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CORRELATIONAL STUDY ON THE TRANSFORMATION-ADVANCING COMPETENCIES AND SUSTAINABILITY KNOWLEDGE AMONG CIVIL ENGINEERING STUDENTS: A CASE IN A STATE UNIVERSITY IN PAMPANGA, PHILIPPINES

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Abstract:

In recent years, civil engineering has placed importance on sustainability. The need to address global concerns through sustainable practices has become more apparent. This study assesses the transformation-advancing competencies of fourth-year civil engineering students and evaluates the alignment of the curriculum with these competencies, as well as their perceptions regarding the incorporation of sustainability concepts and practices into their academic curriculum. A quantitative research design was used which involved descriptive and correlational analysis using Pearson Product Moment Correlation. Survey questionnaires were employed for this study, with 255 4th-year Civil Engineering Students serving as the respondents.The study's findings revealed that participants had an overall positive attitude toward critical thinking, problem-solving, communication, collaboration, adaptability, and resilience. It implies that the continuous development of TACs is essential in dealing with modern challenges. Courses in the civil engineering curriculum excel in gauging critical thinking and problem-solving skills while there is a potential to improve the integration of communication, collaboration, adaptability, and resilience throughout the curriculum – all of which are important for the civil engineering profession. Moreover, there was a positive outlook on sustainability knowledge and practices in the civil engineering field. Although students exhibit an understanding of sustainability concepts, there is still room for improvement. The study highlights the need to incorporate sustainability education into civil engineering curricula and recommends that further efforts should be made. Furthermore,The study shows moderate to high positive correlations between critical thinking, problem-solving, communication, adaptation, and resilience, emphasizing their interrelatedness. On the other hand, collaboration has lower correlations with other skills, whereas sustainability knowledge has constantly low correlations with all competencies (TACs). In conclusion, these findings may increase the importance of sustainability in the area of engineering and provide significant insights for establishing curriculum and educational methods that encourage sustainability within the civil engineering profession.

Keywords ***—transformation-advancing competencies, sustainability knowledge, sustainability education***

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I. INTRODUCTION

Engineering education is under increasing pressure to promote sustainability awareness among its graduates since it is at the center of influencing the future by providing aspiring engineers with the knowledge and skills required to develop innovative solutions to difficult issues affecting society. In recent decades, there has been a paradigm shift in engineering education, with a greater emphasis placed on incorporating concepts regarding sustainability into the curriculum. Sustainability in engineering education goes beyond the usual emphasis on technical skills. It emphasizes a holistic approach that considers the environmental, social, and economic implications of engineering practices [1].

The practice of civil engineering has been under pressure to prioritize sustainability. Civil engineers are required to design, construct, and maintain civil structures that society uses today. They are also accountable for taking action on the most significant global problems, such as socioeconomic inequity, resource shortages, and climate change. Engineers must be able to think logically, consider complex trade-offs, and make decisions that balance environmental, social, and economic concerns in order to excel in this role.

Sustainability appears to cover a wide range of topics and is frequently seen as a global concept. It includes ideas like ethical challenges, regulations, and guiding principles that provide an organizational decision-making framework. A conventional definition of sustainability and therefore sustainable development is ”developments that enable one to meet present needs without compromising the ability of future generations to meet their own.”[2].

Civil engineers aim to accomplish safe and sustainable development in an economical, environmentally friendly, and socially responsible way. Given their extensive responsibilities, which range from the design to the deconstruction of the built environment, future civil engineers must be prepared to handle all facets of construction. [3]. There is a worldwide trend to modify traditional engineering education programs such that sustainability principles are integrated into undergraduate curricula. In order to address the shift in social expectations of the engineering profession, such programs must offer engineers a long-term view of the world as well as the skills necessary for engineers to adapt and meet the problems that they will confront when they enter the industry. As a result, educating future civil engineering professionals necessitates a comprehensive approach that promotes sustainability through new techniques, methods, and information technology [4].

Education for sustainability is a progressive process to incorporate sustainability into engineering education.It comprises revising existing curricula, using new teaching methods, and promoting multidisciplinary collaboration. This approach aims to produce engineers who are not just technically proficient, but also competent at handling the complexity of sustainability issues. Thus, the holistic concept of sustainable development of engineering education cannot be an option but a necessity in order to prepare the next generation for stewardship of a world becoming increasingly challenging[5].

Sustainable development is a comprehensive approach that takes into account economic, environmental, and social factors. The economic dimension aims to cut costs while improving people's well-being by allocating resources efficiently. The environmental factor ensures the environment's long-term viability by supplying resources and absorbing pollution. The social aspect meets sociocultural demands by promoting well-being, interpersonal connections, and societal balance. This comprehensive strategy is critical for achieving long-term environmental and socioeconomic benefits. As a result, sustainable development in civil engineering is gaining importance as an independent discipline. Civil engineers have a significant impact on economic development and citizens' quality of life. Sustainable development, an important topic of discussion in the twenty-first century, affects all elements of human life, resulting in a more balanced society in which economic, social, and environmental issues are mutually beneficial.

Sustainability education has expanded a few decades ago in all levels of the education system to call for the assessment of sustainability knowledge. [2]. Sustainability knowledge refers to an individual's understanding of sustainability concepts and practices in the field of civil engineering that allow them to contribute to sustainable development effectively. It comprehensively explains sustainability's interconnected environmental, social, and economic aspects. Those who understand sustainability can assess, develop, and make judgments that balance present demands without risking future generations [7]. Thus, sustainability knowledge is of paramount importance in today's world as it equips individuals and societies with the understanding and skills to address pressing environmental, economic, and social challenges. By fostering sustainability knowledge, we can help to create a more sustainable and equitable future for all. Furthermore, while there has been some research on the general competencies of civil engineering graduates, these studies have not explicitly focused on transformation-advancing competencies (TACs) for sustainability. There is not enough comprehensive research on sustainability knowledge with the application of the transformation-advancing competencies of civil engineering students of Don Honorio Ventura State University. Past studies are more focused on the academic approach typically limited in scope, and do not provide an extensive evaluation of students' TACs. This study aims to assess the transformation-advancing competencies and sustainability knowledge among DHVSU civil engineering students and identify gaps in the current curriculum that are required for sustainable development in civil engineering.

A. BACKGROUND OF THE STUDY

Civil engineering is one of the largest branches of engineering encompassing the construction industry and the construction of physical assets, infrastructures, and the surrounding built environment. Civil engineers play an important role in society because they design and maintain the structures and systems that individuals and communities rely on every day.

In recent years, civil engineering has emphasized sustainability. The need to address global challenges in sustainable ways has increased, and civil engineers are increasingly expected to design and develop infrastructure that is both useful and long-lasting, as well as environmentally friendly and sustainable. This leads to the development of the necessary skills and competencies for dealing with the situation.

Don Honorio Ventura State University DHVSU, a university dedicated to academic excellence, is at the center of this transformative path. The necessity for a thorough evaluation of the knowledge and skills of civil engineering students emerges from the dynamic shifts in expectations within the engineering profession, especially with regard to sustainability. Findings from Don Honorio Ventura State University (DHVSU)'s evaluation of civil engineering students' transformation-advancing competencies and knowledge of sustainability might prove useful. In order to guarantee that its graduates are prepared for the opportunities and challenges that lie ahead, the university must determine what skills students need to acquire in order to succeed in the constantly evolving field of civil engineering. The following are the specific transformation-advancing competencies (TACs) that civil engineering students should develop:

1. Critical thinking and problem-solving skills: The ability to think critically and solve complicated problems while under pressure.

2. Communication and collaboration skills: The capacity to effectively communicate with a wide range of people. To design and implement solutions, they must also be able to collaborate effectively with other professionals.

3. Adaptability and resilience: The ability to adjust to change and remain resilient in the face of adversity.

II. REVIEW OF RELATED STUDIES

A.Sustainability in Engineering Education

For people to progress and live in a sustainable future, it is imperative for them to grasp the intricacies of the earth and accept that life needs to be sustained sustainably[8].Today, the activity of engineering students and prospective professionals is to solve global issues while adhering to environmental and social equity standards and with limited capabilities for environmental sustainability and without depleting the resources that future generations will need [9].

The integration of Sustainable Development into engineering curricula has progressed beyond environmental inclusion to include economic and social domains. This has been made possible by the efforts of such professional bodies as the International Engineering Alliance (IEA) which has set a general framework for the standard assessment of competency in sustainable development. But scholars have also advocated for it. CRUE, the Conference of Spanish Rectors established in 2005, has stressed including competencies of sustainable development into the university degrees and throughout the curricula[10]. Since the establishment of the SDGs in 2015, UNESCO has introduced various approaches and the models that have referred to sustainability in the teaching area of higher education only are being replaced little by little by the comprehensive inclusion models for the integration of the SDGs and the overall sustainable development into all parts of the university including the teaching[11].

Although the twenty-first century has been regarded as a golden time for expanding higher education for sustainability, few research syntheses have yet examined the results of sustainability-related tasks in engineering education. In summary, UNESCO initiated the Decade of Education for Sustainable Development from the year 2005 to 2014 aiming at channeling activities in higher learning institutions toward the promotion of sustainable development [12].

