Strategic Alliances in Institutions of Higher Education to promote Sustainable Development Goals:
A case study from two universities in Taiwan

Ying-Yan Lu[1], Ching-Hui Lin[2], Bo-Hsien Hu[2], Szu-Yin Lin[3], Chien-Hung Lee[1]

[1]*Kaohsiung Medical University, Taiwan*
[2]*National Sun Yat-sen University, Taiwan*
[3]*Natopnal Kaohsiung University of Science and Technology, Taiwan*

ABSTRACT

Higher Educational Institutions (HEIs) are vital contributors to achieving the United Nations' Sustainable Development Goals (SDGs). It is essential in meeting sustainable development challenges, including educating excellent teachers, producing ground-breaking research, and connecting services to communities. This research aims to explore the effects of forming a strategic alliance between two universities on facilitating the academic publication of SDG-related topics and determine the benefits of strategic alliances between HEIs. Data were collected from SciVal® for the period 2004 to 2020 to determine the numbers and percentages of joint authorship papers between the two universities related to the 16 SDGs and explore the growth trends in joint authorship publications on topics related to SDGs between the two case universities after their strategic alliance in 2012. Results showed that scholars from the two universities focused more on SDGs 2, 5, 7, 13 than the other goals. Regression analysis was also used to examine if the defined variables significantly affected the increase of joint authorship publications. The results showed that universities might benefit from the strategic alliance, bringing collaboration on SDG-related research. This research sheds light on strategic alliances between two institutions in Taiwan with different orientations, which can be used as a reference in higher education to promote sustainable development goals.

Keywords: Higher Education, Regression Analysis, Strategic Alliances, Sustainable Development Goals, Case Study

Introduction

In September 2015, all 193 Member States of the United Nations adopted an inclusive plan, "The 2030 Agenda for Sustainable Development," which provides a shared blueprint for peace and prosperity for people and the planet to end extreme poverty, fight inequality and injustice, and protect the environment now and into the future (United Nations, 2015; Lee et al., 2016). The notion of Sustainable Development Goals (SDGs) is not a new concept but an extension of the Millennium Development Goals (MDGs) proposed in 2000 to tackle the indignity of poverty. The SDG agenda was designed to mobilize multiple stakeholders' creativity, knowledge, skills, and resources to take global action by embracing a wide range of interconnected economic, social, and environmental dimensions of sustainable development for our planet.

The SDGs address a wide range of specific issues such as poverty, hunger, health, education, gender equality, water and sanitation, energy, industry and innovation, infrastructure, consumption and production, climate, life below water and on land, and justice. A list of the 17 goals is listed in the Appendix. The goals are integrated into a global framework with strong buy-in and adoption among governments, businesses, academic institutions, funding agencies, civil society, and local communities (World Health Organization, 2016). The importance of education for sustainable development is highlighted in a number of the goals, such as for all learners to "acquire the knowledge and skills needed to promote sustainable development" (Avelar et al., 2019), which are directly relevant to universities. Additionally, a survey conducted by the Times Higher Education (THE) showed 79% of students agreed that universities should play a key role in promoting sustainable values and skills for the next generation. 69% agreed that acquiring knowledge of sustainability development during their studies could benefit their future job searches (THE, 2021a). Therefore, the SDGs provide a unique opportunity for higher education institutions (HEIs) to demonstrate their willingness and capability to play an active and meaningful role in their respective countries development and contribute towards global sustainable development.

The SDGs provide a universally agreed-upon organizing structure for HEIs to promote awareness of global sustainability issues. Viewed from another angle, HEIs can provide the knowledge, innovations, and solutions to underpin the implementation of the SDGs by addressing the challenges that require new knowledge and new ways of doing things (Fleacă et al., 2018). Moreover, HEIs can also support the development of the professional knowledge, capabilities, and motivation of future leaders, decision-makers, innovators, entrepreneurs, and citizens who can contribute to achieving the SDGs (López et al., 2019).

The THE Impact Rankings showcase the work of universities as essential actors in the quest for sustainable development (Hess and Collins, 2018; Žalėnienė and Pereira, 2021), as they help to discover new technologies that make societies, communities, and businesses around the world more sustainable and resilient (Hansen and Stilling, 2021; THE, 2021b). To implement SDGs, the Ministry of Education in Taiwan (2018) has promoted the "University Social Responsibility

Practice Project" focusing on "local care," "the industrial chain," "sustainable environment," "food safety and long-term care," and "international connections." It encourages universities and colleges to actively connect with and enhance their contribution to local communities and regional schools, promote the development of urban and rural education, and support sustainable urban and rural, industrial, and cultural development. However, to effectively achieve SDGs, global organizational partnerships for sustainable development are necessary (Casarejos et al., 2017). Accordingly, many HEIs around the globe have voluntarily formulated and implemented sustainability-related initiatives on their own (Freidenfelds et al., 2018). Based on the results of the latest 2021 THE Impact Rankings (THE, 2021c), there were a record-breaking 35 Taiwanese universities on the list, a sharp increase from the year 2020, documenting a growing trend among that universities and colleges in Taiwan to become involved with sustainability initiatives and transformations aligned with their missions. For example, two southern Taiwan universities, National Sun Yat-sen University (NSYSU), a comprehensive public university, and Kaohsiung Medical University (KMU), a private medical university, started their strategic alliances in 2012. They explored a series of sustainable strategies to generate knowledge about, awareness of, and solutions to environmental issues to help face these challenges. Cooperative partnerships among HEIs play a key role in achieving sustainability by initiating and developing teaching, curriculum, research, community outreach, and everyday activities (Sonetti et al., 2016). As mentioned above, the first main idea of the study would focus on the percentage of joint publications related to SDGs from 2004-2020 by NSYSU and KMU to explore the effects of the strategic alliances.

