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Implementation of sustainable development goals in higher education modalities: Literature review

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ABSTRACT
A systematic mapping review of the implementation of the Sustainable Development Goals (SDGs) in higher education has been carried out. Forty-six articles published from 2018 to 2022 were identified using the Systematic Literature Review. The purpose of this literature review was to derive a research framework that effectively raise awareness of SDGs from the realm of higher education and show SDGs research opportunities that have not been widely implemented. Research findings in the implementation of SDGs innovation in higher education have a trend in the categories of learning, stakeholders (institutions), teaching and approach. Based on the five modalities of higher education, the category is spread over the aspects of education (79%) and knowledge production (10%). The other three aspects such as public debate, provision of public services and embodiment only have quantities below 5%. Innovations include the development of SDGs-based courses by integrating aspects of knowledge production and provision of public services into one learning goal through the Project-based Learning Model. Mapping of the implementation of the SDGs in higher education provides information that supports researchers, educators and policy-making institutions interested in educational innovation. The results of the analysis show that the integration of these aspects can not only increase the understanding of higher education graduates regarding the SDGs but also increase public awareness regarding the SDGs through the provision of public services by universities.

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Introduction

The rapid advancement of information, communication technology and the increasingly complex future challenges mark a new era referred to by some as the era of the industrial revolution 4.0 (Lim, 2019). In this era, information technology has become a companion to human life. This has real consequences and impacts on various areas of life. In the field of education, government must educate the nation's successors based on the need to meet future needs through the use of technology. Higher education in particular has a role in producing human resources who are innovative and have

superior competencies both in soft skills and hard skills (21st-century skills) to be able to face various challenges, ranging from of poverty, gender equality, climate change, inequality and financial inequality (Oral & Erkilic, 2022), in line with the sustainable development programme of the United Nation (UN) for the 2030 agenda which aims to end poverty and inequality along with improving health, education and spurring economic growth.

Sustainable development is development that meets the needs of the industrial revolution era 4.0 without compromising the ability of future generations to meet their own needs (UN Secretary General, 2019). Sustainable Development Goals (SDGs) are global development targets that aim to sustainably increase the economic welfare of the community, maintain the sustainability of people's social life, preserve environmental quality, and ensure justice and the implementation of good governance. They are designed to maintain an improvement in the quality of life from one generation to the next. The SDGs are a refinement of the more comprehensive Millennium Development Goals (MDGs) by involving more countries, both developed and developing, expanding funding sources, and emphasising human rights through the involvement of community organisations and the media, philanthropy and business actors, as well as academics and experts.

In September 2015, UN declared 17 Sustainable Development Goals (SDGs) with 169 targets referring to the 2030 Agenda. These goals include: (1) No Poverty; (2) No Hunger; (3) Healthy and Prosperous Life; (4) Quality Education; (5) Gender Equality; (6) Clean Water and Proper Sanitation; (7) Clean and Affordable Energy; (8) Decent Work and Economic Growth; (9) Industry, Innovation and Infrastructure; (10) Reducing Gaps; (11) Sustainable Cities and Settlements; (12) Responsible Consumption and Production; (13) Climate Change Management; (14) Ocean Ecosystems; (15) Land Ecosystems; (16) Peace, Justice and Strong Institutions; and (17) Partnerships to Achieve Goals (UN General Assembly, 2015).

Efforts to achieve the SDGs' targets become a global development priority, which requires a synergy of planning policies at the national level and at the provincial and district/city levels. SDG targets in Indonesia are in line with the 2015-2019 National Medium-Term Development Plan (RPJMN) and 2020-2024 RPJMN in the form of programmes, activities and measurable indicators as well as indications of financial support (BAPPENAS, 2020).

In 2019, the results of United Nations investigation showed that public awareness of the SDGs and the 2030 Agenda was low (UN Secretary General, 2019). Based on the results of the 2019 Sustainable Development Goals Summit, it was held that the government could not carry out the sustainable development programme alone to achieve the 2030 Agenda, thus requiring various groups including civil society, the scientific community, and others to work together to reach sustainable development for the success of the 2030 Agenda (UN Secretary General, 2019). Public awareness of SDGs is a prerequisite for formulating policy preferences and putting pressure on policy makers (Otto et al., 2019). The public sector is expected to improve its performance based on the targets of the SDGs (Figueira et al., 2018).

Meeting the 2030 Agenda targets, in addition to investing in advanced technology as needed in the industrial revolution 4.0 era, the creation and dissemination of knowledge on sustainable development is seen as important through higher education and research institutions in various fields and disciplines (Tchamyou, 2020). Based on this, it is important to know what roles higher education can play in the feasibility and implementation of SDGs that can carry out as drivers of SDGs in the field of education. This is done to effectively raise awareness of the SDGs and equalize SDG feasibility and SDG implementation in all aspects of higher education partnerships. The contribution of higher education institution partnerships to the SDGs is also referred to as higher education modalities (McCowan, 2019). The partnership field consists of five areas or aspects, namely education, knowledge production, public debate, public service provision, and embodiment.

There have been numerous studies related to sustainable development goals. A search using the Scopus database with the keywords "sustainable AND development AND goals" in the past five years (2018-2022) yielded 36,954 documents. Meanwhile, a search using the keywords "sustainable AND development AND goals AND higher AND education" in the Scopus database in the past five

years resulted in 1,423 documents. Further exploration using the keywords "integration AND sustainable AND development AND goals AND higher AND education" in the Scopus database in the past five years produced 278 documents. The keyword search "modalities AND higher AND education AND sustainable AND development AND goals" in the Scopus database in the past five years yielded only 4 documents. Many studies have been conducted using these four combinations of keywords. However, a study that combines all four keywords has not been conducted yet. The search using the keywords "implementation AND sustainable AND development AND goals AND higher AND education AND modalities" in the Scopus database in the past five years resulted in only 1 document. The title of that document is "Challenge based learning: Innovative Pedagogy for Sustainability Through E-learning in Higher Education" (Castro et al., 2020). However, this study does not directly demonstrate the implementation of SDGs in the aspects of higher education modalities.