The United Nations' efforts to define sustainable development goals (SDGs) for the 21st century have led to the incorporation of sustainability concepts into curricula ranging from elementary to university education. UN-SDGs focus on the environmental (climate change, existence on land, lives below water), social (gender equality, peace), and economic (no poverty, decent work, and economic growth) aspects of sustainability [13].

B. Education for Sustainable Development

Global society must undergo an ambitious and comprehensive transformation if the Sustainable Development Goals (SDGs) are to be met by tackling enduring sustainability issues like climate change, biodiversity loss, and socioeconomic inequities[14]. According to Linnér and Wibeck [15], [16], facilitating these changes will call for innovative methods, which should be implemented by change agents with training in sustainability and sustainable development. As a result, there are now a significant number of sustainability programs offered at universities and colleges across the globe [17].

The Sustainable Development Goals are a set of goals numbering seventeen which were opted for by the United Nations Member States in 2015 for the purpose of attaining a better and sustainable course for the future in every part of the world. The goals are interconnected and inseparable, balancing the three pillars of sustainable development: Economic, social, and environmental, These are broad categories of risks and any event that will fall under these categories is considered a risk event.

Education for Sustainable Development (ESD) is an effective tool for the attainment of the internationally acclaimed Sustainable Development Goals (SDGs). It has the potential to deliver the transformation that society requires to build a sustainable country [18]. Education is the most effective strategy for cultivating and implementing ideals for sustainable development. Furthermore, education is seen as the most strategic means of supporting sustainable development and boosting human capacity to deal with environmental and development concerns and problems.

Education for Sustainable Development (ESD) provides and develops the knowledge, skills, values, and worldview required for individuals to act in ways that promote more sustainable lifestyles and address global issues such as climate change, environmental degradation, consumerism, and so on. ESD is essentially an educational technique for increasing awareness and knowledge of sustainability issues, improving critical thinking and reflection skills, and fostering creativity and solutions for a more sustainable way of living. A comprehensive view on education and learning encourages such education, which attempts to assist people in comprehending the necessity of collaboration, where synergy between economic, social, ethical, and engineering skills is important [19].

It is crucial that civil engineering students and future civil engineers approach global problems with an understanding of the environment and social justice, being environmentally sustainable and not harming the generations to come. The purpose is to promote a world vision in which students will become activists for sustainability once they graduate, whether in a civic realm or by incorporating sustainability principles into their work [20].

C. Sustainability Domains

The study by the UN presented a link between the growth of the GDP and the level of sustainability of the environment. Basically, sustainability has been described by the Brundtland Commission as development that must fulfill the needs of the current generation in every way at the same time maintaining the quality of life of the next generations [21]. This explains how sustainable development is conceived of in general and how both concepts are enforced in the case of a developing country. In academic disciplines in science, policy, health, and the environment, sustainability has become significant in recent years [22]. Issues related to sustainability are recognized and are comprehended at the international level. Many discussions have been made regarding the meaning and significance of the sustainability concept addressing the social, environmental, and economic pillars.

Economic Aspect

Sustainability in the context of economies can be defined as the preservation of natural capital as investments in economic processes or stocks for physical assets for a long-term economy. It was done with the understanding that markets in their normal functioning are not efficient in preserving the 'natural capital' but undermine and destroy it. [23]. The economics of sustainability was first adopted by a few followers with the notion that pollution-controlling laws would spur innovations which in turn would bring about economic success. The emergence of new technologies and innovations that are aimed at reducing pollution and increasing production efficiency can go hand in hand with economic and environmental improvements. It was in 1987 that the concept of "Sustainable Development" was established with an assumption that long-term stability of the environment and economic prosperity are inevitable partners [24].

Another dimension of sustainable consumption is the extent to which the design of a manufacturing system should sustain current needs without compromising future requirements. This gives us knowledge of economic sustainability which seeks to maintain the economy in the long run [25]. Moreover, sustainable development discusses the continuance of the concept of development and growth of the economy, and the need to set the bounds for the economy's growth and environmental conservation [22].

Environmental Aspect

According to Harris, it is necessary to elaborate an environmentally sustainable society by implementing efficient social policy in relation to energy resources, providing balanced resources for the future, investing in alternative energy resources, and preventing the excessive consumption of renewable and degrading non-renewable resources. This is in line with the protection of the ecosystem for example conserving the species of animals for example and the atmosphere to remain stable. Thus, from the view of environmental conservation, it is argued that population should be checked in a way that does not affect the balance between the general population and the total amount of resources needed for species' and ecosystems' preservation [26].

Social Aspect

Although it was introduced later into the discourse on sustainable development, societal sustainability has the ideals of social justice, safety, and opportunities to gain safeguard in vulnerable situations, sustainable urban layout, spaces, constructions, land usages, the method of production and consumption, energy efficiency, proper utilization and management of resources to minimize wastage and recycling, and equitable living [28]. These are considered as tools or components of sustainable development even though they relate to environmental sustainability. To support social sustainability, the following basic preconditions are required: The pursuit of life, liberty, and the opportunity to develop one's individual talents, voting rights, individual rights, public spiritedness, contribution to knowledge, civil security, and safety, acceptable standard of living, pride of place, and division of competence [24], [26], [27].

D. Transformation Advancing Competencies

Transformation-advancing competencies represent the particular knowledge and skills (critical thinking, communication, adaptability, etc.) that prepare upcoming civil engineers to adjust to changing conditions as well as promote the continuous shift toward sustainability.

Critical Thinking Skill

Scholars recently proposed training options for engineering students to improve their understanding of the links between the environmental, social, political, and economic domains of sustainability and how those relationships affect design solutions. Similarly, engineers should have a broader variety of professional abilities, such as understanding how engineering solutions affect the global, economic, and environmental arenas, as well as the necessity of sustainability in the design of systems, parts, and procedures [28].

Hedden [29] recognizes that teaching engineers to adopt a sustainable stance entails preparing them to address real-world sustainability difficulties. However, students have to be creative and learn how to analyze different situations and solve problems on the one hand, and learn to be rebels when necessary, on the other. The ability to challenge standards, processes, and viewpoints is referred to as critical thinking. Through it, one reviews one's beliefs and attitudes and takes a stand on the sustainability issues to all tenets of professional engineering; especially technical advancement and, since the formulation of the ABET 2000 standards, there has been enhanced focus among engineering students on the cultivation of analytical skills. The intended outcome of building logical reasoning skills for the students is that they will enhance their critical thinking skills. Therefore, critical thinking is developmental and cannot be taught by the kind of instruction where one teaches a step-by-step process to be followed by a drill on the particular skill as is the case with the logical thinking skills. The quality of what students and engineers design, produce, or make is determined by the quality of their thinking and how they think [30].

Baillie [31]defines critical thinking in terms of results, saying at the beginning of the course, " Students will be able to demonstrate an ability to think critically and reflexively about their work in this unit as well as about engineering practices in the abstract; evaluate and apply various perspectives of the relationship between science, technology, and society; consider rights, justice, freedom, and ethics and illustrate their relationship to science, technology, and society [32]. This extensive definition implies that critical thinking goes beyond thinking clearly or rationally and investigates different key concepts in depth by investigating underlying concerns, loosely connected topics, or seemingly unconnected issues.

Problem-Solving Skill

The major difficulties of the twenty-first century need the human race to solve issues and face uncertainties that we have never encountered before. Complex problem-solving is the most crucial talent for the fourth industrial revolution by 2020, according to the World Economic Forum. As a result, having effective problem-solving skills has become increasingly important in this century. Students must be able to think critically, and creatively, and solve issues at all stages of school, particularly at the university level.

Thurer[33] defines problem-solving as skills that include the capacity to apply engineering design to develop solutions that satisfy particular demands while also considering global, cultural, social, environmental, and economic considerations, as well as aspects like public health, safety, and well-being.

Engineering education has identified a need for students to be prepared to solve difficult challenges. Despite the proven importance of motivation in learning, there has been little research into how motivation and problem-solving in engineering interact. The ultimate purpose of practice in modern learning theories is problem-solving. Furthermore, the Washington Accord [32] defines complex engineering issues as those that necessitate in-depth engineering competence to handle. Comprise a wide range of opposite technical, engineering, and other issues.

Developing skills in problem-solving in sustainability is a major obstacle for higher education. Historically, technical problem-solving has dominated engineering education, sometimes with little concern for the social, political, and economic implications. Many of the characteristics of poorly organized problems that need analytical thought may be seen in the sustainable development challenge. As a result, the combination of critical concepts from sustainable development and education contributes significantly to the education of future civil engineering students[32].

Communication and Collaboration Skills

Communication is the exchange of information to improve understanding. Collaboration is the interchange of knowledge and resources to improve the status of a collaborative product. Collaboration simply adds the purpose of moving a shared product forward; nevertheless, collaboration cannot occur without communication. Communication permits connections to work, and the functioning of those relationships allows collaboration to take place and be beneficial [34].