In recent years, there has been a dramatic increase in strategic alliances among global multinational firms and institutions of higher education to tackle complex industrial problems of a significant business or societal significance through cooperative partnerships (Saffu and Mamman, 2000). The higher education sector also has a growing trend of alliances and mergers to achieve economic benefits and research productivity (Patterson, 2001; Ahmed et al., 2015). Nowadays, more and more studies are focusing on promoting SDGs in HEIs (Fuchs et al., 2020; Groulx et al., 2021; Zahid et al., 2021). In Taiwan, the government at this stage was also actively promoting learning, teaching, and research based on the SDGs framework in HEIs. However, few examinations of the HEIs' pursuit of SDGs through strategic alliances (Leal Filho et al., 2015) and no related studies in Taiwan. Thus, there is a need to investigate the Taiwan HEIs' strategic alliances regarding SDGs. Accordingly, this study primarily focused on the strategic alliances of two universities, NSYSU and KMU, to promote SDGs. As stated above, the second main idea of the study would put more emphasis on the change in percentages of publications on SDGs by NSYSU and KMU after the strategic alliance in 2012. It also extensively discusses how both universities use their strengthened items on SDGS to help each other in different research fields to gain complementary advantages.

In the current study, we combined the above indicators in the sustainability index to investigate strategic alliances between NSYSU and KMU. First, we analyzed the growth trends of the percentage of joint publications related to SDGs by authors at the two universities for 2004-2020

to explore the effects of the strategic alliances. Second, we compared percentages of jointly authored publications on SDGs before and after 2012 to determine changes in rates after the strategic alliance of the two universities and further explore whether the two universities gained complementary advantages by helping each other in different fields of research. To investigate how the two universities cooperated and integrated sustainable strategies into their routine campus operations, curriculum development, and local, regional, national, and international community outreach, regression analysis is used to examine the factors that significantly affect the production of jointly authored publications on SDGs. The following research questions (RQs) guided this study:

RQ1: Can forming a strategic alliance between two universities facilitate academic publication on SDG-related topics?

RQ2: What are the growth trends in joint authorship publications on SDG topics between the 2 case universities after their strategic alliance in 2012?

RQ3: What are the significant factors affecting the percentages of joint authorship publications on SDGs during the strategic alliance?

Literature review

Promoting SDGs in higher education institutions in Taiwan

Recently, scholars have emphasized the impact of higher education on sustainability development (e.g., Fehlner, 2019; Leal as agents of change (Shields, 2019). Littledyke et al. (2013) describe the following ways in which higher education institutions can play critical roles in education for sustainability: 1) research and teaching can support the development of sustainability principles across the disciplines, 2) the practices carried out in different disciplines and through interdisciplinary collaboration can broaden perspectives and enrich outreach activities; 3) an institutional culture of sustainability can increase awareness of university staff as well as local and extended communities; 4) higher education institutions have significant responsibility for the preparation of next-generation professionals; and 5) by implementing sustainable campus practices (e.g., reducing greenhouse emissions and efficient use of energy), they help reduce the ecological footprint. Thus, developing a sustainability culture on campus activities can raise stakeholders' awareness of sustainability and substantially impact the environment, economy, and society (Findler et al., 2019).

Taiwan has taken a long time to promote environmental education, including ecological conservation, resource recycling, energy saving, and carbon reduction, which have become everyday environmental protection actions on campuses (Tsai, 2012). However, in recent years, the Ministry of Education has given more attention to the United Nations' sustainable development goals and global changes by promoting education for sustainable development (Pauw et al.,2015).

In 2017, the Ministry issued the document "Key Points of the Ministry of Education's Promotion of a Social Responsibility Practice Program for Colleges and Universities," which emphasizes the social responsibilities of higher education, promotes cooperation between communities and universities, and encourages students to engage in social action (Ministry of Education, 2020). The Ministry of Education has also announced the importance of education for sustainable development through school education to tackle environmental issues and produce citizens who make wise decisions to achieve environmental integrity, economic feasibility, and social justice. Also, in response to the UN's Sustainable Development Goals, the document "Taiwan's Sustainable Development Goals" and related plans were released at the end of 2018 (Ministry of Education, 2020). Following international trends, Taiwan universities have taken the initiative to promote sustainable development by increasing sustainable education-related activities, conducting relevant research, and developing new technologies that make societies, communities, and businesses worldwide more sustainable and resilient (Jenny Su and Chang, 2010). In addition, Taiwan HEIs are responsible for developing skilled human capital to assist in the transition to sustainable practices. To achieve this comprehensive mission, there must be firm commitment and institutional engagement within the HEIs to promote ethical and responsible values, goals, and actions (Wu and Shen, 2016).