Therefore, we intend to identify previous research related to the trend or dominance of SDGs research themes and the forms of implementation that have been carried out by universities based on aspects of higher education modalities. The aim is to provide an overview of research frameworks that effectively raise awareness of SDGs from the realm of higher education and show SDGs research opportunities that have not been widely implemented. This is done to provide information that supports researchers, educators, and policy-making institutions interested in educational innovation. To conduct this research, we posed the following research questions: 1) which areas of higher education did the sustainable development goals study focus on? 2) how is the distribution of Sustainable Development Goals studies in higher education based on Higher Education Modalities; and 3) how is the implementation of Sustainable Development Goals in higher education?

Methods

A Systematic Literature Review method is used in this article to identify, evaluate and interpret the availability of research relevant to the research question (Calderón & Ruiz, 2015; Kitchenham et al., 2009). The purpose of this study is to provide an overview of an effective research framework to raise awareness of SDG from the realm of higher education and point out SDGs research opportunities that have not been widely implemented, by identifying previous studies related to the trend or dominance of SDGs research themes and forms of implementation that have been carried out by universities based on aspects of higher education modalities. In the next sections, we present the main stages of the research process according to Petersen's guidelines, namely: (1) defining research question, (2) conducting searches, (3) selecting articles, (4) data extraction, (5) analysing and classifying schemas, and (6) validity evaluation (Petersen et al., 2015).

Stage 1 - Defining Research Questions

The objective of this study is to provide an overview of an effective research framework for raising awareness of the SDGs from the higher education domain and show the distribution of SDGs implementation research based on aspects of higher education modalities. This leads to the research question (RQ) shown in table 1.

Table 1

Research Question

Codes	Question
RQ1	Which areas of higher education did the sustainable development goals study focus on?
RQ2	How is the distribution of Sustainable Development Goals studies in higher education based on Higher Education Modalities?
RQ3	How is the implementation of Sustainable Development Goals in Higher Education?

Stage 2 - Conducting Searches

Kitchenham & Charters (2009) introduced PICO (Population, Intervention, Comparison and Outcome) as a tool designed for the identification of keywords and the creation of search strings based on research questions (Kitchenham et al., 2009).

- Population: it may refer to specific role, category, an application area or an industry group. In our context, the population are systematic mapping/scoping studies about SDGs.
- Intervention: it refers to a methodology, tool, technology or procedure. In the context of this study, we do not have a clear intervention to be investigated.
- Comparison: in this study we compare the different processes of conducting the implementation of SDGs by means of identifying the different strategies that have been used by author in higher education.
- Outcome: it refers to the outcomes that author measure to assess the effectiveness of an intervention. In this study, no measurable outcomes were considered, as we did not focus only on empirical studies.

Table 2 shows the identified keywords, i.e. Sustainable Development Goals, higher education, undergraduate, and university grouped into sets and their synonyms considered to formulate the search string.

Table 2

Search string of this research

Set 1	Scoping the search for population	Set 2	Search terms related to the process of classification and categorization
(1.1)	"Sustainable Development Goals" OR	(2.1)	"Higher education" OR
(1.2)	"SDGs"	(2.2)	"Undergraduate" OR
		(2.3)	"University"

The word "Sustainable Development Goals" or "SDGs" was entered to delimit the search area. The word "Higher education" is used to filter articles at the level of higher education. The words "Undergraduate" and "University" eventually became synonyms of "Higher education" due to several similarities in the data. Mendeley, a reference management tool, was used to remove duplication and to manage a large number of references.

Stage 3 - Selecting Articles

We exclude articles by considering their titles and abstracts, and also through a thorough examination of the full text and quality assessment. Additionally, studies were incorporated through backward snowball sampling. The first author applied inclusion and exclusion criteria to titles and abstracts, introducing a potential reliability threat to the mapping study, as each article was reviewed by a single author. To mitigate this threat, the second, third and fourth author conducted an evaluation of the final set of articles included, as explained later. The inclusion criteria specified for titles and abstracts were as follows:

- Studies present the result of Sustainable Development Goals study.
- Studies are in the field of higher education level.
- Studies were published online in the time frame 2018 to 2022.
- Studies that were catalogued as articles (classified as "articles" or "articles in print" by the same database).

The exclusion criteria specified for titles and abstracts were as follows:

- Studies not accessible in full-text.

- Studies not presented in English.
- Studies using research methods such as opinion surveys.
- Studies involving samples of students who are not from the Faculty of Education or the Faculty of Science.
- Books and Gray Literature.

During full-text reading it became obvious that further articles should be removed as they were not in the scope based on the inclusion and exclusion criteria. There were 67 studies deemed relevant during inclusion and exclusion based on title and abstract. The second, third and fourth authors reviewed all included studies during quality assessment and full-text reading, leading to 21 excluded studies, which had been included previously. A total of 46 studies proceeded to enter the data extraction stage.

Stage 4 - Data Extraction

To extract data from the identified primary studies, we created a template outlined in Table 3. The template comprises data items and their corresponding values. In the data extraction form, 46 articles are presented with identification keys A1 to A46.

Table 3

Data Extraction Form

Data Item	Value	RQ
Study ID	Identification key	
Article Title	Name of the article	
Author Name	Set of names of the authors	
Year of Publication	Calendar year	
Research purpose	What goals they set and in what areas they conduct the study	RQ1
Intervention	What intervention were used in order to introduce the SDGs	RQ3
Aspect in higher education modalities	Congruence between how they achieved their research targets and the definition of aspects of higher education modalities. (Fill in the name of the appropriate aspect, including: Education, Knowledge, Production, Public Debate, or Embodiment).	RQ2

The first author conducted the extraction, and the second, third, and fourth author subsequently reviewed it by cross-referencing the information in the extraction form with statements in each paper, ensuring accuracy. This practice of having a second author verify the extraction is a standard procedure in systematic reviews within the social sciences (Petticrew & Roberts, 2008).