Collaboration, as well, is a broad phrase with components spread across various topologies: The main issue is not so much our grasp of classification bands as it is how we use them to improve the quality of learning and teaching in our schools. Collaborative learning, by definition, necessitates efficient communication to take place. Can communication persist in the absence of collaboration? Is it possible to collaborate while communicating? We could respond to these two issues by arguing that for each to be a successful learning tool, they must work in unison [35].

In the Architecture, Engineering, and Construction (AEC) sector, the increasing intricacy of construction projects demands the functioning of intricate organizations and a wide range of professional associations.[36]. During the course of a project, a civil engineer works in coordination and collaboration with many different stakeholders, such as architects, builders, engineers, suppliers, laborers, and the community. Together with technical proficiency, other necessary traits include leadership, social skills, professional ethics, and effective communication.[37]. These competencies complement each other and facilitate the professional's ability to work efficiently in multidisciplinary teams when creating building projects[38].

Adaptability

In the face of escalating global concerns such as climate change, resource scarcity, and social and economic injustice, resilience and adaptability have emerged as critical traits for individuals, organizations, and society to navigate change, overcome hardship, and construct a sustainable future.

Adaptation is a psychological process in which humans actively evolve and alter themselves to cope with changes in the objective world, and then harmonize and balance with the external environment. Academic adaptation, according to Feng et al, is a psychological and behavioral process in which participants seek to adapt themselves to the needs of the environment and learn to create a balance with the learning environment [39].

Adaptability in the face of rapid environmental change is essential for achieving positive outcomes. Adaptability is viewed as a vital source of mental resources and is referred to as "a person's capacity, ability, attitude, willingness, as well as motivation to change or adapt various duties, interpersonal, or environment aspects." More psychological resources can be saved by those who are highly adaptable than by people who are less adaptable. People need to be flexible in their thinking and behaviour in order to adapt to changing conditions.[40].

Resilience

The concept of resilience varies greatly depending on the topic to which it is applied. Essentially, the general requirements that unite the various literature definitions of resilience refer to a system's ability to absorb, adapt, and recover from external stress while reducing disturbances to its normal functioning[41].

The ability to constantly maintain vital functions without a decline in quality is referred to as sustainability. Resilience is defined as the ability to thrive in the face of change. These two concepts characterize today's most essential social, economic, and environmental goals: to construct systems that benefit the world around them rather than harm it, and thus to be able to withstand the inevitable shocks of environmental and technological change.

In the context of general resilience, academic resilience research has led to the establishment of seemingly distinct but connected views and frameworks, each seeking to tackle a seemingly similar problem. Despite many apparent differences between their constructions and resilience [42]. Martin and Marsh suggest another concept, academic buoyancy, which is strongly related to academic resilience. Defined as the "ability to overcome obstacles, barriers, and problems that arise in daily academic life"[43].

However, as one of the main programs in higher education that prepares the future generation of professionals and decision-makers in the field of infrastructure resilience—a crucial component of community resilience—CEC disciplines are among those that do this. While there are some specialized topic differences between construction and civil engineering programs, they both typically give their students a foundational understanding of infrastructure resilience. Graduates from these programs can then go on to pursue infrastructure resilience topics in their further education or professional careers [44].

III. METHODOLOGY

A. RESEARCH DESIGN

The study "Correlational Study on the Transformation-Advancing Competencies and Sustainability Knowledge among Civil Engineering Students: A Case in a State University in Pampanga, Philippines" employs a quantitative and non-experimental research design, primarily utilizing correlational to comprehensively examine the Transformation-Advancing skills among fourth-year civil engineering students at Don Honorio Ventura State University.

Non-experimental research designs address research questions without manipulating a variable. The research events may have previously occurred in the past, controlled experiments are not carried out, the participants or artifacts to be examined exist in their natural environments, and the phenomena are studied as they occur. It is mostly based on descriptive, observational, or correlational data [45]. The correlational aspect of our research design enables us to explore the relationships between different competencies, providing insights into their connections.

Quantitative data is used to assess students' sustainability knowledge as they apply transformation-advancing competencies. The use of quantitative data allows the researchers to capture various perspectives and ideas from students. Quantitative data is objective and can be analyzed using statistical methods to draw inferences about the population. Variables include critical thinking and problem-solving, communication and collaboration, and adaptability and resilience.

B. POPULATION

This study employed a specific criterion to ensure the selection of the right respondents. The primary respondents in this study are fourth-year students of Don Honorio Ventura State University. Only fourth-year students with the most experience and exposure to the civil engineering curriculum are selected to participate. The selection of fourth-year students of DHVSU aims at capturing the perspectives of individuals who have made significant progress in their academic journey. Participants were selected with the help of a probability sampling technique known as stratified sampling. The probability sampling technique which is also referred to as proportionate random sampling or quota random sampling works by subdividing the population into homogeneous groups (strata) to undertake the sampling process. It is commonly used when one wants to gain a sample from several smaller subgroups or strata in order to reach the optimal population in a short time[47].

The researchers utilized the Sample Size Calculator by Raosoft, Inc. to compute the minimum number of respondents. For the 4th year civil engineering students with a total population size of 476, with a 95% level of significance, a 5% margin of error, and a 50% response distribution, the minimum number of respondents of students is 213.

Using stratified sampling, the researchers determined the recommended sample size for each stratum, which was at least 250 participants. The final number of respondents is 255 4th year civil engineering students.

C. RESEARCH INSTRUMENT

The researchers collected the data for this study's findings analysis via survey questionnaires. To assure quality and avoid bias and animosity in the techniques, the instrument was validated by a grammarian and psychometrician, as well as the approval of a research consultant. Any necessary improvements to the instrument have been made based on the feedback provided. Besides, reliability was determined by the survey questionnaire through Cronbach's alpha pilot test. Furthermore, this study explained that Cronbach's alpha is used to measure the internal consistency or reliability of items, measurements, or ratings. In other words, it investigates the accuracy of the questionnaire's (or the domain of the questionnaire's) response, instrumentation, or rating volunteered by the respondents, which would the stability of the instruments[47].

Survey Questionnaires: The questionnaires were created by the researchers and adopted from previous studies. It consists of 3 parts that measure the level of students' transformation-advancing competencies such as their critical thinking and problem-solving skills, communication and collaboration skills, and adaptability and resilience.In addition, it also examined the student's understanding of sustainability concepts and practices as well as their application from an academic perspective.

D. DATA COLLECTION METHODS

The data for this study was gathered in two stages. First, the researcher designed a survey instrument, which has been validated. The researchers submitted a letter of approval to the university to formalize and validate the study's procedure. Following the signing of the letter, the survey instrument was distributed to fourth-year civil engineering students at Don Honorio Ventura State University in hard copy via face-to-face. Two statistical techniques were applied to all collected data to analyze the findings and outcomes. To retain the authenticity of the data, the researchers ensured that it was gathered in an unbiased manner.

E. DATA ANALYSIS

The data collected from the survey instrument was analyzed using statistical methods, such as descriptive, and Pearson product-moment correlation.

Descriptive Statistics

The researchers used descriptive statistics to give a summary of the current status of the different competencies and knowledge regarding sustainability. This is used to compute means, and standard deviations and provide interpretations for critical thinking, problem-solving, communication, collaboration, adaptability, and resilience statements.

The weighted data was interpreted using a Likert scale. A Likert scale is a rating system used to assess opinions, attitudes, and behaviors. It begins with a statement or question followed by five or seven answer statements. Respondents select the choice that best reflects how they feel about the statement or topic. [48].

The researchers used the 4-point Likert scale because it provides simplicity, reduced neutral bias, enforced choice, ease of analysis, faster response time, and suitability for limited variability. It encourages respondents to express their thoughts in the absence of a neutral option, making it appropriate for quick surveys and situations with little to no variability. The scale may result in less social desirability bias and a more distinct distinction of answer levels.

Point	Scale Range	Interpretation
4	3.24 – 4.00	Strongly Agree
3	2.50 – 3.24	Agree
2	1.75 – 2.49	Disagree
1	1.00 – 1.74	Strongly Disagree

TABLE I. 4-Point Likert Scale

Pearson Product Moment Correlation

Pearson Product Moment Correlation was used by the researchers to examine the relationships between students' self-reported knowledge of sustainability concepts and their demonstrated competencies. This demonstrates whether or not there is a connection between their knowledge and competency levels.

The results of a Pearson product-moment correlation reveal whether or not the two variables have a statistically significant link, as well as the direction of that relationship. The interpretation suggests that when r approaches ±1, the linear relationship becomes stronger. Correlation is an effect size, and we might internally characterize the strength of the correlation using the following guidance for the absolute value of r.

r Value	Indication
Between ± 0.8 to ± 1.00	Very High Correlation
Between ± 0.6 to ± 0.79	High Correlation
Between ± 0.4 to ± 0.59	Moderate Correlation
Between ± 0.2 to ± 0.39	Low Correlation
Between ± 0.1 to ± 0.19	Negligible Correlation

TABLE II. Correlation Interpretation Scale

SPSS Statistics Software

The quantitative data collected from survey questions was structured and processed using IBM SPSS Statistics software. It is a set of software applications used in the analysis of various scientific data in the Social Science field. It is a fast GUI-based software that can be used to develop models of all kinds, for all types of research. SPSS data can be used in surveys, data mining, market research, and other activities that concern data analysis. Another reason why SPSS is popular is that the command language it is quite friendly and there is a user guide available. Today people ranging from government agencies, education institutions, different survey enterprises, marketing researchers, marketing groups, health researchers, data miners, and many more people, make use of it in the analysis of the survey data [49].