Another strategy to promote SDGs in HEIs is integrating SDG-related topics into research and identifying relevant research outputs (Purnell, 2022). The THE Impact Rankings also measure a university's contributions to SDG-related research and emphasize research in each Goal (Times Higher Education, 2021b). Since the 17 SDGs cover a wide variety of topics, most research can be mapped onto one or more SDGs. The Scopus publication database developed by the publishing company Elsevier provides the metrics data on how each paper is mapped onto the SDGs. Elsevier collected keywords related to SDGs 1 to 16, supplemented by additional keywords and related topics identified by artificial intelligence. The methods and the search strategies were published by Rivest et al. (2021).

Activating partnerships through strategic alliance in Taiwan

Strategic alliances originated in the corporate world and have been in various fields, including agriculture, aviation, tourism, and medical care (Borsch, 1994). Due to the strong culture of competition in the corporate, strategic alliances are formed to create mutual advantages for partners. In recent years, the education sector has increasingly emulated corporate practices with the liberalization, marketization, and internationalization of education. It includes forming strategic alliances to bring new opportunities and visions to HEIs (Gulati et al., 2000). While there is currently no universally accepted definition of the strategic alliance due mainly to its adaptability to diverse contexts and enterprises, scholars' various explanations of the concept capture its core meanings. Kale et al. (2000) proposed that strategic alliances refer to cooperation between individuals or organizations to maintain or enhance their competitive advantages, consider long-term interests, and unite to pursue common goals, hoping to control the destinies of individuals or

organizations. Wolf (2000) described a strategic alliance as a coalition of two or more organizations to respond to the commercial environment, survive or grow, and achieve specific strategic purposes through mutual support and cooperation, such as joint contract management, chain/direct sales, and mergers. Knoke (2001) asserted that a strategic alliance is an agreement between two or more manufacturers to cooperate for specific purposes to reduce risks and expand their business areas in rapidly changing environments. Based on these perspectives, in this study, a strategic alliance is conceived as follows:

To respond to the environment, two or more organizations survive, enhance their competitive advantages, and share responsibilities, risks, and rewards through resource sharing and complementary functions. To pursue common goals, they cooperate strategically while each retains independent power.

A school is a non-profit organization whose primary Goal is to seek the greatest well-being of teachers and students. Therefore, a strategic alliance of schools can be defined as follows: "Two or more independent schools, through cooperation, effectively integrate school resources, carry out sharing of resources and curriculum, teaching cooperation, administrative support, and academic research (Patterson, 2000; Ripoll-Soler and de-Miguel-Molina, 2014). Thomas (2015) indicated that complementarity and sharing, including information technology exchanges, knowledge innovation sharing, and teaming to enhance competitive advantages, can bring new opportunities to teachers and students. Therefore, schools should make good use of strategic alliances, integrate educational resources, and promote inter-school exchanges and cooperation to enhance sustainable operations and development in universities.

In Taiwan, domestic universities have strategic alliances that serve various purposes. For example, in January 2008, the National Tsing Hua University, National Chiao Tung University, National Yang-Ming University, and National Central University formed the "Taiwan United University System" to implement the integration of teaching, research, and administrative resources and promote cooperation in international affairs. In November 2012, the Taiwan Comprehensive University System, consisting of National Cheng Kung University, National Sun Yat-sen University, National Chung Cheng University, and National Chung Hsing University, created a joint alliance for cross-university course enrollment recruitment of students, collaborative activities, and other cooperation matters. On December 26, 2016, The National Defense University and National Chung Hsing University signed a strategic alliance to promote resource sharing and industry-university co-prosperity. Alliances may be formed based on geographic location, school type, or school needs. Other alliances include the long-established Excellent University Consortium of Taiwan, which consists of 12 private universities, and the Taipei Union University system, consisting of the National Taipei University of Technology, National Taipei University, Taipei Medical University, and National Taiwan Ocean University. All are located in the greater Taipei metropolitan area in a juxtaposition of professional universities with different academic disciplines. By promoting cooperation among institutions, strategic alliances provide students with

more diversified learning opportunities, avoid problems that may arise separately, and enhance members' market competitiveness through unity (Cai and Yang,2016).

In this study, the 2012 NSYSU and KMU Alliance serve as a case to explore the effects of strategic alliances on the promotion of SDGs. NSYSU and KMU are index universities of Taiwan's public comprehensive and private medical systems, respectively, located in Kaohsiung City. The close geographical proximity and the different natures of the two universities have resulted in their strong complementarity, which is conducive to substantive cooperation and improvement of teaching and research. In addition, the two schools have long cooperated in supporting rural education and medical services. Drawing on the advantages of their location and complementarity, NSYSU and KMU integrate resources to enhance the effectiveness of learning, teaching, research, and social services, aiming to become one of the world's top joint university systems. Their resource sharing extends to libraries, computers, internet access, merchant discounts, vehicles, sports facilities, parking, and other aspects. Students can take courses across schools, which recognize each other's credits, and participate in cross-campus programs and international cultural exchange activities. After years of in-depth cooperation between the two universities, NSYSU and KMU have also achieved remarkable results in the use of cutting-edge mass spectrometry in food safety and other innovative applications, the development of natural marine drugs, an intelligent system for diagnosing Alzheimer's disease, and the assessment of the risk of air pollution to human health. In the future, both universities will continue to invest in research and development, cultivate cross-domain research talents, and actively pursue frontline discoveries. These cover fields such as artificial intelligence and electronic engineering applied to medical care, reaping the benefits of their academic alliance and maintaining Taiwan's medical science and technology leader. Besides integrating resources to achieve excellence in teaching and research, these expected benefits include expanding students' learning horizons by providing more diversified experiences. It includes strengthening social and community service liaisons, supporting regional development functions, and increasing both institutions' international visibility and competitiveness (NSYSU and KMU strategic alliances news, 2019).

