%, as is being implemented this semester, the curriculum is shifting towards a model that encourages deeper student engagement with sustainability topics, not only through academic evaluation but also by enhancing their role as active contributors to societal knowledge on Sustainable Development Goals (SDGs) (Dario C. et al., 2019). ESD's advocates for more experiential learning and real-world application, and publication-based assignments serve as an effective vehicle for this by extending the reach of student outputs beyond the classroom. While the results of this curriculum revision are yet to be seen, it reflects the broader ESD goal of fostering skills that allow students to communicate sustainability issues effectively, both within and beyond academic circles (Jagneet K. and Raino B., 2023).

The mapping indicates that SDG 7 (affordable and clean energy), SDG 9 (industry, innovation, and infrastructure), and SDG 6 (clean water and sanitation) are the most discussed topics, likely due to their relevance to the students' focus on Industrial Engineering. Although the curriculum doesn't mandate specific SDGs for discussion, allowing students to freely select the topics, it is essential to recognize that the other 14 SDG topics are equally relevant and should be explored to broaden public understanding. To ensure comprehensive coverage, the subject curriculum could be designed to encourage a more balanced distribution of SDG topics for publication.

Another issue is that not all student publications explicitly state their support for specific SDG key topics. Addressing this would enable readers to easily identify and connect with the different SDG goals. A curriculum redesign could prompt students to explicitly link their ideas to relevant SDG topics, fostering a clearer understanding of how their work supports global sustainability goals. To effectively address key Sustainable Development Goals (SDGs), one approach could be directly assigning specific SDG topics to students, ensuring a broader range of important issues are discussed and published.

Currently, green technology courses are mandatory for at least 5 study programs, making it essential to evaluate how each program's body of knowledge aligns with the relevant SDG topics. For example, topics related to SDG 7 (Affordable and Clean Energy) are well-suited for the electrical engineering curriculum. Mapping more SDG topics to corresponding study programs can be further refined through curriculum meetings, helping ensure that the quality of students' work aligns with global sustainability efforts. This strategy would not only enhance learning outcomes, but also contribute to meaningful academic discourse on sustainability.

In crafting an article aimed at solving real-world challenges outlined by the UN's Sustainable Development Goals (SDGs), it's crucial to not only discuss each goal in a general sense, but also provide actionable strategies for achieving them. For example, SDG 9, emphasizes building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. To address the global decline in manufacturing growth, students of industrial engineering can analyze trends, identify bottlenecks and propose solutions to revitalize industries. This could include strategies for increasing industry share in GDP through investments

in high-tech sectors while simultaneously reducing emissions. Furthermore, expanding mobile broadband access is another critical factor in fostering innovation and industrial growth. Industrial engineers can also explore innovative ways to balance technological advancement with environmental sustainability, ensuring that industrial development not only benefits the economy, but also protects the planet. By integrating these specific approaches, students can contribute to impactful, evidence-based discussions aligned with the ADGs, positioning themselves as problem solvers on a global scale.

5. CONCLUSION

In summary, this study highlights the critical role of publication metrics in assessing the effectiveness of the green technology subject in disseminating knowledge about Sustainable Development Goals (SDGs). The data demonstrates that while a significant proportion of students received high grades (AB), the majority of their publications have substantial outreach potential, reaching approximately 1,395 viewers per assignment. This aligns with previous studies that emerge the importance of engaging broader audiences, particularly those outside of formal education, in sustainability discussions (Filho, W. L., et al., 2024). It also emphasizes the ESD as active learning, where students are not just consumers of information but also contributors to wider societal discourse on sustainability (J. Boeve-de, et. al., 2015) The outreach achieved through student publications exemplifies this active engagement, bridging academic achievement with real-world impact.