F. ETHICAL CONSIDERATION

Throughout the research process, ethical considerations were taken into account. Participants were informed of the goal of the research before any data was collected, and their participation was entirely voluntary. The information was gathered in compliance with Republic Act No. 10173 also known as the Data Privacy Act of 2012 and was only used for the purposes of the study. All authors of the publications, relevant studies, related literature, and other information cited and acknowledged in this study followed the Institute of Electrical and Electronics Engineers (IEEE) format.

III. RESULTS AND DISCUSSIONS

A. Assessment of Transformation-Advancing Competencies

Transformation-advancing competencies refer to the skills that are essential for civil engineering students to prepare them to address challenges and opportunities in the field.

TABLE III. Descriptive Statistics on the current state of Critical Thinking and Problem-Solving Skills of 4th year CE students.

Critical Thinking and Problem-Solving Skills		**Mean**	**SD**	**Interpretation**
5.1	I have learned to improve my ability to judge the value of new information on the evidence presented.	3.3077	0.5674	Strongly Agree
5.2	I have developed a more open-minded approach to interpreting, analyzing, and judging alternative points of view.	3.3231	0.5724	Strongly Agree
5.3	I am a quick learner, but I don't like theoretical futuristic concepts.	2.8577	0.6912	Agree
5.4	I often found myself actively engaged in thinking about complex issues.	2.9538	0.6960	Agree
5.5	I can focus and think clearly without pressure.	2.7038	0.8059	Agree
5.6	I can analyze a situation and identify areas for improvement.	3.1423	0.6080	Agree
5.7	I excel at problem-solving by applying analytical reasoning, creativity, and logic.	2.9423	0.6280	Agree
5.8	I have learned more about how to analyze the key issues in my subject area.	3.0192	0.5989	Agree
5.9	I remain calm when I encounter problems.	2.8346	0.8241	Agree
5.10	I quickly come up with solutions to the problems that I encounter.	2.8846	0.7366	Agree
Grand Mean		**2.9969**		Agree

The table above shows the results of the problem-solving and critical-thinking skills of the survey respondents. Statements 9.1, 9.2, 9.3, 9.4, and 9.5 pertain to the critical thinking skills of the students while statements 9.6, 9.7, 9.8, 9.9, and 9.10 reflect their problem-solving skills. It was determined that the top three statements with the highest mean scores are 'I have developed a more open-minded approach to interpreting, analyzing, and judging alternative points of view' (M = 3.2331, SD = 0.5724), 'I have learned to improve my ability to judge the value of new information on the evidence presented' (M = 3.3077, SD = 0.5674), and 'I can analyze a situation and identify areas for improvement' (M = 3.1423, SD = 0.6080). This shows that respondents support their ability to remain open-minded, critically evaluate the value of new information, and effectively analyze situations for improvement. These findings are indicative of a strong foundation in making informed judgments, developing innovation in their field, and a disposition to embrace multiple perspectives, which are essential for effective critical thinking and problem-solving. On the other hand, the three statements with the lowest mean are 'I am a quick learner, but I don't like theoretical futuristic concepts' (M = 2.8577, SD = 0.6912), 'I remain calm when I encounter problems' (M = 2.8346, SD = 0.8241), and 'I can focus and think clearly without pressure' (M = 2.7038, SD = 0.8059). These areas highlight potential issues in exploring innovative solutions, stress management, and keeping composure while dealing with difficult situations.

Addressing these areas can enhance students' overall critical thinking and problem-solving skills. According to Mohd Sohod[50], the critical thinking and problem-solving skills of students is an ability that needs to be developed because it involves several abilities to think critically, creatively, innovatively, and analytically, as well as the ability to apply understanding and knowledge to new and different problems. Students who receive additional assistance might enhance their critical thinking and problem-solving skills, enabling them to perform better.

TABLE IV. Descriptive Statistics on the current state of Communication and Collaboration Skills of 4th year CE students.

Communication and Collaboration Skills		Mean	SD	Interpretation
6.1	I can communicate my thoughts and ideas to the team to make a group decision.	3.1692	0.7314	Agree
6.2	I ask questions when I get curious about how things work.	3.3346	0.6689	Strongly Agree
6.3	I accept and provide feedback in a constructive and considerate manner.	3.3577	0.6016	Strongly Agree
6.4	I stay confident when I share my thoughts and ideas with others.	2.9231	0.7871	Agree
6.5	I can effectively communicate my thoughts and ideas by using oral, written, and non-verbal communication skills.	3.0808	0.7066	Agree
6.6	I can be active in listening while understanding different points of view.	3.3000	0.6044	Strongly Agree
6.7	I prefer to work with group members who ask questions about the information I provide.	3.1923	0.6986	Agree
6.8	I actively contribute ideas and insights during team discussions.	3.1346	0.6983	Agree
6.9	I can function effectively in a group as a team member.	3.2808	0.6532	Strongly Agree
6.10	I take recommendations from my group members to improve team success.	3.4615	0.6044	Strongly Agree
Grand Mean		**3.2235**		Agree

Table 6 presents the descriptive statistics on the communication and collaboration skills of the surveyed respondents. Statements 6.1, 6.2, 6.3, 6.4, and 6.5 address communication skills, whereas statements 6.6, 6.7, 6.8, 6.9, and 6.10 address collaboration skills. The top three statements with the highest mean are ‘I take recommendations from my group members to improve team success’ (M = 3.4615, SD = 0.6044), ‘I accept and provide feedback in a constructive and considerate manner’ (M = 3.3577, SD = 0.6016), and ‘I ask questions when I get curious about how things work’ (M = 3.3346, SD = 0.6689). This implies a willingness to consider group member recommendations for team success, provide and accept constructive feedback, and foster a culture of curiosity.These skills promote a positive and inclusive team environment in which they feel encouraged to contribute and cooperate effectively. On the contrary, the three lowest mean scores are ‘I actively contribute ideas and insights during team discussions’ (M = 3.1346, SD = 0.6983), ‘I can effectively communicate my thoughts and ideas by using oral, written, and non-verbal communication skills’ (M = 3.0808, SD = 0.7066), and ‘I stay confident when I share my thoughts and ideas with others’ (M = 2.9231, SD = 0.7871). This suggests that there is potential for improvement in developing confidence, communication skills, and working collaboratively. This finding is consistent with earlier research, which has shown that one's impression of communication skills affects one's willingness to communicate, placement in situations where communication is required, and initiation and involvement in other interpersonal relationships[51].

TABLE V. Descriptive Statistics on the current state of Adaptability and Resilience Skills of 4th year CE students.

Adaptability and Resilience		Mean	SD	Interpretation
7.1	I quickly adjust to the changes going on around me.	3.1000	0.6440	Agree
7.2	I influence where I can, rather than worrying about what I can’t influence.	3.0462	0.6320	Agree
7.3	I would see a difficult situation as a challenge.	3.1308	0.6851	Agree
7.4	I try to control events rather than being a victim of circumstances.	3.0346	0.6537	Agree
7.5	I tend to become different when I’m in different situations.	3.1269	0.6716	Agree
7.6	I would use a difficult situation to motivate myself.	3.1077	0.7219	Agree
7.7	I generally manage to keep things in perspective.	3.1923	0.6163	Agree
7.8	When I find myself in a bad situation, I quickly consider what may be done to make things right.	3.2731	0.6681	Strongly Agree
7.9	I would like to think more about my strengths and weaknesses to help me work better.	3.2923	0.6628	Strongly Agree
7.10	Past success gives me the confidence to face new challenges.	3.3923	0.6275	Strongly Agree
Grand Mean		**3.1696**		Agree

Table 7 displays the descriptive statistics on the adaptability and resilience of the respondents considered for this study. Statements 7.1, 7.2, 7.3, 7.4, and 7.5 indicate adaptability while statements 7.6, 7.7, 7.8, 7.9, and 7.10 indicates resilience. The three statements that have the highest mean are ‘Past success gives me the confidence to face new challenges’ (M= 3.3923, SD = 0.6275), ‘I would like to think more about my strengths and weaknesses to help me work better’ (M= 3.2923, SD = 0.6628), and ‘When I find myself in a bad situation, I quickly consider what may be done to make things right’ (M = 3.2731, SD = 0.6681). These characteristics signify a proactive and resilient mindset, which allows them to effectively navigate problems and seize growth opportunities. Meanwhile, the three lowest means are ‘I quickly adjust to the changes going on around me’ (M = 3.1000, SD = 0.6440), ‘I influence where I can, rather than worrying about what I can’t influence’ (M = 3.0462, SD = 0.6320), and ‘I try to control events rather than being a victim of circumstances’ (M = 3.0346, SD = 0.6537). Improving these skills could improve their resilience and ability to adapt and thrive in uncertain situations. As Olayemi F.S[52] stated, that developing adaptability and resilience is critical for dealing with life's inevitable adversities. Individuals can handle hardship with grace and emerge stronger by fostering a growth mindset, practicing self-care, forming a support network, learning from mistakes, taking on new challenges, exercising resilience on a daily basis, and maintaining a positive attitude.