Research Significance

In a higher education ecosystem with limited financial resources and insufficient student resources, strategic alliances may allow schools of different types to achieve complementarily and schools with high homogeneity to make progress together (Flora and Hirt, 2010). However, whether the cooperation can achieve equitable sharing and true reciprocity is an essential factor influencing the success of a strategic alliance. There is a subtle but complex relationship between competition and cooperation between universities. Achieving the common good is the ultimate Goal of a strategic alliance and the most significant challenge (Stensaker et al., 2016). Therefore, this study makes a theoretical contribution to addressing the issue of reciprocity in alliances by adding new insights through an in-depth study of NSYSU's and KMU's experiences cooperating in promoting SDGs. It focuses mainly on jointly authored publications, sustainable campus operations, curriculum development, and local, regional, national, and international community outreach to explore how

both universities achieve mutually beneficial win-win cooperation through strategic alliance. Finally, this particular strategic alliance can be a reference for policymakers, government agencies, and educators to promote sustainable development through higher education.

Methodology

The Goal of this research was to explore how a strategic alliance between two universities could facilitate academic publication on SDG-related topics and examine the growth trends in joint authorship publications on topics related to SDGs between the 2 universities after the strategic alliance. Data were obtained from Scopus, a subscription-based academic publication database. The processes of data collection and data analysis are described below.

Data Collection

We used the Research Areas menu of the online tool SciVal® to search for publications in the Scopus database related to each of the SDG targets. A comprehensive set of queries can define Research Areas, referred to as "Elsevier 2021 SDG mapping," developed by Rivest et al. (2021). We used a set of queries for assessing a university's SDG-related research impact and for its international rankings, such as by the THE rankings. We then selected publications related to SDGs by authors of both universities from 2004 to 2020 in the database and compared the numbers of joint authorship papers before and after establishing the strategic alliance in 2012.

Data Analysis

To understand how joint authorship publications between the two universities changed before and after the strategic alliance, we calculated the total number of publications related to SDGs, and the percentage of joint authorship papers in each of the 16 SDGs. Next, we used the open-source software R to conduct a cluster analysis to explore whether the two universities collaborate on specific SDG research topics. clusters of SDGs based on the growth patterns of joint authorship into three groups, designated as "high," "medium," and "low," were created. It helps illustrate which clusters of SDGs are essential to each university and how the percentage of joint authorships changes after the strategic alliance. We also drew charts and diagrams to visualize the Inter-relationships among SDGs of joint-authorship publications and the growth trends. Finally, regression analysis was applied to examine whether the defined variables significantly affected the percentage of joint authorship publications and whether a strategic alliance between the two universities facilitated collaborative research.

Results

First, the total number of SDG-related publications of both universities is shown. As shown in Figure 1, these totals increased for both universities from 2004 to 2020. Figure 2 shows the percentage of joint authorship publications from both universities, which also increased over the

16 years. A detailed breakdown of the percentages of joint authorship publications on each SDG over the years is shown in Table 1. Because some publications are cross-disciplinary, they were not classified under a single SDG. We used a Sankey diagram to show how the publications overlap to further examine the inter-relationships among joint-authorship SDGs. As shown in Figure 3, neither university had joint-authorship publications on SDG10. Within the collaborations, SDG 1 has the highest connections to other SDGs, followed by SDG14, SDG3, and SDG6.
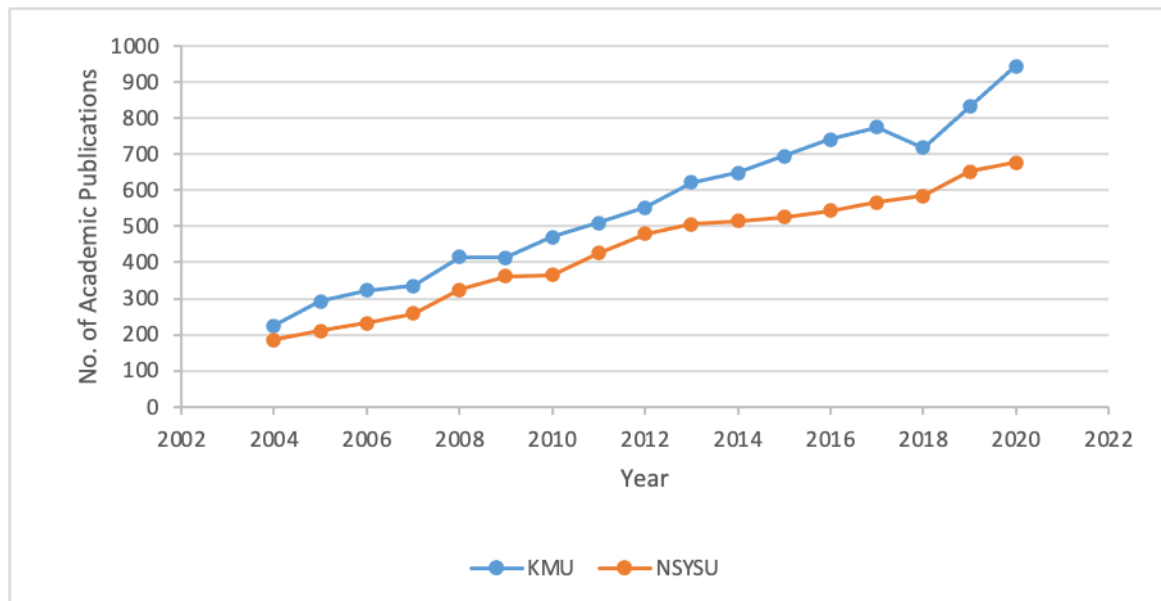