Step 5 - Analysing and Classifying Schemas

The extracted research purpose and intervention were grouped and themed by the first author during analysis using the NVivo application. The NVivo application output indicates that only 21 articles are valid for forming study area themes, and this theme is necessary to answer the RQ1 (see Table 4).

The congruence of the papers included in each aspect of higher education modality was then calculated to answer RQ2 (see Fig. 1). Classification was based on the conformity of the intervention to the following definitions of each aspect of higher education modality (McCowan, 2019):

- Education: promotion of sustainable development knowledge, skills and values to design the latest ideas on sustainable development education and global citizenship education.
- Knowledge production: conduct basic and applied research as a function of Higher Education Institutions, e.g. climate change research, the impacts arising from it, and possible mitigation factors.
- Public debate: higher education institutions' contributions to community deliberation, providing spaces for deliberation to take place and raising public awareness of critical national/global issues.
- Provision of public service: the creation of facilities (e.g. Internet, recreational areas, educational areas, sports halls) and services (e.g. health and legal services) in Higher Education Institutions for the service of the local community.
- Embodiment: form of SDGs practice policies in higher education institutions to encourage positive changes within the higher education institution community and outside of the institution, e.g. implementing gender equality in the internal processes and structures of higher education institutions, and preserving the environment around higher education institutions in relation to resource use, carbon footprint, and local emissions.

Based on the aspect in higher education modalities (education, knowledge production, public debate, public service provision, and embodiment), their themes were identified (see Table 5). The aspect for the process were known a priori and were based on McCowan's (2019) theory of higher education modalities. Themes were identified to see what interventions they have put in place to introduce the SDGs in order to foster SDG awareness and answer RQ3 (see Fig. 2).

Stage 6 - Validity Evaluation

Systematic literature review is a vital part of qualitative research. Validity and reliability in qualitative studies are achieved through triangulation of diverse data sources, enhancing research accuracy. Source triangulation, as employed in this study, strengthens evidence from various individuals in describing qualitative research themes. Creswell emphasises that researchers meticulously examine each information source, ensuring accuracy and credibility by drawing from multiple individual sources (minimum 2) to support themes (Creswell, 2009). Ultimately, findings or themes in this research are deemed valid and reliable when backed by at least 2 supporting studies or articles. The accuracy of the findings has been examined by all research members. This method is called member checking. Aspects that were assessed include whether the article is suitable for developing the categorisation theme, whether the description is comprehensive and realistic, whether the categorisation theme is accurate to be included, and whether the interpretation is fair and representative (Creswell, 2009).

Findings

Study Areas (RQ1)

The study areas covered are classified based on the structure of the NVivo output. The output results were then made into themes. The first author added theme areas such as approach, development, stakeholders, teaching, and learning to cover the study area generated by NVivo. Table 4 shows the mapping articles per study area category. It can be seen that all activities are well represented, while the emphasis is on approach, development, stakeholders, teaching, and learning.

Table 4

Study Areas Covered in SDGs Studies at Higher Education

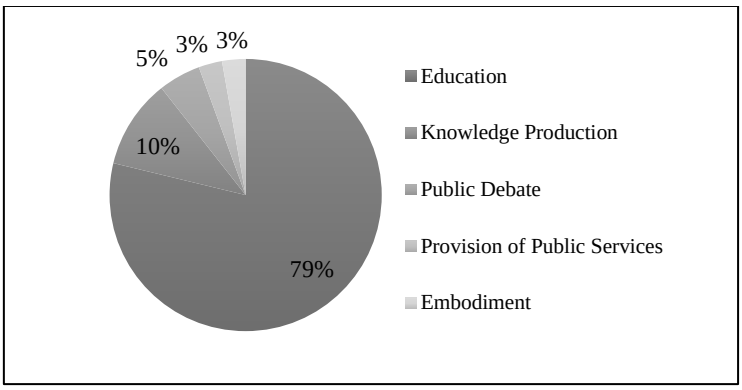
Theme	Study areas	Review citation
Approach	Interdisciplinary approaches	(Michalopoupou et al., 2019)
	Multidisciplinary approach	(Álvarez et al., 2021)
	Pedagogical approach	(Alm et al., 2021)
	Systemic approach	(Camacho et al., 2019; Pallant et al., 2020)
Development	Bilateral education agreements	(Zguir et al., 2021)
	Biological education area	(Lucas, 2018)
	Education system	(Alexio, et al., 2021; Ambariyanto & Utama, 2020; Clark et al., 2020; Hansen et al., 2021; Heleta & Bagus, 2020)
	Pre-service teacher education programs	(Chisingui & Costa, 2020; Tan, 2019)
Stakeholders	Education institution	(Aleixo et al., 2021; Alm et al., 2021; Ambariyanto & Utama, 2020; Hansen et al., 2021; Kioupi & Voulvoulis, 2020)
	Institution curricula	(Pallant et al., 2020; Rajabifard et al., 2021)
	Institution strategy	(Rajabifard et al., 2021)
Teaching	Inductive teaching methods	(Prince & Felder, 2018)
	Initial teacher education	(Chisingui & Costa, 2020; Cryne, 2018; Tan, 2019)
	Just-in-time teaching	(Prince & Felder, 2018)
Learning	Learning models	(Prince & Felder, 2018)
	Learning functions	(Ramaswamy et al., 2021)
	Learning method	(Bolmsten & Kitada, 2020)
	Learning objectives	(Dlouha et al.,2019)
	Learning outcomes	(Rajabifard et al., 2021; Kioupi & Voulvoulis, 2020)
	Learning point	(Álvarez et al., 2021)

Frequency of Publication (RQ2)

The interventions discussed are classified based on the aspect definitions of higher education modalities. The definition was described earlier in the methods section. Figure 1 shows the number of mapping articles per aspect category.

Figure 1

Frequency of Publications Based on Aspects of Higher Education Modalities



Publications related to the education aspect dominate the distribution. This tendency arises as a result of the important role and sense of responsibility of higher education in the sustainability of the SDGs, namely increasing awareness of the SDGs through education (Crespo et al., 2017).