B. Assessment of Sustainability Knowledge as well as the Application in Academic Perspective

Sustainability Knowledge refers to the understanding of concepts and practices that promote sustainability in construction, infrastructure development, and other civil engineering projects.

TABLE VI. Descriptive Statistics on the Sustainability Knowledge of 4th year CE Students.

Sustainability Knowledge		Mean	SD	Interpretation
8.1	I feel knowledgeable about the sustainability concepts within the field of civil engineering.	3.1000	0.5675	Agree
8.2	I am extensively familiar with the Sustainable Development Goals (SDGs).	2.9154	0.7912	Agree
8.3	I have a good understanding of the principles of sustainable practices in civil engineering.	2.9500	0.6286	Agree
8.4	I have a broad understanding of sustainable construction materials and their applications in civil engineering.	3.0538	0.6612	Agree
8.5	I have a great understanding of using energy-efficient design in civil engineering.	2.9692	0.6799	Agree
8.6	I am well aware of the concept of "green infrastructure" in the field of civil engineering.	3.0615	0.6722	Agree
8.7	I have extensive knowledge of incorporating renewable energy sources into civil engineering projects.	2.9885	0.7057	Agree
8.8	I have a decent understanding of concepts related to environmental sustainability.	3.1154	0.6353	Agree
8.9	I am knowledgeable in the economic aspect of sustainability in the field of civil engineering.	3.0231	0.6630	Agree
8.10	I am well-versed in the social aspect of sustainability in the field of civil engineering.	3.0115	0.6890	Agree
Grand Mean		**3.0188**		Agree

The table above presents descriptive statistics on respondents' knowledge of sustainability concepts in the field of civil engineering. Respondents generally agree with statements regarding various aspects of sustainability in civil engineering. The top three statements with high mean scores are ‘I feel knowledgeable about the sustainability concepts within the field of civil engineering’ (M = 3.1000, SD = 0.5675), ‘I have a decent understanding of concepts related to environmental sustainability’ (M = 3.1154, SD = 0.6353), and ‘I am well aware of the concept of "green infrastructure" in the field of civil engineering’ (M = 3.0615, SD = 0.6722). These findings demonstrate a good foundation for understanding sustainability and its application in the civil engineering field. This knowledge is essential for promoting environmentally friendly and sustainable approaches to infrastructure construction. Conversely, the bottom means are ‘I have a great understanding of using energy-efficient design in civil engineering’ (M = 2.9692, SD =0.6799), ‘I have a good understanding of the principles of sustainable practices in civil engineering’ (M = 2.9500, SD = 0.6286), and ‘I am extensively familiar with the Sustainable Development Goals (SDGs)’ (M = 2.9154, SD = 0.7912). These findings indicate areas where respondents could benefit from more education to improve their knowledge and application of sustainability principles in the field. Overall, the results offer useful information about the respondent's current state of sustainability knowledge in the field of civil engineering. As stated by Salzman, N. et al.[53], Even though sustainability is acknowledged as an essential topic in civil engineering, a sample of senior civil engineering students demonstrated considerable differences in their understanding of sustainability and the importance of sustainable concepts and practices. Furthermore, he stated that students typically identify sustainability with environmentalism or a commitment to conserve the environment for the future through long-term strategies.A thorough understanding of sustainability as a balance of economic, environmental, and social components was lacking among the students, even if several acknowledged the economic trade-offs of sustainable civil engineering.

TABLE VII. Descriptive Statistics on the Application of Sustainability Concepts in Academic Perspective

Academic Perspective		Mean	SD	Interpretation
9.1	Sustainability concepts and practices have been effectively incorporated into my civil engineering courses.	3.1692	0.5646	Agree
9.2	I think there is a notable emphasis on sustainability in the curriculum of the civil engineering program.	3.0769	0.5711	Agree
9.3	My courses effectively teach me to consider environmental factors in civil engineering projects.	3.2692	0.5734	Strongly Agree
9.4	My courses effectively prepare me to understand the social implications of civil engineering projects.	3.2346	0.6110	Agree
9.5	My courses thoroughly prepared me to consider the economic aspects of civil engineering projects.	3.2115	0.6004	Agree
9.6	My civil engineering courses actively encourage me to think critically about the environmental impact of projects.	3.3308	0.6010	Strongly Agree
9.7	Incorporating sustainability practices into my future engineering career is important.	3.4077	0.5789	Strongly Agree
Grand Mean		**3.2429**		Agree

The table shows the descriptive statistics of the respondents' academic perspectives on sustainability. The top three highest means are 'Incorporating sustainability practices into my future engineering career is important' (M = 3.4077, SD = 0.5789), 'My civil engineering courses actively encourage me to think critically about the environmental impact of projects' (M = 3.3308, SD = 0.6010), and 'My courses effectively teach me to consider environmental factors in civil engineering projects' (M = 3.2692, SD = 0.5734). These results emphasize the importance of sustainability education and its relevance to the civil engineering profession. On the other hand, the bottom means are 'My courses thoroughly prepared me to consider the economic aspects of civil engineering projects' (M = 3.2115, SD = 0.6004), 'Sustainability concepts and practices have been effectively incorporated into my civil engineering courses' (M = 3.1692, SD = 0.5646), and 'I think there is a notable emphasis on sustainability in the curriculum of the civil engineering program' (M = 3.0769, SD = 0.5711). This shows that there is not enough emphasis on sustainability in the curriculum, limiting the depth of understanding in the areas of economic and social aspects. Salzman, N. et al. [53], knowledge of sustainability was attributed to individual experiences, such as internships or roles on senior design projects, rather than a consistent encounter with the undergraduate civil engineering curriculum.

TABLE VIII. Pearson Correlation of Critical Thinking Skill

Correlation	*Problem-Solving*	*Communication*	*Collaboration*	*Adaptability*	*Resilience*	*Sustainability Knowledge*
Critical Thinking	0.525	0.484	0.396	0.438	0.437	0.419

TABLE IX. Pearson Correlation of Problem-Solving Skill

Correlation	*Critical Thinking*	*Communication*	*Collaboration*	*Adaptability*	*Resilience*	*Sustainability Knowledge*
Problem-Solving	0.525	0.478	0.390	0.530	0.500	0.394

TABLE X. Pearson Correlation of Communication Skill

Correlation	*Critical thinking*	*Problem-Solving*	*Collaboration*	*Adaptability*	*Resilience*	*Sustainability Knowledge*
Communication	0.484	0.478	0.634	0.548	0.509	0.329

TABLE XI. Pearson Correlation of Collaboration Skill

Correlation	*Critical Thinking*	*Problem-Solving*	*Communication*	*Adaptability*	*Resilience*	*Sustainability Knowledge*
Collaboration	0.396	0.390	0.634	0.456	0.474	0.246

TABLE XII. Pearson Correlation of Adaptability

Correlation	*Critical Thinking*	*Problem-Solving*	*Communication*	*Collaboration*	*Resilience*	*Sustainability Knowledge*
Adaptability	0.438	0.530	0.548	0.456	0.669	0.370

TABLE XIII. Pearson Correlation of Resilience

Correlation	*Critical Thinking*	*Problem-Solving*	*Communication*	*Collaboration*	*Adaptability*	*Sustainability Knowledge*
Resilience	0.437	0.500	0.509	0.474	0.669	0.324

TABLE XIV. Pearson Correlation of Sustainability Knowledge

Correlation	*Critical Thinking*	*Problem-Solving*	*Communication*	*Collaboration*	*Adaptability*	*Resilience*
Sustainability Knowledge	0.419	0.394	0.329	0.246	0.370	0.324

The tables above show that critical thinking has a moderate correlation with problem-solving, communication, adaptability, resilience, and sustainability knowledge (ranging from 0.419 to 0.525), however, it exhibits a lower correlation with collaboration (r of 0.396). Problem-solving demonstrates a moderate correlation with critical thinking, communication, adaptability, and resilience ranging from r=0.478 to r=5.300. Yet, it has lower correlations (r=0.390 and r=0.394) with collaboration and sustainability knowledge, respectively. Communication skills have a high correlation with collaboration with an (r = 0.634), a moderate correlation with the remaining TACs (ranges from 0.478 to 0.548), and a low correlation with sustainability knowledge (r =0.329). Furthermore, collaboration has a high correlation with communication, whereas there is a moderate correlation with adaptability and resilience (r = 0.456 and 0.474), and a low correlation with critical thinking, problem-solving, and sustainability knowledge (ranging from 0.246 to 0.396). Adaptability and resilience have a high correlation with each other (r = 0.669), with a moderate correlation with the other TACs (ranging from 0.438 to 0.548), and a low correlation with sustainability knowledge indicating that individuals who are adaptive and resilient tend to show a high level of critical thinking, problem-solving, communication, and collaboration skill but not necessarily in sustainability knowledge. The results of these findings are in line with previous studies which also managed to find a positive correlation between critical thinking and problem solving. Critical thinking makes students actively search for solutions to problems during problem-solving, making it a crucial component of problem-solving comprehension[54]. In addition, the correlation analysis results supported prior research that found a link between these variables. Firstly, communication has a strong correlation with collaboration as an outcome. All Pearson's r values were discovered to be around 0.5, which is considered a large-size effect [55].