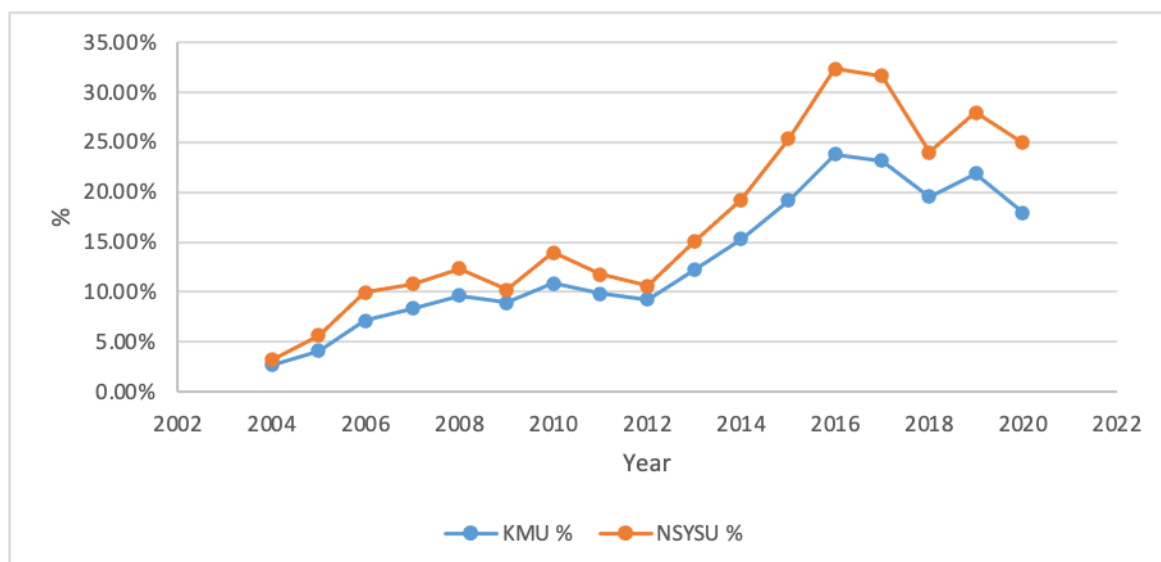**Figure 1: Total number of SDG-related publications**

Figure 2: Percentages of joint authorship publications
Table 1: Publications count and percentage of joint authorships