The findings suggest that enhancing audience engagement metrics on platforms such as the FTMM UNAIR website could provide valuable insights for improving content strategies. This approach echoes the recommendations of prior research, which advocates for data-driven methodologies to enhance the impact of educational initiatives (Volkov, A., et al., 2023). Moreover, revising the subject curriculum to increase the weight of publication assignments and encourage a balanced distribution of SDG topics can further enrich the learning experience, ensuring that all 17 SDGs are adequately represented.

Furthermore, the mapping of student publications revealed a focus on SDG 7, SDG 9, and SDG 6, reflecting students' academic interests in Industrial Engineering. While this concentration is valuable, it is essential to broaden the scope of discussion to include all SDGs, as previous studies have shown that active involvement with a range of sustainability issues deepens understanding and strengthens commitment to global initiatives (Filho, W. L., et al., 2024).

In conclusion, this research underscores the importance of a comprehensive approach to curriculum design that not only promotes academic achievement but also actively contributes to public awareness of the SDGs. By incorporating publication metrics as a key tool for assessing the effectiveness of student work, the study highlights the potential for academic programs to extend their impact beyond the classroom and engage wider audiences in sustainability efforts. Revising the curriculum, such as by increasing the weight of publication assignments from 30% to 50%, aligns with ESD's goal of fostering deeper student engagement and ensuring that their work contributes meaningfully to public understanding of sustainability issues. By establishing strong connections between student work and SDG topics, educators can enhance both the relevance and impact of their programs, driving greater participation in sustainability efforts by 2030, in line with the broader aims of ESD.

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Declaration of Conflicting Interests

The authors declare that they have no competing interests.

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Biographical Statement of Author(s)

Muniroh was born on August 25, 1992, in Surabaya, Indonesia. She holds a Master's degree in Industrial Management from the National Taiwan University of Science and Technology (NTUST), Taiwan, and is currently pursuing her PhD in the same field at NTUST. In 2024, she joined the Department of Industrial Engineering at Universitas Airlangga (UNAIR), Indonesia, as a lecturer, where she contributes to both teaching and research.

Her academic interests encompass a broad range of topics, including decision-making processes, applied statistics, the Sustainable Development Goals (SDGs), and the circular economy. In addition to her scholarly work, Muniroh enjoys traveling and exploring diverse cultures—an interest that enriches her global perspective and complements her commitment to interdisciplinary research and sustainable development.

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Currently, Kartika is a lecturer in the Industrial Engineering Study Program at the Faculty of Advanced Technology and Multidiscipline, Universitas Airlangga.

Her research interests include decision analysis, applied statistics, and quality management, with a focus on both academic advancement and practical applications. Beyond her academic career, she is passionate about traveling, exploring new cultures, and engaging with diverse individuals to foster continuous personal and professional growth.

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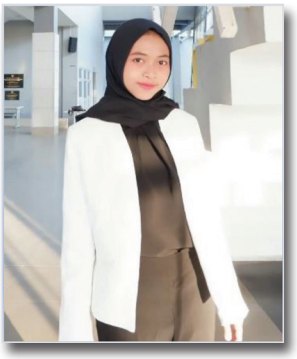

Laras Swandayai, born in 1996, possesses a keen interest in Human Factors and Occupational Health & Safety. She has developed a strong foundation in Industrial Engineering, holding a Bachelor of Engineering in Industrial Engineering from *Institut Teknologi Sepuluh Nopember*, Indonesia (2019).

She furthered her education with dual master's degree: one in Industrial Engineering from *Institut Teknologi Sepuluh Nopember*, Indonesia *(Magister Teknik)*, and another in Industrial Management from National Taiwan University of Science and Technology, Taiwan (Master of Business Administration) (2021). Currently, she is pursuing a Ph.D. in Industrial Management at National Taiwan University of Science and Technology, Taiwan, aiming to gain valuable insights in the same field.

Alongside her academic pursuits, Laras participated in bridge sports and engaged in various communities to find balance and inspiration in her life. Proudly serving as an Industrial Engineering Lecturer at the Faculty of Advanced Technology and Multidiscipline, Airlangga University, Surabaya, Indonesia.

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