Intervention (RQ3)

Analysis of publications related to the implementation or intervention of SDGs in higher education will be discussed based on the five modalities of higher education by McCowan (McCowan, 2019). The intervention data from the data extraction (see Table 3) were classified into themes of each aspect within the corresponding higher education modality. This was done to provide a clearer framework for the form of interventions that can be carried out in each aspect of higher education modalities. The findings complement Mc Cowan's theory of higher education modalities, which was not previously explained in detail.

We collected research data for RQ3 after reading each publication thoroughly. We organized the identified intervention data in the form of keywords that represented them and placed them in a table with the name of the activity (e.g. see table 5). Similar activities were brought together to build intervention themes with appropriate names. The themes were matched with the definition of each aspect of higher education modality to see which aspect they belonged to.

Education Aspect

Nine themes of Sustainable Development Goal interventions in higher education based on education aspect have been found. Table 5 shows the intervention activities represented by the themes under the education aspect.

Table 5

Intervention Activities Represented by the Themes Under the Education Aspect.

Activities	Theme
Co-creation approach, crosscutting approach, Impact-oriented approach, Integrated approach, Learning approaches, Methodology approach, Inductive approach, Two-phase approach	Approach
Integrative competence development, Sustainability competences, Transversal competences	Competence
Compulsory course, Course component, Course content (broad topics	Course

Activities	Theme
integrating climate change topics, topic investigation), Course inventory, Course objectives	
Character (SDGs awareness) education, Climate change education, Education institutions compromise, Education systems, Experiential education, International education policies, Quality education.	Holistic Education
SDGs-based academic institutions, introduction of SDGs at all levels of the institution, Institution's vision and mission	Institutions
Developed knowledge, Instructional knowledge, Knowledge areas, Normative knowledge, Scientific knowledge, Sustainability knowledge	Knowledge
Autonomous learning, Blended learning, Creative learning environment, Learning cycle, Learning landscapes, Learning methodology, Learning objectives, Learning process, Learning room, Learning methods, Learning trip	Learning
Introduction to teaching fundamentals, Teaching methods, Lesson plan (LSP), Pre-service teachers, Student-centered teaching, Teaching materials, Teaching sustainability	Teaching

Based on the intervention data, the SDGs intervention under the education aspect is generally carried out through: early introduction of SDGs to first semester students, including SDGs material in special courses (Chaleta et al., 2021; Willats et al., 2018), conducting work-based learning or projects related to SDGs (Álvarez et al., 2021; Fuertes-Camacho et al., 2019), creation of teaching modules/materials on SDGs (Crespo et al., 2017), curriculum development and evaluation (Pallant et al., 2020; Rajabifard et al., 2021) and scientific publications related to each pillar of SDGs: social, economic, legal and environmental.

Knowledge Production Aspect

Change, Project, Engineering are intervention themes found under the knowledge production aspect. Table 6 shows the intervention activities represented by the themes under the knowledge production aspect.

Table 6

Intervention Activities Represented by the Themes Under the Knowledge Production Aspect

Activities	Theme
Behavioural change, Climate change education, Integrating climate change topics, Sound climate science instruction, Substantial change	Change
Academic projects, Ecological projects, Engineering projects, Road infrastructure projects	Project
Innovative engineering	Engineering

Some interventions that higher education institutions can do based on the definition of knowledge production aspects include: researching climate change (change theme), the impacts arising from it (project theme), and possible mitigation factors (engineering theme).

Public Debate Aspect

The aspect of public debate has been stated as higher education's contribution to society including providing a forum for deliberation, information dissemination efforts to raise public

awareness on critical issues. Table 7 shows the 2 themes of SDGs intervention in higher education that were found in the public debate aspect.

Table 7

Intervention Activities Represented by the Themes Under the Public Debate Aspect

Activities	Theme
Audience barriers, Potential target audience, Wide audience	Audience
Environmental impact, Macro-level impact, Real-life impact, Update the impact review	Impact

The audience area discusses possible targets to be invited to work together to achieve the successful implementation of the SDGs. Meanwhile, the Impact theme is a theme that covers the causal effects of SDGs implementation on the environment outside higher education institutions.

Provision of Public Services Aspect

The theme of SDGs intervention in higher education found in the aspect of public service provision is called the dimensional services theme. Table 8 shows the types of intervention activities carried out under the dimension theme.

Table 8

Intervention Activities Represented by the Themes Under the Provision of Public Services Aspect

Activities	Theme
Economic dimension, health dimension, personal dimension, and social dimension	Dimensional services

This aspect is known to have not been studied in many publications published between 2018 and 2022.

Embodiment Aspect

Table 9 shows the intervention activities conducted under the advocacy theme. In the embodiment aspect, only one activity was found, namely SDGs advocacy. The activity discusses how all faculty members have the responsibility to introduce SDGs perspectives and ideas to students and the surrounding community.

Table 9

Intervention Activities Represented by the Themes Under the Embodiment Aspect

Activities	Theme
SDGs advocacy	Advocacy

This aspect is known to be under-researched, similar to the Provision of Public Services aspect.

Discussion

This discussion outlines the findings by grouping the identified area studies and interventions according to the similarity of their underlying theoretical frameworks. Five overarching aspects of higher education modalities are discussed, with particular reference to the field of SDGs in higher education, as it is one of the focuses of this systematic literature review. We then examined the positioning of the area study themes we found against the aspects of higher education modalities. The discussion continued by articulating the findings with a detailed description of the activities that have been undertaken on each aspect of the higher education modality. We conclude the discussion with a consideration of implications for future studies on the implementation of SDGs integration in higher education, noting the gaps in the current literature.

Publication Theme of Sustainable Development Goals in Higher Education

After examining the research objectives and interventions at the data extraction stage, it can be seen that there are connections and similarities among the various approaches identified in Table 4. It is clear that there are five overarching study area themes: approach, development, stakeholders, teaching, and learning. These approaches are not mutually exclusive and many papers fall into more than one theme study area. In the following we will provide a broad explanation of the five themes according to the way they are used in this SLR article.