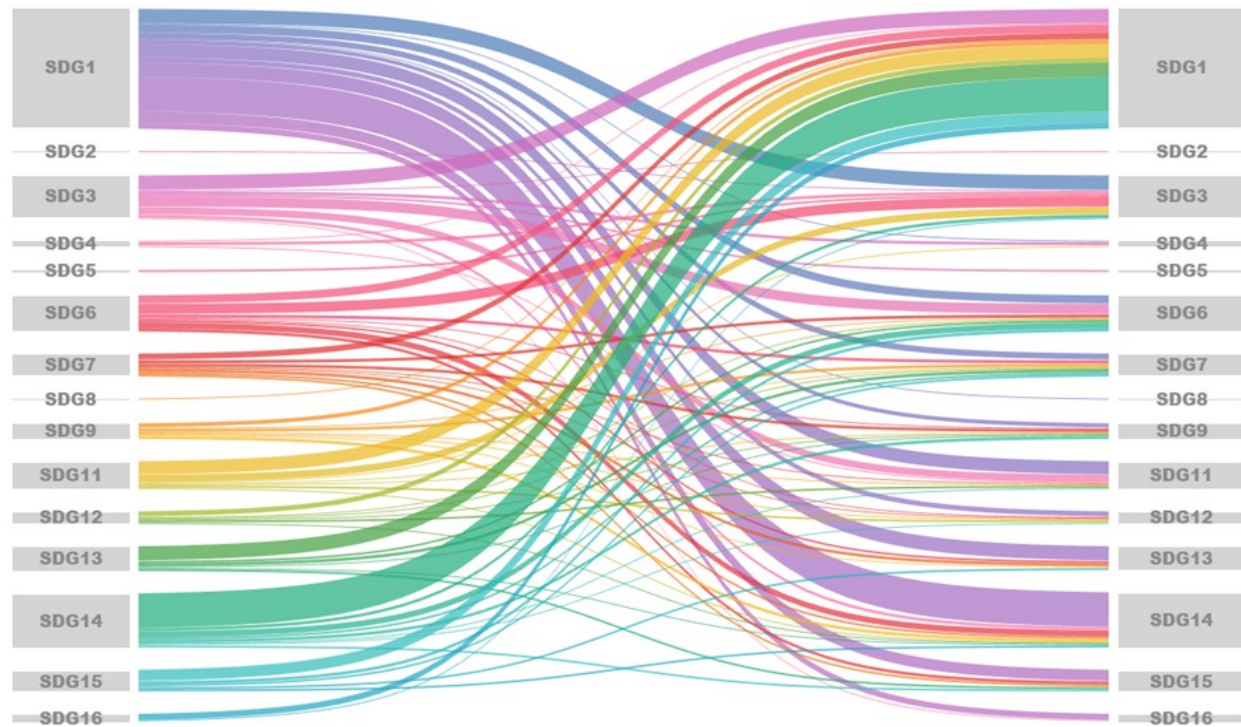|	Publications Count						% of Joint Authorships			
	KMU		NSYSU		Joint Authorship		KMU		NSYSU	
Years SDGs	2004-2011	2012-2020	2004-2011	2012-2020	2004-2011	2012-2020	2004-2011	2012-2020	2004-2011	2012-2020
SDG1	99	327	420	862	11	69	11.11%	21.10%	2.62%	8.00%
SDG2	9	30	10	33	-	5	0.00%	16.67%	0.00%	15.15%
SDG3	2,621	5,468	579	1,632	218	993	8.32%	18.16%	37.65%	60.85%
SDG4	26	72	98	222	-	8	0.00%	11.11%	0.00%	3.60%
SDG5	36	90	13	34	-	2	0.00%	2.22%	0.00%	5.88%
SDG6	65	75	151	211	4	19	6.15%	25.33%	2.65%	9.00%
SDG7	12	78	346	709	-	30	0.00%	38.46%	0.00%	4.23%
SDG8	8	22	73	147	-	1	0.00%	4.55%	0.00%	0.68%
SDG9	10	39	208	231	2	7	20.00%	17.95%	0.96%	3.03%
SDG10	16	53	37	95	-	-	0.00%	0.00%	0.00%	0.00%
SDG11	36	52	88	172	1	12	2.78%	23.08%	1.14%	6.98%
SDG12	4	17	68	113	2	3	50.00%	17.65%	2.94%	2.65%
SDG13	4	29	33	128	-	14	0.00%	48.28%	0.00%	10.94%
SDG14	9	62	149	265	5	29	55.56%	46.77%	3.36%	10.94%
SDG15	4	21	58	116	2	9	50.00%	42.86%	3.45%	7.76%
SDG16	24	88	31	77	2	4	8.33%	4.55%	6.45%	5.19%

Figure 3: Inter-relationships among SDGs of joint-authorship publications

Figure 4 shows the changes in percentages of joint authorship publications over time. Based on the change rate of percentages of joint authorship publications, we divided the 16 SDGs into three groups: high, medium, and low, as shown in Table 2. The groups of SDGs were different for the two universities, reflecting their differences in academic focus, which were also shown in their increases in a joint publication. For example, the increased rate of joint authorship publications for SDG3 falls into the medium group for KMU; as for NSYSU, the change rate for joint authorship publications of SDG3 falls into the high group, which increased by about 24% after the strategic alliance. For both universities, co-authored papers related to SDG2, SDG6, and SDG13 were in the high group after 2012, while those associated with SDG10, SDG12, and SDG16 decreased after 2012.
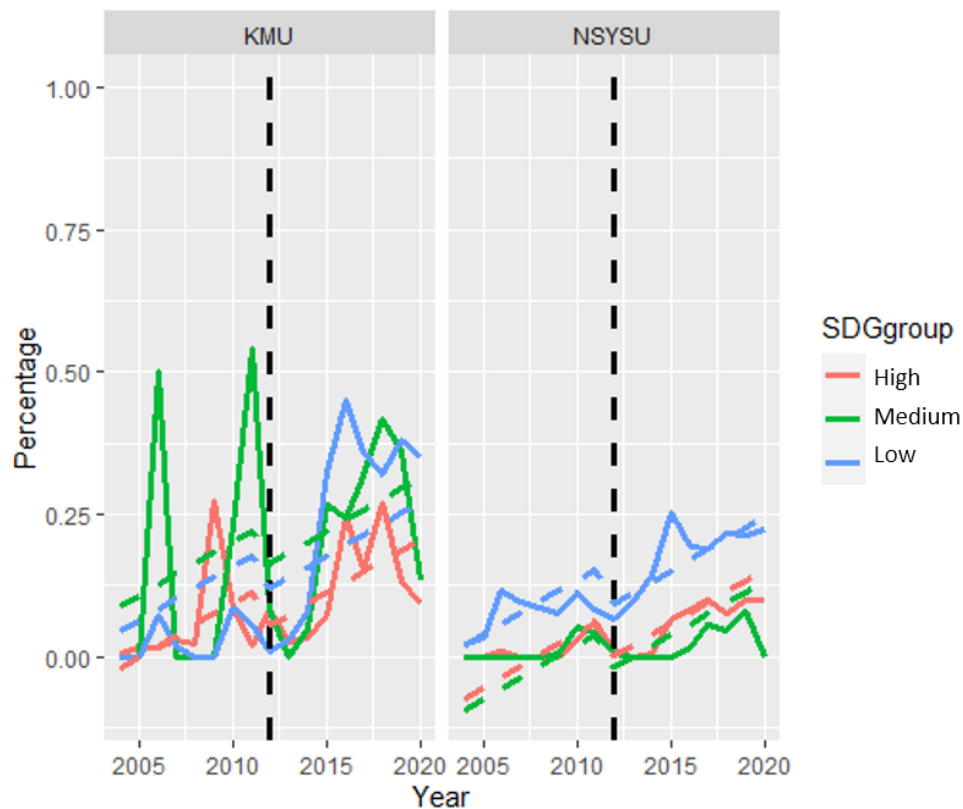
Figure 4: The rate of change in percentages of joint authorship publications