C. Analysis of the Civil Engineering Curriculum

The researchers used the Ched Memorandum Order of 2017 as the basis for the analysis of transformation-advancing competencies in the different courses through the program outcomes. The alignment of the transformation-advancing competencies was reviewed by an expert in curriculum who is a qualified civil engineer with a master's degree in education.

Program Outcomes:

a) Apply knowledge of mathematics and science to solve complex civil engineering programs;
b) Design and conduct experiments, as well as to analyze and interpret data;
c) Design a system, component, or process to meet desired needs within constraints, in accordance with standards;
d) Function in multidisciplinary and multi-cultural teams;
e) Identify, formulate, and solve complex civil engineering problems
f) Understand professional and ethical responsibility;
g) Communicate effectively civil engineering activities with the engineering community and with society at large
h) Understand the impact of civil engineering solutions in a global, economic, environmental, and societal context
i) Recognize the need for, and engage in life-long learning
j) Know contemporary issues;
k) Use techniques, skills, and modern engineering tools necessary for civil engineering practice;
l) Know and understand engineering and management principles as a member and leader of a team in a multidisciplinary environment;
m) Understand at least one specialized field of civil engineering practice

TABLE XV.Alignment of TACs to Program Outcome

Program Outcomes	**Transformation-Advancing Competencies**
a.) Apply knowledge of mathematics and science to solve complex civil engineering programs	critical thinking and problem-solving
b.) Design and conduct experiments, as well as to analyze and interpret data	critical thinking and problem-solving
c.) Design a system, component, or process to meet desired needs within constraints, in accordance with standards	adaptability and resilience
d.) Function in multidisciplinary and multi-cultural teams	collaboration
e.) Identify, formulate, and solve complex civil engineering problems	critical thinking and problem-solving
f.) Understand professional and ethical responsibility	adaptability
g.) Communicate effectively civil engineering activities with the engineering community and with society at large	Communication
h.) Understand the impact of civil engineering solutions in a global, economic, environmental, and societal context	critical thinking and adaptability
i.) Recognize the need for, and engage in life-long learning	adaptability and resilience
j.) Know contemporary issues	Adaptability
k.) Use techniques, skills, and modern engineering tools necessary for civil engineering practice	critical thinking
l.) Know and understand engineering and management principles as a member and leader of a team in a multidisciplinary environment	critical thinking, communication, and collaboration
m.) Understand at least one specialized field of civil engineering practice	critical thinking and adaptability

The civil engineering curriculum includes thirteen program outcomes. As a result, each of these program outcomes demonstrates transformation-advancing competencies. Program outcomes a, b, and e demonstrate critical thinking and problem-solving skills, as shown in Table 5. Program outcome d focuses on collaboration skills. On the other hand, program outcomes c and i emphasized resilience and adaptability, while program outcomes f and j emphasized exclusively adaptability skills. Additionally, program outcomes h and m demonstrate both critical thinking and adaptability, whereas program outcome k solely demonstrated critical thinking skills. Moreover, the program outcome g focuses entirely on the development of communication skills. Furthermore, program outcomes l promote TACs including collaboration, communication, and critical thinking.

TABLE XVI. *Sample Curriculum Map*

Code	Description
I	Introductory Course
E	Enabling Course
D	Demonstrating Course
Code	**Definition**
I	An introductory course to an outcome
E	A course that strengthens the outcome
D	A course demonstrating an outcome

C.1 TECHNICAL COURSES

A. Mathematics

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Calculus 1	I												
Calculus 2	I												
Differential Equations	I										I		
Engineering Data Analysis	I	I									I		
Numerical Solutions to CE Problems	E				D		E		E		E		

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Calculus 1	✓	✓				
Calculus 2	✓	✓				
Differenti al	✓	✓				

Equations						
Engineering Data Analysis	✓	✓				
Numerical Solutions to CE Problems	✓	✓	✓		✓	✓

TABLE XVII. Alignment of TACs with Courses based on the program outcomes in Mathematics

TACs such as critical thinking and problem-solving abilities are promoted by technical mathematics courses including Calculus 1, Calculus 2, Differential Equations, Engineering Data Analysis, and Numerical Solutions to CE Problems. In addition, only Numerical Solutions to CE Problems foster TACs like communication, adaptability, and resilience.

B. Natural and Physical Sciences

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Chemistry for Engineers	I	I									I		
Physics for Engineers (Calculus-Based)	I	I									I		
Geology for Civil Engineers					E	E		D	E	E	I		

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Chemistry for Engineers	✓	✓				
Physics for Engineers (Calculus-Based)	✓	✓				
Geology for Civil Engineers	✓	✓			✓	✓

TABLE XVIII. Alignment of TACs with Courses based on the program outcomes in Natural and Physical Sciences

Technical courses in the Natural and Physical Sciences, such as Chemistry for Engineers, Physics for Engineers (Calculus-Based), and Geology for Civil Engineers, help students develop TACs such as critical thinking and problem-solving skills. On the other hand, Geology for Civil Engineers also promotes the TAC's adaptability and resilience.

C. Basic Engineering Sciences

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Civil Engineering Orientation						I		I		I			
Engineering Drawing and Plans				E		I	I				E		
Computer Fundamentals and Programming	I										E		
Computer-Aided Drafting	I										E		
Statics of Rigid Bodies	I										D		
Dynamics of Rigid Bodies	I												
Mechanics of Deformable Bodies	E				D								
Engineering Economics	E										E		
Engineering Management							E		E			E	
Technopreneurship 101													

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Civil Engineering Orientation	✓				✓	
Engineering Drawing and Plans	✓			✓	✓	
Computer Fundamentals and Programming	✓	✓				
Computer-Aided Drafting	✓	✓				
Statics of Rigid Bodies	✓	✓				
Dynamics of Rigid Bodies	✓	✓				
Mechanics of Deformable Bodies	✓	✓				
Engineering Economics	✓	✓				
Engineering Management	✓		✓	✓	✓	✓
Technopreneur-ship 101						

TABLE XIX. Alignment of TACs with Courses based on the program outcomes in Basic Engineering Sciences

TACs like critical thinking abilities are promoted in all technical courses related to Basic Engineering Sciences except Technopreneurship.As the table above shows, courses such as Engineering Economics, Computer-Aided Drafting, Mechanics of Deformable Bodies, Computer Fundamentals and Programming, and Statics of Rigid Bodies help students develop problem-solving skills. On the other hand, Engineering management is the only course that promotes communication, whereas Engineering Drawing and Plans and Engineering Management foster collaboration skills. Moreover, programs including Engineering Management, Engineering Drawing and Plans, and Civil Engineering Orientation support the development of adaptability skills. And finally, the only course that promotes resilience is engineering management.

D. Allied Course

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Engineering Utilities 1			E	E		E	E		E				
Engineering Utilities 2			E	E		E	E		E				

TABLE XX. Alignment of TACs with Courses based on the program outcomes in the Allied Course

The table above shows that technical courses associated with Allied courses, such as Engineering Utilities 1 and 2, uphold the TACs collaboration, communication, adaptability, and resilience.

E. Professional Course-Common

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Fundamentals of Surveying		D		E	I		E				E		
Construction Materials and Testing	E	D		E			E			E	E		
Structural Theory	E	I			E						I		
Highway and Railroad Engineering	E		E		E		E						
Building Systems Design			E	E	E	I	I	I		I	E		
Principles of Steel Design	E	I									E		
Principles of reinforced/Prestressed Concrete	E	I									E		
Hydraulics	E	D		E	E		E						
Hydrology	E				E		E				E		
CE Law, Ethics and Contracts						D	E						
Geotechnical Engineering 1 (Soil Mechanics)	E	D		E	E		E			E	E		
Principles of Transportation Engineering	E		D			D							
Quantity Surveying	E			E		E	E		E		E	E	
Construction Methods and Project Management	E		D		E	E	D				D	E	
CE Project 1	E	D	D	D	D	D	D	D			D	D	
Ce Project 2	E	D	D	D	D	D	D	D			D	D	

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Fundamentals of Surveying	✓	✓	✓	✓		
Construction Materials and Testing	✓	✓	✓	✓	✓	
Structural Theory	✓	✓				
Highway and Railroad Engineering	✓	✓	✓		✓	✓
Building Systems Design	✓	✓	✓	✓	✓	✓
Principles of Steel Design	✓	✓				
Principles of reinforced/Prestressed Concrete	✓	✓				
Hydraulics	✓	✓	✓	✓	✓	
Hydrology	✓	✓	✓			
CE Law, Ethics and Contracts			✓		✓	
Geotechnical Engineering 1 (Soil Mechanics)	✓	✓	✓	✓	✓	
Principles of Transportation Engineering	✓	✓			✓	✓
Quantity Surveying	✓	✓	✓	✓	✓	✓
Construction Methods and	✓	✓	✓	✓	✓	✓