The results of data extraction found 5 articles that have a similar area of study framework. Two articles from Pallant et al. (2020) and Camacho et al. (2019) are about applying a systemic approach to the curriculum, where all departments in a Higher Education are required to take courses related to SDGs. Three other articles have a focus area study on interdisciplinary or multidisciplinary approaches based on pedagogical approach thinking on courses that adopt SDGs as an overarching framework (Alm et al., 2021; Álvarez et al., 2021; Michalopoulou et al., 2019). The basis for the theme building of these area studies is the similarity in the framework of the approach taken. In the context of education, the term "approach" refers to the approach or method used to design, develop, and implement educational programs (in this case, SDGs education programs). Examples of approaches commonly used in education include interdisciplinary approaches, multidisciplinary approaches, pedagogical approaches, systemic approaches, thematic approaches, discipline-specific approaches, and others.

Seven publications from the data extraction were found not to fit into the study area approach themes. One article (Zguir et al., 2021) discusses higher education in low-income countries overcoming existing limitations to still implement the SDGs in higher education with the development of inclusive socio-economic bilateral cooperation. Five articles focus on education system development by mapping institutional needs for the future sustainability of SDGs in higher education (Aleixo et al., 2021; Ambariyanto & Utama, 2020; Clark et al., 2020; Hansen et al., 2021; Heleta & Bagus, 2021). One article (Lucas, 2018) has a study area of SDGs integrated biology education curriculum development by conducting an evaluation (assessment) study, a research study based on program usage, and discussing the implications of the existence of the curriculum. Two other articles (Chisingui & Costa, 2020; Tan, 2019) were identified as having a study focus area related to the development of an SDGs-aware pre-service teacher education program through piloting the program in ways that can be measured, reported, and incorporated into all education faculty curricula efficiently. It appears that the 7 publications have a common research framework related to processes and efforts that aim to improve the abilities, knowledge, skills, and potential of individuals or groups towards the sustainability of the SDGs. The research objectives of the seven publications are known in general to strengthen higher education institutions by developing SDGs-related programs at the inter-faculty and inter-institutional levels. Based on this, a study area theme called development was built to cover these 7 publications.

Four articles (Aleixo et al., 2020; Alm et al., 2021; Ambariyanto & Utama, 2020; Hansen et al., 2021) that were previously identified in the theme study area development, were decided to be included in the same study area as the publication from Kioupi & Voulvoulis (2020) after checking by the second, third, and fourth authors. These publications also address stakeholder-related study areas that review the alignment of desired learning outcomes with enabling conditions for a vision of sustainability based on the Sustainable Development Goals (SDGs). For example, in the publication of Aleixo et al. (2020) there are keywords in the sentence "an analysis of the perception of sustainable development carried out by higher education institutions", and in the publications of Alm et al. (2021), Ambariyanto & Utama (2020), Hansen et al. (2021) there are identified similarities in the way of achieving goals related to follow-up analysis conducted on stakeholders in higher education institutions to explore interdisciplinary curricula or pedagogical approaches that are suitable for advancing knowledge and understanding of sustainable development goals. In the publication of Kioupi & Voulvoulis (2020), there is a key sentence that describes a study related to an assessment framework for educational institutions to evaluate the strategies for contributing educational programs to sustainability carried out by stakeholders. Based on this, five articles have similar study areas related to education institutions. Further identification results on the extraction data also found that 2 publications (Pallant et al., 2020; Rajabifard et al., 2021) conducted research on stakeholders who reviewed the alignment of SDGs-based learning outcomes at the university curriculum level (general basic courses that must be taken for all first-year students), not only that in the Rajabifard et al. (2021) publication, it was also identified that they also analysed the strategies carried out by stakeholders to implement the university's vision and mission that were directed at the SDGs. The three study areas (education institution, institution curricula, and institution strategy) have similar goals and ways to achieve these goals, namely by conducting research on stakeholders. This is the basis for the formation of a new study area theme called stakeholders to cover these seven publications (Aleixo et al., 2020; Alm et al., 2021; Ambariyanto & Utama, 2020; Hansen et al., 2021; Kioupi & Voulvoulis, 2020; Pallant et al., 2020; Rajabifard et al., 2021).

A new area study was built by the first author after identifying publications from Prince & Felder (2018), which achieved the research objectives (introducing SDGs) with the application of Inductive teaching methods and Just-in-time teaching (instructors respond to students' specific needs and facilitate concept understanding more effectively). Another area of study called initial teacher education builds on the identification of publications from Chisingui & Costa (2020) and Crayne (2018). The two publications examined the experiences of college graduates from education faculties and pre-service teachers (final-year students who are interning as teachers) to find out how they promote the 2030 Agenda. Another article categorized under the study area initial teacher education is a publication that applies Shulman's pedagogical concepts in a micro-teaching class that education students take before their internship (Tan, 2019). The study areas of inductive teaching methods, just in time teaching and initial teacher education are classified in a new study area theme, called teaching. A total of 4 publications were in the teaching theme (Chisingui & Costa, 2020; Crayne, 2018; Prince & Felder, 2018; Tan, 2019). The theme was built on the basis of the similarity of study areas that examined the effectiveness and application of teaching methods (in higher education) by emphasizing students' multidimensional thinking skills to deepen their understanding of SDGs.

The discovery of a new study area was identified from the publication of Ramaswamy et al. (2021), namely the study area of learning functions. This publication integrates sustainable development goals (SDGs) into learning functions (Ramaswamy et al., 2021). Another new study area discovery is the learning method from the publication of Bolmsten & Kitada (2020), which focuses the research area on agile social learning methods to achieve the research goal of forming a community of professional people to have an interest in SDGs and develop sustainable solutions in their origin organizations. Another discovery is the learning objectives area study from the publication of Dlouha et al. (2019). The focus of Dlouha's study area is the analysis of learning objectives to assess the personal competency dimensions (addressing individual values, attitudes, and life experiences) and systemic dimensions (cognitive) of students, as an impact of implementing an SDGs-based approach.