Table 2: SDG groups by change rate

University	KMU		NSYSU	
Groups	**SDGs**	**Change Rate**	**SDGs**	**Change Rate**
High	SDG01	0.113	SDG02	0.119
	SDG02	0.110	SDG03	0.240
	SDG06	0.207	SDG05	0.056
	SDG07	0.380	SDG06	0.066
	SDG11	0.228	SDG13	0.092
	SDG13	0.427	SDG14	0.066
Medium	SDG03	0.100	SDG01	0.053
	SDG04	0.103	SDG04	0.043
	SDG05	0.017	SDG07	0.044
	SDG08	0.037	SDG11	0.049
	SDG09	0.060	SDG15	0.049
	SDG10	0.000	SDG08	0.006
Low	SDG12	-0.500	SDG09	0.018
	SDG14	-0.159	SDG10	0.000
	SDG15	-0.067	SDG12	0.001
	SDG16	-0.028	SDG16	0.025

To assess the effects of various factors on the percentages of joint authorship publications, we included year, strategic alliance, university, SDG groups, and an interaction term between school and SDG group as predictors. As shown in Table 3, the year significantly predicts the percentage of joint authorship publications as the number increases with time ($\beta=0.02^{***}$, [0.01, 0.03]). We compared the regression results between different groups within each variable, the items in brackets indicating the reference group. The results showed a significant increase in the percentage of joint authorship publications after the strategic alliance ($\beta= -0.08^{*}$, [-0.14, -0.01]) and no significant difference between the two schools in the percentage of joint authorship publications ($\beta= -0.05$, [-0.11, 0.00]). For SDG groups, compared to the medium group, both the low-SDG group ($\beta=0.11^{***}$, [0.05, 0.17]) and the high-SDG group ($\beta=0.06^{*}$, [0.01, 0.12]) showed significant differences between schools. As for the interaction between schools and groups, the interaction effect shows that within NSYSU, the low group differs from the medium group in having a positive intercept and a lower slope. In addition, within the low-SDG group, the slope of KMU was significantly lower than that of the NSYSU.

Table 3. Regression Analysis Results

Predictors	Percentage of Joint Authorship Publications		
	Estimates	CI	p
(Intercept)	-38.08***	-50.98 – -25.18	**<0.001**
Year	0.02***	0.01 – 0.03	**<0.001**
Strategic Alliance [1]	-0.08*	-0.14 – -0.01	**0.015**
University[NSYSU]	-0.05	-0.11 – 0.00	0.057
SDG group [low]	0.11***	0.05 – 0.17	**<0.001**
SDG group [high]	0.06*	0.01 – 0.12	**0.020**
School [NSYSU] * SDG group [low]	-0.13**	-0.21 – -0.05	**0.002**
School [NSYSU] * SDG group [high]	0.03	-0.05 – 0.10	0.461
Observations	498		
R^2 / R^2 adjusted	0.208 / 0.196		

Notes:
-Alliance: 1=after strategic alliance; 0=before strategic alliance.
-University: NSYSU, KMU
-SDG group: high, medium, & low.

Discussion and Conclusion
Discussion
This research aimed to explore whether a strategic alliance between two universities will effectively promote sustainable development goals. The study echoed the results of Kale et al. (2000), that proposed that strategic alliances focus on cooperation between organizations to maintain or enhance their competitive advantages, consider long-term interests, and unite to pursue common goals. In addition, it also added new value to the complementarity of strategic alliances in HEIs.

By examining the joint authorship of publications related to different SDGs by scholars at both universities, we determined that institutions with diverse missions may benefit from forming a strategic alliance. First, we found that while there was no collaboration on SDGs 2, 5, 7, and 13 before 2012, after the formation of the alliance, the two universities attended to these goals to strengthen sustainable campus operations; curriculum development; and local, regional, national and international community outreach. For SDG2 (zero hunger), the two universities cooperatively developed the "Sustainable Development Plan for Namasia and Kaohsiung Original Township". It aims to ensure sustainable food production systems and agricultural practices through secure and equal access to land, knowledge, financial services, and opportunities for remunerative employment. For SDG5 (gender equality), the two universities have joint curricula on gender equality education and related issues to nurture respect for gender diversity, eliminate gender discrimination, and advance genuine gender equality. For SDG7 (affordable and clean energy) and SDG13 (climate action), the two universities have jointly conducted research and created centers, such as the Taiwan and Sri Lanka Environmental Change Sciences and Technology Innovation Center (TS/ECSTIC). The issues on which the center focuses include marine ecosystems, plant ecology, bio-resources, global warming, and anthropogenic impact on tropical and subtropical regions belts to meet SDGs goals in education and strengthen resilience and adaptive capacity to respond to climate-related hazards and natural disasters in these countries.