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Engineering Utilities 1			✓	✓	✓	✓
Engineering Utilities 2			✓	✓	✓	✓
Project Management						
CE Project 1	✓	✓	✓	✓	✓	✓
CE Project 2	✓	✓	✓	✓	✓	✓

TABLE XXI. Alignment of TACs with Courses based on the program outcomes in Professional Course-Common

Aside from CE Law, Ethics, and Contracts, all courses connected to Professional Course-Common foster critical thinking and problem-solving abilities. All courses also promote Communication skills except Structural Theory, Principle of Steel Design, Principle of Reinforced/Prestressed Concrete, and Principles of Transportation Engineering. Courses like Structural Theory, Highway and Railroad Engineering, Principle of Reinforced/Prestressed Concrete, Principle of Steel Design, Hydrology, CE Laws, Ethics and Contracts, and Principles of Transportation Engineering do not gauge collaboration skills. Furthermore, all courses exhibit adaptability except for Fundamentals of Surveying, Structural Theory, Principle of Steel Design, Principle of Reinforced/Prestressed Concrete, and Hydrology. Finally, Highway and Railroad Engineering, Building Systems Design, Principles of Transportation Engineering, Quantity Surveying, Construction Methods and Project Management, and CE Projects 1 and 2 are the courses that promote TAC resilience.

F. Professional Courses – Specialized (HEI to select five courses per track)

F.1 Construction Engineering and Management

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Project Construction and Management							E		E	E	E	E	E
Advanced Construction Methods & Equipment							E		E	E	E	E	E
Construction Cost Engineering							E		E	E	E	E	E
Database Management in Engineering							E			E	E	E	E
Construction Occupational Safety and Health (COSH)							E		E	E		E	E

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Project Construction and Management	✓		✓	✓	✓	✓
Advanced Construction Methods & Equipment	✓		✓	✓	✓	✓
Construction Cost Engineering	✓		✓	✓	✓	✓

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Computer Software in Structural Analysis	✓				✓	
Earthquake Engineering	✓	✓	✓		✓	✓
Design of Steel Structures	✓	✓	✓		✓	✓
Reinforced Concrete Design	✓	✓	✓		✓	✓
Prestressed Concrete Design	✓	✓	✓		✓	✓
Structural Design of Towers/Other Vert. Structures	✓	✓	✓		✓	✓
Bridge Engineering	✓	✓	✓		✓	✓
Foundation and Retaining Wall Design	✓	✓	✓		✓	✓
Database Management in Engineering	✓		✓	✓	✓	
Construction Occupational Safety and Health (COSH)	✓		✓	✓	✓	✓

TABLE XXII. Alignment of TACs with Courses based on the program outcomes in Professional Course-Specialized under Construction Engineering and Management

All courses in the Professional Courses-Specialized category for Construction Engineering and Management foster the TACs of critical thinking, communication, collaboration, adaptability, and resilience. Problem-solving skills are not being exhibited in this category.

F.2 Geotechnical Engineering

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Geotechnical Engg 2 (Rock Mechanics)	E		E		E		E	E			E		D
Foundation Engineering	E		D		E		E	E			D		D
Geotechnical Earthquake Engineering	E		D		E		E	E			D		D
Ground Improvement	E		D		E		E	E			D		D

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Geotechnical Engg 2 (Rock Mechanics)	✓	✓	✓		✓	✓
Foundation Engineering	✓	✓	✓		✓	✓
Geotechnical Earthquake Engineering	✓	✓	✓		✓	✓
Ground Improvement	✓	✓	✓		✓	✓

TABLE XXIII. Alignment of TACs with Courses based on the program outcomes in Professional Course-Specialized under Geotechnical Engineering

Except for collaboration skills, all courses in Geotechnical Engineering, which is also included in the Professional Courses-Specialized category, promote all TACs.

F.3 Structural Engineering

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Computer Software in Structural Analysis											D		D
Earthquake Engineering	E		E				E				E		D
Design of Steel Structures	E		E		E		E				E		D
Reinforced Concrete Design	E		E		E		E				E		D
Prestressed Concrete Design	E		E		E		E				E		D
Structural Design of Towers/Other Vert. Structures	E		E		E		E				E		D
Bridge Engineering	E		E		E		E				E		D
Foundation and Retaining Wall Design	E		E		E		E				E		D

TABLE XXIV. Alignment of TACs with Courses based on the program outcomes in Professional Course-Specialized under Structural Engineering

Apart from Computer Software in Structural Analysis, all courses in Structural Engineering which are included in the Professional Courses-Specialized category, promote critical thinking, problem-solving, communication, adaptability, and resilience. On the other hand, Computer Software in Structural Analysis only promotes critical thinking and adaptability skills. Additionally, all courses do not foster collaboration.

F.4 Transportation Engineering

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Transportation Systems and Planning and Design	E		E		E		E			E	E		D
Highway Engineering	E		E		E		E		E	E	E		D
Airport Design	E		E		E		E	I	E	E			D
Ports and Harbors	E		E		E		E	I	E	E			D

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Transportation Systems and Planning and Design	✓	✓	✓		✓	✓
Highway Engineering	✓	✓	✓		✓	✓
Airport Design	✓	✓	✓		✓	✓
Ports and Harbors	✓	✓	✓		✓	

TABLE XXV. Alignment of TACs with Courses based on the program outcomes in Professional Course-Specialized under Transportation Engineering.

All courses in Transportation Engineering which is also included in the Professional Courses-Specialized category, promote critical thinking, problem-solving, communication, adaptability, and resilience. However, collaboration is not being fostered in all courses.

F.5 Water Resources Engineering

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Water Resources Engineering	D		D						E		E		D
Flood Control and Drainage Design	D				E						D		D
Irrigation Engineering	E				E		E				E		
Water Supply and Planning and Development	D				E		E			E	D		D
Coastal Engineering	E		D		E		E						
River Engineering	E				E		E				E		D
Ground Water Modeling	E				E		E				D		D

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Water Resources Engineering	✓	✓			✓	✓
Flood Control and Drainage Design	✓	✓	✓		✓	
Irrigation Engineering	✓	✓	✓			
Water Supply and Planning and Development	✓	✓	✓		✓	
Coastal Engineering	✓	✓	✓		✓	✓

TABLE XXVI. Alignment of TACs with Courses based on the program outcomes in Professional Course-Specialized under Water Resources Engineering

All Water Resources Engineering courses, which are also included in the Professional Courses-Specialized category, promote critical thinking and problem-solving skills. Also, all courses under it promote communication except for Water Resources Engineering. There is no single course that encourages collaboration. In addition, adaptability is present in all courses except Irrigation Engineering. Furthermore, Water Resources Engineering and Coastal Engineering are those courses that exhibit resilience.

G. On-the-Job Training

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
On-the-Job-Training (minimum of 240 hours)				D		D	D	E	E	E	E	E	D

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
On-the-Job-Training (minimum of 240 hours)	✓	✓	✓	✓	✓	✓

TABLE XXVII. *Alignment of TACs with Courses based on the program outcomes in OJT*

The table shows that all TACs, including critical thinking, problem-solving, collaboration, adaptability, and resilience, are promoted by the technical course associated with on-the-job training.

C.2 NON-TECHNICAL COURSES

A. General Education Courses

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Science, Technology, and Society				I			I	I	I				
Readings in Philippine History						I				I			
Mathematics in the Modern World	I				I								
Contemporary World								I	I	I			
Understanding the Self						I			I			I	
Purposive Communication							D						
Art Appreciation			I	I									
Ethics						I						I	

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Science, Technology, and Society	✓		✓	✓	✓	✓
Readings in Philippine History					✓	
Mathematics in the Modern World	✓	✓				
Contemporary World	✓				✓	✓
Understanding the Self	✓		✓	✓	✓	✓
Purposive Communication			✓			
Art Appreciation				✓	✓	✓
Ethics	✓		✓	✓	✓	

TABLE XXVIII. Alignment of TACs with Courses based on the program outcomes in General Education Courses

For Non-Technical Courses related to General Education Courses, courses that exhibit Critical thinking skills are Science, Technology and Society, Mathematics in the Modern World, Contemporary World, Understanding the Self, and Ethics. Also, the only course that promotes Problem-solving skills is Mathematics in the Modern World. However, courses such as Readings in Philippine History, Mathematics in the Modern World, Contemporary World, and Art Appreciation did not promote communication skills. Collaboration skills were exhibited in courses like Science Technology and Society, Understanding the Self, Art Appreciation, and Ethics. Moreover, adaptability is present in all courses except Mathematics in the Modern World and Purposive Communication. Lastly, Resilience is present only in Science, Technology and Society, Contemporary World, Understanding the Self, and Art Appreciation.