The three publications (Bolmsten & Kitada, 2020; Dlouhá et al., 2019; Ramaswamy et al., 2021), are categorized under the same area study theme, and named learning. The theme of the learning study area was built on the basis of the similarity of the study area of using learning methods in higher education to build sustainable development capacity in the institutional community (university) to the community level. In the member checking session, the second, third and fourth authors agreed to include 4 publications (Álvarez et al., 2021; Kioupi & Voulvoulis, 2020; Prince & Felder, 2018; Rajabifard et al., 2021) to the learning study area theme because they were identified as having study areas that could also be covered by this theme. Prince & Felder (2018) also conducted research related to learning, namely analysing the virtues of a multidisciplinary approach with active learning models (inquiry-based learning, problem-based learning, project-based learning, teaching-based learning) for SDGs-based learning. Meanwhile, Álvarez et al. (2021) tested the effectiveness of the application of learning in higher education that incorporates the points of sustainable development goals (in the form of learning points) in the classroom. Finally, Rajabifard et al. (2021) and Kioupi & Voulvoulis (2020) analysed the impact of stakeholder policies on the success of SDGs-based learning in their higher education institutions. Based on this, there are 7 publications under the theme of learning studies (Álvarez et al., 2021; Bolmsten & Kitada, 2020; Dlouhá et al., 2019; Kioupi & Voulvoulis, 2020; Prince & Felder, 2018; Rajabifard et al., 2021; Ramaswamy et al., 2021).

The identification and classification we have done gives the scope of each study area theme as follows:

- Approach refers to the study area of introducing SDGs in Higher Education Institutions using a model approach, theme approach, specific disciplinary approach or even a specific curriculum to advance knowledge and understanding of sustainable development goals (SDGs) in higher education.
- Development is a study area of bilateral relationship ideas to support the implementation of sustainable development goals (SDGs) through various educational programs for higher education.
- Stakeholders is a study area related to the perception of sustainable development organized by Higher Education Institutions related to vertical integration (from the scope of the institutional community then expanding nationally) of sustainable development goals and assessment of the contribution of their education programs to the SDGs. This is done by reviewing the alignment of desired learning outcomes, with enabling conditions for a vision of sustainability based on the SDGs.
- Teaching is an area study that covers experiential and pedagogical testing of education study program students to pre-service teachers (final year students who intern as teachers) related to teaching techniques to introduce SDGs for students.
- Learning is an area study on the implementation of effective learning methods to improve student competencies in higher education related to the SDGs in the affective, cognitive, and psychomotor dimensions.

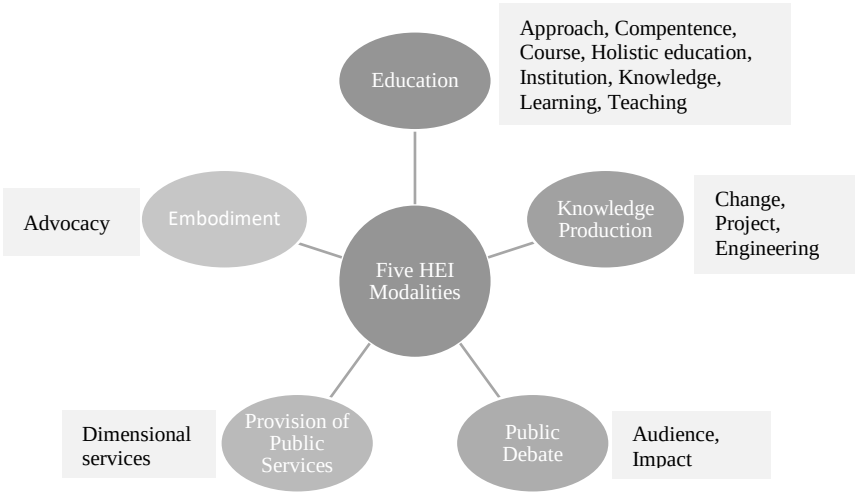
Framework for Raising SDG Awareness Based on Higher Education Modalities

Implementation of the SDGs in higher education is an effort to implement or carry out the Sustainable Development Goals (SDGs) in the higher education environment. The implementation of SDGs in higher education involves various interventions made by higher education institutions to ensure that the principles and goals of sustainable development are reflected in their policies, programs and activities. Publications related to SDGs implementation in higher education have been identified and categorized based on aspects of higher education modalities. The interventions written in the publications show the trend of research related to SDGs in higher education based on higher education modalities. On the other hand, we used the classification results of these interventions to refine McCowan's (2018) theory of higher education modalities. McCowan's theory only provides definitions for each aspect of higher education modalities or aspects of higher education institutions'

partnership contributions to the SDGs. In this study, we provide an overarching framework for how these aspects are actually carried out by constructing corresponding intervention themes. Figure 2 shows the improvements we made to McCowan's theory. The words in the box are intervention themes that we added to Mc Cowan's theory on the implementation of higher education modalities. Through this refinement, Mc Cowan's theory of higher education modalities, which previously provided explanations or predictions about how and why a phenomenon occurs, can now be practically used as a framework or conceptual structure or systematic thinking used to structure and organize ideas or concepts in a research or project.

Figure 2

Higher Education Modality Framework



In the next session we explain each of the themes in higher education modality framework as follows:

Education Aspect

Approach Theme: Approach is an intervention theme related to the development of active learning models that have been followed by a co-creation approach. The framework offered from this theme is the development of a model to facilitate students and college staff to learn about the challenges of global issues and how to overcome them. The characteristics of this theme are built from the identification of existing publication interventions in the 2018-2020 range, including: Longoria et al. (2021) and Aartz et al. (2020), who analysed the success of developing a model for SDGs-based learning through a co-creation approach for a balanced elaboration of knowledge, skills, attitudes and global citizenship. Other examples of interventions are those of Alm et al. (2021), Camacho et al. (2019) and Dlouha et al. (2019) that promote project methods in multidisciplinary and transdisciplinary teams to improve SDGs competencies related to SDGs knowledge, psychomotor, attitudes and values.