Second, previous studies emphasized the importance of organizational partnerships to effectively achieve SDGs (Casarejos et al., 2017; Thomas, 2015). In this study, we further focused on the sustainable development of NSYSU and KMU after the strategic alliance. We found that the two universities gained complementary advantages by helping each other in different research fields. For NSYSU, the percentage of joint authorship publications of SDG3 Good Health and Well-being increased from 37.65% to 60.85% after the strategic alliance. For KMU, while cooperation on SDG 3-related publications grew, SDG 7- and 13-related publications topped the list. As KMU focuses mainly on medicine, pharmacy, and health care, NSYSU's research capacity in natural science and engineering created opportunities for novel avenues of interdisciplinary collaboration. In recent years, the two universities combined their expertise in information technology, intelligent healthcare systems, and disease management to plan for global health cooperation plans to solve healthcare problems and promote the Goal of sustainable well-being.

Furthermore, after years of in-depth strategic alliance, NSYSU and KMU had achieved remarkable results in developing natural marine drugs, an intelligent diagnosis system for Alzheimer's disease, and assessing the risk of air pollution to human health. In the future, the two universities will continue to give substantive attention to SDGs research and international community outreach in medical fields, including applications of artificial intelligence, biomedical engineering, and translation medicine. López et al. (2019) asserted that HEIs could provide professional and cross-disciplinary contributions to solve real-world problems and achieve SDGs. The results from the current study parallel the earlier studies and add new insights, focusing on the value of the SDGs promotion and sharing through strategic alliance in Taiwan's higher education.

Implications and Recommendations

Higher education institutions are responsible for preparing future sustainability leaders and supporting the implementation of ambitious SDGs targets. This study showed that a strategic alliance between two universities could increase joint research and publications related to SDGs and implement projects that promote SDGs. It also fulfills the partnership goals proposed in SDG17. Overall, the strategic alliance provides a solid basis for achieving all the SDGs and makes an essential contribution to forming a society willing to support critical SDGs (e.g., global citizenship, gender equality, and respect for human rights). Despite their crucial role in social transformation, higher education institutions must grapple with several internal (e.g., curricula, ethical principles) and external (e.g., different types of audiences, political environment, stakeholders' interest) challenges and barriers.

Further, the study's results are mainly descriptive; hence, future studies may focus on qualitative approaches for a richer and clearer framework. Likewise, this is one of the first preliminary studies of strategic alliances, focusing on the alliance between two universities in Kaohsiung. Therefore, more studies can be done in the future to check the framework's validity for more institutions, including both public and private universities, from all areas of Taiwan. Success in achieving the SDGs will depend on action and collaboration by all actors. Therefore, we recommend that universities continue to form strategic alliances to initiate and facilitate cross-sectoral dialogue and action on SDG implementation, as well as play an essential role in policy development and advocacy for sustainable development. Higher education has a vital role in meeting the sustainable development challenges of our times, and it can do much more than offer advanced training and skills. Through strategic alliances that magnify their strengths, they have the potential to educate excellent teachers and other practitioners, conduct ground-breaking research and connect services to communities. Governments, multilateral agencies, and universities must work together to promote a sustainable development agenda by targeting publicly funded research and building cooperative partnerships across sectors.

Concluding Remarks

Through their extended research capabilities and activities, universities in strategic alliances play critical roles in providing the necessary knowledge, evidence-based solutions, and innovations to support achieving SDG goals. Strategic alliances have enabled universities to integrate multiple SDGs-related courses and collaborative projects to give students opportunities to reflect on issues related to SDGs and join networks set up to implement SDG programs. Besides helping to achieve SDGs through collaborative research, universities in strategic alliances can coordinate relevant research at individual sites and advocate for national support. They can also strengthen intra- and interdisciplinary research community efforts across campuses to support the SDGs and, in this way, have significant impacts on social, cultural, and environmentally sustainable development within their campuses, communities, nations, and, ultimately, the planet.

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Appendix – List of 17 Sustainable Development Goals (SDGs)

The 17 sustainable development goals (SDGs) to transform our world:

GOAL 1: No Poverty

GOAL 2: Zero Hunger

GOAL 3: Good Health and Well-being

GOAL 4: Quality Education

GOAL 5: Gender Equality

GOAL 6: Clean Water and Sanitation

GOAL 7: Affordable and Clean Energy

GOAL 8: Decent Work and Economic Growth

GOAL 9: Industry, Innovation and Infrastructure

GOAL 10: Reduced Inequality

GOAL 11: Sustainable Cities and Communities

GOAL 12: Responsible Consumption and Production

GOAL 13: Climate Action

GOAL 14: Life Below Water

GOAL 15: Life on Land

GOAL 16: Peace and Justice Strong Institutions

GOAL 17: Partnerships to achieve the Goal