B. GEC Elective

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
GEC (3) Electives				I				I		I			

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
GEC (3) Electives	✓			✓	✓	

TABLE XXIX. Alignment of TACs with Courses based on the program outcomes in GEC Elective

For the GEC Elective Course, the TACs it promotes include critical thinking, collaboration, and adaptability.

C. Mandated Course

Courses	Relationship to Program Outcomes												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Life and Works of Rizal				I		I			I				

Courses	Transformation-Advancing Competencies (TACs)					
	Critical Thinking	Problem-Solving	Communication	Collaboration	Adaptability	Resilience
Life and Works of Rizal				✓	✓	✓

TABLE XXX. Alignment of TACs with Courses based on the program outcomes in Mandated Course

For Non-Technical Courses related to Mandated Course, the TACs it exhibits include collaboration, adaptability, and resilience.

IV. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

A. SUMMARY OF FINDINGS

1. What is the current state of transformation advancing competencies among civil engineering students at Don Honorio Ventura State University?

1.1 Critical thinking and Problem-solving skills

The survey results show that participants had a generally good attitude toward critical thinking and problem-solving skills having a grand mean of 2.9969. The strong agreement is noted in areas such as the ability to judge new information based on evidence and their open-mindedness towards different viewpoints.While engagement in thinking about complex issues and the ability to focus and think effectively under pressure are acknowledged, there is a slightly lower level of agreement compared to other aspects. Nonetheless, participants generally agree that they have good analytical reasoning, problem-solving skills, and knowledge of key problems in their area.

1.2 Communication and collaboration skills

Communication and Collaboration skills indicate a positive outlook based on the results. The grand mean of 3.2235 implies that respondents generally agree with the combined statements, reflecting a positive perception of communication and collaboration. Participants can effectively express ideas for group decision-making and demonstrate curiosity through questions. They show a strong inclination to provide and receive constructive criticism, as well as actively listen to different points of view. Furthermore, participants demonstrate a willingness to engage within a group by actively contributing and being open to suggestions for improving team success.

1.3 Adaptability and Resilience

Adaptability and resilience obtained a grand mean of 3.1696 implying agreement with the statements. Participants show a readiness to adapt to changes, view difficult situations as challenges, and use their influence whenever possible instead of being helpless. They also have a tendency to maintain perspective, seek answers in difficult situations, and use past success to build confidence. Also, participants indicate an important need to improve their work performance by reflecting on their strengths and weaknesses. Overall, the findings suggest a solid basis in adaptability and resilience with measures to efficiently manage adversities.

2. To what extent does the existing civil engineering curriculum foster Transformation and Advancement of Competencies?

The civil engineering curriculum promotes a diverse set of transformation-advancing competencies (TACs) throughout thirteen program outcomes. Each technical and non-technical course under the Civil Engineering curriculum contributes significantly in promoting different TACs however it is also evident that not all the courses adhere to all the TACs consistently. These discrepancies can impact students' ability to meet the expected standards for the said profession. Moreover, it shows that critical thinking and problem-solving skills are the predominant TACs in the civil engineering curriculum. The curriculum excels in gauging critical thinking and problem-solving skills both of which are necessary for civil engineering practice while there is a potential to improve the integration of communication, collaboration, adaptability, and resilience across the curriculum, particularly in non-technical courses. In order for the civil engineering curriculum to effectively prepare students for their future profession, it is crucial that all technical and non-technical courses consistently align with the TACs. Addressing the inconsistencies in TAC implementation and ensuring alignment across technical courses is essential for maintaining the quality and effectiveness of the Civil Engineering curriculum in preparing students for their future careers.

3. How do civil engineering students perceive sustainability concepts and practices, as well as incorporating them into their academic perspective?

The grand mean of 3.0188 indicates that, on average, the students agree that they have knowledge of sustainability concepts within civil engineering. The majority of students agree that they possess knowledge of various aspects of sustainability in civil engineering. Across the various aspects of sustainability knowledge surveyed, students generally agree with their level of understanding. The majority of mean scores fall within the range of 2.9 to 3.1, indicating a moderate to good level of knowledge of the different topics. However, it also shows that their familiarity with specific topics varies. Overall, respondents consider themselves as having a solid understanding of sustainable practices within their field of study.

The results of the academic perspective survey show that students have a generally good attitude toward the incorporation of concepts of sustainability in the civil engineering program. While students recognize the value of including environmental aspects in their courses, there appears to be a significantly lower emphasis on the social and economic aspects of sustainability. Furthermore, students' strong agreement on the significance of incorporating sustainable practices into their future careers emphasizes the importance of sustainability education in educating future civil engineers to address society's complex challenges.

B. CONCLUSION

The findings show that there is a good foundation for critical thinking and problem-solving skills, as well as room for growth in some areas including dealing with theoretical concepts and keeping calm under pressure. In summary, these results indicate how crucial it is to continuously improve one's critical thinking and problem-solving skills to successfully navigate the complexities through the intricate nature of modern society. Additionally, students possess excellent communication and collaboration abilities which are the highest mean scores among the TACs illustrating the importance of developing effectiveness in other tasks by working together properly. Also, students promote positive adaptability and resilience capacities which are important qualities in managing unforeseen events in addition to overcoming overcoming efficiently.

The analysis of Transformation-Advancing Competencies in the technical and non-technical civil engineering courses is not consistent. The curriculum on both the technical and non-technical courses gives strengths in developing critical thinking as well as problem-solving skills; however, there are room for improvement particularly in other transformation-advancing competencies. Therefore, this means that all TACs that are transformation-advancing should be emphasized equally when it comes to balancing the curriculum. Thus, for complete integration of these transformation-advancing competencies to take place in both technical and non–technical courses, the institution must evaluate its curriculum and make necessary adjustments. As a result of such an inclusive approach, the students will be better prepared to overcome various challenges that they may encounter in their professional careers.

Moreover, students' general knowledge of sustainability concepts and practices still needs to be developed as the social and economic aspects of sustainability are still lacking. The findings show that sustainable education is crucial in preparing engineers of the future for difficult tasks and making them able to integrate sustainable practices into their future careers. Furthermore, it emphasizes the need for a development in curriculum so as to enable aspiring civil engineers to have a substantial understanding of sustainable principles and practices. This can result in infrastructure that is economically viable, socially responsible, and environmentally friendly. In addition, it creates a culture of sustainability within the engineering profession whereby; engineers are consistently looking for ways to reduce environmental impacts from their work towards achieving sustainable development goals.

The findings of this study have great implications for civil engineering education and practice. The results show how the current curriculum at Don Honorio Ventura State University enhances transformation-advancing skills (TACs), which are essential for students in pursuit of civil engineering. This indicates a strong link that exists between TACs and sustainability knowledge since students can apply their critical thinking and problem-solving abilities to develop sustainable solutions for sustainable issues. Effective communication and collaboration play a crucial role when working as teams in addressing sustainability challenges. Students who possess resilience and adaptability are able to perceive the way technology, societal expectations, and environmental preservation are changing over time together with other factors.Particularly, the research emphasizes on extensive education which goes beyond just teaching technical knowledge to also include skills development as well as commitment towards sustainable practices. Such an approach would significantly improve the quality and impact of civil engineering practice, resulting in more skilled professionals capable of effectively addressing the present challenges.

In line with this, there is a significant relationship between the transformation advancing competencies, knowledge of sustainability concepts and practices, and the effectiveness of the existing curriculum. Thus, students' transformation-advancing competencies level affects their understanding of sustainability concepts and practices, whereas the curriculum helps in the development of their skills and knowledge.

C. IMPLICATIONS OF THE STUDY

1. One of the study's limitations was the questionnaire's length, it is time-consuming and some of the

participants expressed a lack of interest, which led to incomplete responses.
2. The data collected from the self-assessment survey may be subject to self-reporting bias, in which participants provide responses that they think are socially acceptable rather than their true opinions.
3. There is a lack of consideration for instructors' opinions. The study overlooks important insights that teachers could give regarding the curriculum, teaching practices, and students' competencies by focusing primarily on students' perceptions.
4. Since the study is purely quantitative data, the desired conclusion was not reached. This limitation results from the lack of qualitative data, which could have provided further insight into the research.

D. RECOMMENDATIONS

Based on the conclusion, the following recommendations are made:

1. The researchers recommend improving the integration of sustainability concepts and practices across the civil engineering curriculum particularly addressing social and economic dimensions. This can be done through modifying existing courses or introducing new modules directed towards education for sustainable development.
2. Develop specific measures within the curriculum that improve civil engineering students' transformation-advancing competencies (TACs), which might help them develop and ensure that they are prepared for the needs and challenges of the civil engineering profession.
3. Researchers recommend establishing a systematic approach for evaluating and enhancing the curriculum in order to ensure its effectiveness and identify areas for development. This includes the consistent application of Transformation Advancing Competencies (TACs) across technical and non-technical courses.
4. It is recommended to employ statistical tools such as independent T-testing with both students and teachers as respondents.
5. Future researchers are recommended to assess the industry perspective on the preparedness of civil engineering students in terms of sustainability knowledge and conduct a qualitative assessment to broaden the scope of the study and provide a better understanding of the research.

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