Competence Theme: This theme is built on the basis of identifying interventions in a sample of publications, including: Chang & Lien (2020) and Dlouha et al. (2019). Competence theme is how general education plays an important role in supporting the need to provide normative knowledge, transversal competencies, integrative competencies into courses, to compensate for the lack of holistic understanding and systems thinking when SDGs are integrated into the overall university curriculum. Transversal competencies, known as cross-disciplinary skills or cross-functional skills, refer to skills and knowledge that can be applied across different contexts or fields.

Meanwhile, integrative competencies refer to an individual's ability to combine or integrate knowledge, skills and resources from different sources or disciplines to achieve a more holistic or comprehensive goal or solution (Dlouhá et al., 2019).

Course Theme: The course theme is an intervention in the form of curriculum extension to introduce SDGs to students. This intervention creates a compulsory course that includes understanding the SDGs in a context-adaptive framework. Examples of existing publications on this theme are those of Tandon & Pandey (2019), Tan (2019) and Chang & Lien (2020). We identified important information in the intervention data related to the implementation of the new research framework in the intervention course theme, namely: (1) the SDGs course inventory should offer useful information for academic administration to better understand the interdisciplinary capacity and internal collaboration opportunities in the university; (2) SDGs-based classes can serve as a platform to develop innovative and interdisciplinary programs through multi-university collaboration, where faculty can engage in the same SDGs through different approaches; and (3) the integration of SDGs points should be clearly aligned with the expertise of specific departments in the university.

Holistic Education Theme: Publications related to holistic education focus more on policy interventions and international educational entities as well as historical calls that paved the way for the emergence of the concept of SDGs integration in higher education as a result of the international adoption of the UN 2030 sustainable development agenda. Examples of activities we identified are mobilizing students to take action to support SDGs (Fekih Zguir et al., 2021), designing sustainable development education to form sustainable citizens at the university level (Ambariyanto & Utama, 2020), support for SDGs-related work and capacity building (Žalėnienė & Pereira, 2021). Sustainable citizen refers to individuals who are committed to contributing to the sustainability or sustainability of the environment and society and they endeavour to choose a way of life that supports sustainability goals (Ambariyanto & Utama, 2020).

Institution Theme: The institutional intervention theme is a theme that we developed based on interventions in the activities of managers of academic institutions to serve as a protocol for assessing the sustainability dimension. The aim is to promote behavioural change within the university community towards sustainable development at the individual, organizational and institutional levels. One example of a publication that discusses this intervention is Hübscher et al. (2022), where he conducts SDGs-based academic institutions by analysing institutional policies to motivate students through meaningful campus agendas with the SDGs as guiding principles. The majority of institutional intervention themes are built from the activity of analysing the perception of the impact of SDGs-based policies on students, because students are considered as agents of sustainability change that have the potential to generate SDG-related impacts externally, from student organizations to institutions (Hübscher et al., 2022).

Knowledge Theme: The knowledge intervention theme is one that builds on the commonality of SDGs knowledge transfer activities to the course reflected in the course syllabus. In the process of transferring SDGs knowledge, four publications (Antó et al., 2021; Manolis & Manoli, 2021; Pallant et al., 2020; Shabalala & Ngcwangu, 2021) used in-class projects to enable them to measure students' knowledge and psychomotor skills.

Learning Theme: The Learning intervention theme leads to the intervention of new learning techniques or ways to improve students and staff learning about the challenges of global issues by bringing concrete issues into the subject and how to address them. Activities in learning interventions emphasize improving SDGs knowledge, problem-solving skills, SDGs-aware attitudes and global citizenship through. Examples of these interventions include implementing active learning methods

(Aarts et al., 2020; Bolmsten & Kitada, 2020), implementing Co-Curricular, which is a learning process where students can choose to engage in paid or unpaid internship activities, conduct research with faculty members through independent study, participate in study abroad or work as volunteers in their communities (Pallant et al., 2020). We conclude from the few existing publications on this theme, that the function of these interventions is to: present challenges for students to broaden their learning (Holmberg & Larsson, 2018) and behavioural based on assumptions of professional attitudes, values, and dispositions (Álvarez et al., 2021; Tan, 2019).

Teaching Theme: The teaching intervention theme refers to the management of SDGs basic teaching development with adaptive techniques in the context of introducing SDGs to education faculty (faculties that produce bachelor's degrees in education) students. Publications under this theme emphasize that teachers can play an important role in education towards a more sustainable world, and to achieve this, teacher education institutions (faculties of education) must explicitly integrate the SDGs into the vision and mission of their faculties (Chisingui & Costa, 2020). Examples of activities covered by teaching interventions are: 1) improvement of education faculty students' competencies related to SDGs with an integrated approach of knowledge, procedures, attitudes, and values through the promotion of the project method in multidisciplinary and transdisciplinary teams (Fuertes-Camacho et al., 2019); 2) Interactive and collaborative activities that invite education faculty students to acquire, align, and demonstrate the V3SK framework, namely the three components of values (i.e. learner-centered values, teacher identity values, service to the profession and community values), skills, and knowledge of the SDGs (Tan, 2019); 3) Creating SDGs-based education fundamentals teaching materials created by lecturers or academic staff members (Willats et al., 2018).

Knowledge Production Aspect

Change Theme: The theme of change is a theme that covers the intervention activities of assessing the real-life impact of students in encouraging behavioural changes towards sustainable development at the individual, organizational, and institutional levels structurally, emotionally and culturally. These activities are carried out because in general, students have a low level of awareness regarding SDGs and global issues, especially climate change. Some of the publications identified as conducting this intervention are Demaidi & Al-Sahili (2021), Cryne (2018), Hübscher et al. (2022), and Prasad (2022). These four publications provide examples of interventions that offer undergraduate students the opportunity to learn more about climate change by integrating climate change topics into the higher education curriculum (Crayne, 2018; Demaidi & Al-Sahili, 2021; Hübscher et al., 2022; Prasad, 2022).

Project Theme: Theme projects are intervention activities that propose research in the form of projects, which are incorporated into the classroom. Examples of project titles that we have identified are Ecological Projects (Manolis & Manoli, 2021), Becoming an Agent of Change (Pallant et al., 2020), Road infrastructure projects (Álvarez et al., 2021). Based on this theme, we recognize the synchronization between the educational and knowledge production aspects of the higher education modality. The elaboration of projects in classroom activities can open new areas of publication in SDGs research in Higher Education.

Engineering Theme: The engineering theme is an advanced intervention activity of the project theme, which substantially evaluates students' skills during the completion of the project. In an educational context, engineering refers to student practices related to designing, building, developing, and maintaining products, systems, structures, or processes. Engineering in the context of SDGs-based projects involves applying scientific knowledge, mathematics, and practical skills to create innovative solutions to problems (Fuertes-Camacho et al., 2019; Shabalala & Ngcwangu, 2021).

Public Debate Aspect

Audience Theme: The audience theme is a theme that covers intervention activities carried out in higher education institutions to become community partners in promoting agents of change. One example we provide from the identification of the Hübscher et al. (2022) publication, is to establish a social marketing program that evaluates the audience (community) as a potential target, sets goals based on audience behaviour, surveys barriers, benefits, motivators, competition, and other things that affect the SDGs campaign at the local and national levels.

Impact Theme: The theme of impact refers to intervention activities that assess the impact of SDGs campaign programs of higher education institutions, to serve as reference material for a very wide audience across internal and external universities. For example, the assessment results of Social marketing programs show the potential to increase the impact of universities at a higher level when they successfully overcome audience barriers in carefully designed campaigns that build on benefits and motivations (Hübscher et al., 2022).

Provision of Public Services Aspect

Dimensional Services Theme: The dimension service theme has a type of SDGs intervention in setting indicators that allow academic institution managers as a protocol to assess the sustainability attitude of the community in the economic dimension, health dimension, personal dimension (values, emotions, and motivation) and social dimension. Examples of activities carried out are: 1) inviting the university community to consider environmental, technical, and social dimensions in formulating solutions to global issues in the SDGs campaign (Abad-Segura & González-Zamar, 2021; Crespo et al., 2017); 2) determine a policy that considers biodiversity issues, which then expands to include socio-cultural, ethical, behavioural, governance, and health dimensions (Kioupi & Voulvoulis, 2020).

Embodiment Aspect

Advocacy Theme: The SDGs Intervention activity on the advocacy theme is an activity that highlights how the SDGs can serve as a platform to develop innovative and interdisciplinary programs through multi-university collaboration, where each faculty member can engage with the same SDGs through different approaches. In the previous themes, the SDGs appeared as if they were part of the course content or pedagogy, but they are not. Therefore, faculty members who are not lecturers can take responsibility for introducing SDGs perspectives and ideas to the internal and external communities of the Institution at their own pace (Chang & Lien, 2020; Tandon & Pandey, 2021). Based on this, it is important to fulfil research distribution in this aspect.

Frequency of Studies on Sustainable Development Goals in terms of Higher Education Modalities

The high frequency in the education aspect is understood as the awareness of higher education to focus on improving the quality of graduates so that they have good personal and systemic competence dimensions towards the SDGs (Dlouhá et al., 2019) and are able to face global issues such as poverty, equality gender, climate change, inequality and social disparity (Berchin et al., 2021; Heleta & Bagus, 2021; Žalėnienė & Pereira, 2021).

Basically, the educational aspect of higher education is considered a focal point to spread knowledge and research inspiration to the younger generation (Manolis & Manoli, 2021). They are key

agents in educating future leaders who contribute to the successful implementation of the Sustainable Development Goals (SDGs) promoted by the United Nations. In addition, the academic community, including students, are the closest community to the general public because they can channel knowledge such as the introduction of the Sustainable Development Goals through programs owned by higher education.

We realise that various contributions outside the institution can be made only if the prerequisites for understanding and ownership of sustainable development awareness are owned by the academic community, including students who are in higher education. So that the largest distribution is in the education aspect where researchers focus on addressing the gap in increasing awareness of the SDGs through creative, practical and interesting ways among university students. Based on this, it is important to conduct research related to aspects of other modalities to provide new innovations in the world of education through new discoveries or a combination of several aspects with the same goal. We suggest a combination of various modalities as stated in the previous statement, namely between education, knowledge production, and public service provision in one goal as alternative research.

Conclusion and Implications

Systematic mapping of SDGs implementation in higher education aims to obtain a theoretical framework that can reveal the concepts of SDGs implementation that are relevant to research cases in higher education. Approach, Education, Stakeholders, Teaching and Learning are the findings of the publication theme of Sustainable Development Goals in higher education in the range of 2018 to 2022. Based on the analysis of the distribution classification of SDGs publications at higher education based on the modalities of higher education, the education aspect has the highest distribution quantity, namely 79%. Followed by knowledge production, public debate, provision of public services and implementation of public services with the percentages, respectively, namely 10%, 5%, 3% and 3%.

Integration is carried out in the education aspect, including in the areas of Approach, Competence, Course, Education, Institutions, Knowledge, Learning, and Teaching. Aspects of knowledge production are areas of change (including behavioural contexts, topics, curricular), projects (Ecological Projects, Becoming an Agent of Change, Road infrastructure projects) and engineering. Aspects Public debate is classified into two areas, namely audience and impact. In the provision of public services and the embodiment, there is only one area, successively dimensional services and advocacy. Based on this, it appears that it is important to fulfil the distribution of research in these two aspects. We suggest combining various aspects of the modalities as previously stated, namely between education, knowledge production and the provision of public services in a goal as an alternative for future research. This concept can not only increase the understanding of graduates of higher education related to the SDGs but also increase public awareness regarding the SDGs through the provision of public services and the implementation of public services by higher education institution.

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