Key strategies of sustainable and energy-saving development for green universities

Yi-Xin Cai1,a, Sheng-Jung Ou2, Hsuan-Hung Chen3, Chien-Chen Chiu4
1 Graduate Student program in Landscape and Urban design, Department of Landscape and Urban Design, Chaoyang University of Technology, Taiwan
2 Department of Landscape and Urban Design, Chaoyang University of Technology, Taiwan
3 Graduate Student program in Theme park management and analysis, Department of Architecture, Chaoyang University of Technology, Taiwan
4 Adjunct Lecturer of General Education Center, Chaoyang University of Technology, Taiwan

Email: acaiyixin840731@gmail.com

Abstract. Sustainable environment development has become a global and popular issue. In Taiwan, regardless of public authorities or private organizations, departments often promote green buildings, green campus and other practices according based upon different sustainable plans. In 2007, the Ministry of Education promoted the green universities and formally launched the Green University Development program. Subsequently, in 2009, 13 schools jointly signed "The Tallories Declaration" to promote the sustainable work of the Green University. Up to 2018, eight universities have entered the ranks of the world's largest green universities. For finding better sustainable development strategies to improve the Green university evaluation and environmental benefits, this study analyzes the current situation of the Green University in Taiwan and presents a trend analysis of the development of Green University assessment indicators in Chaoyang University of Technology (CYUT) over the years. Finally, through the analysis, the study proposes the concrete strategies for achieving green university's requirement, and proposes the key strategies of further achieving sustainable energy saving of green campus for Chaoyang University of Technology.

1. Introduction
As climate change intensifies, the world attaches great importance to the theme of "Sustainable development". The sustainable development and energy conservation issues are also widely discussed in university. The Green University originated in the 1972 The Stockholm Declaration, which was the first declaration of the Sustainability of higher education. In 1990 The Talloires Declaration was the first to express the high school reputation of the management class, declaring on the need for a sustainable development obligation and an indicator to the green university of the global university [1]. In 1992, Agenda 21 addressed the world's lack of environmental awareness, it was necessary to address the state of consumption of Earth resources through education. In 1993, the CRE-Copemicus Charter thought the university should become the leader of sustainable Society. In 2000, Earth Charter applied the sustainable concept into life, combined with formal education and lifelong education to promote the arts, humanities and science in the field of sustainable development of
education practice. In 2002, The Ubuntu Declaration input the key sustainable development into higher education, and asked education resources to lead sustainable development of relevant knowledge, education, and promote the development of a sustainable environment in primary, secondary, tertiary institutions and institutions [2]. In 2002, The Global Green University developed the indicator system, including environmental policy management, architecture equipment energy saving system, environmental education, and daily energy-saving behavior [3]. This shows that the preparation of the Green University must start from campus infrastructure to school environment education, the behavior of campus users, from top to bottom, from inside to outside to implement higher education responsibilities and obligations.

2. Method & data

2.1 Current Situation of Green University promotion in Taiwan

In 2007, Taiwan formally promoted the Green University program. In 2009, 13 universities signed The Talloires Declaration, which originated from French in 1990 and signed by presidents and leaders of the ten participating universities during the International Symposium held by the Tuft University in the United States. Since then, The Talloires Declaration has become the most valuable document for the university to promote sustainable development [4]. Up to date, Taiwan has 48 universities signed, the number of universities signed ranked after the United States and Brazil. To fulfill the social responsibility and task of higher education and put The Talloires Declaration in practice, the Ministry of Education held "the first Green University demonstration school levy activity" in 2009 and selected 13 universities as Taiwan's first green University Demonstration School. At the same year, the Ministry of Education commissioned the National Taiwan Normal University (NTNU) to establish the Green University indicator evaluation system that included environmental system, environmental management, environmental education, and so on. The evaluation of Green campus not only focused on school's energy resources, hard equipment, but also included the measures of the soft system and the common resources of the surrounding community. By doing so, the concept of green can become a regional type of sustainable development extending from campus to the adjacent community.

At present, the green university evaluation system of the world includes six categories: “Setting and Infrastructure”, ”Energy and Climate Change”, ”Waste”, ”Water”, ”Transportation”, and ”Education”. In comparison with the current evaluative system of Green University in Taiwan, the World Green University focused more on the basic equipment, resources and other factors that have a lasting impact on the environment. In 2012, NTNU was actively preparing for the work related to the alliance of the Taiwan Green University. The Alliance established in 2013. Up to date, 51 universities have applied to join the Alliance to jointly strive for and promote the sustainable environment of Green University every year [5]. According to the 2017 UI Green Metric World Universities Ranking, in the overall rankings, eight universities in Taiwan have been listed within the ranks of hundred [6]. In 2010, only three Taiwan universities were in the list, which showed there were preliminary results in the promotion of green universities in Taiwan. At present, there are 163 education schools in Taiwan, only 51 of them involve the work of green university. It is expected that through the strategic analysis of Green University development, we will have more universities participating in this great mission and achieve the goal of becoming an effective energy-saving and reducing carbon campus.
2.2 Development status of Green University in Chaoyang University of Technology (CYUT)

CYUT founded in 1994. In 2009, after the signing The Talloires Declaration, CYUT started the development of sustainable campus environment in order to move towards a low-carbon campus. From promoting the strategies of "Management System Introducing", "Facilities Improvement", "Sustainable Activities Promotion" and "Sustainable Curriculum Planning", CYUT had paid more efforts on the dimensions of "Environmental Management", "Energy Resources Management", "Safety and Health Management" and "Disaster Prevention Management" to achieve a sustainable campus environment [7]. As shown in Figure 1, from 2014 to 2017, the rank of participating in UI Green Metric World Universities, the scores in the worldwide university ratings showed that there is a significant upward trend in the number of projects per year.

CYUT is located in the hillside area. In order to practice ecological campus and Green University, CYUT adopted the basic blueprint of campus to construct hardware facilities, plan campus Landscape Greening and plant a large number of trees so that CYUT achieve the goal of lowering carbon emission. At present, the campus greening area is about 94.43%, in addition to greening and lowering carbon emission, CYUT put a number of sustainable environmental facilities in the campus including: reclaimed water facilities, related energy management systems, rainwater facilities, roof insulation facilities, and solar photovoltaic systems. In addition to hardware facilities, in recent years, CYUT are also committed to environmental education, such as environmental volunteer training, environmental camp, environmental education facilities, and environmental education advocacy. CYUT also integrates curriculum features such as energy-saving and water-saving buildings, water resources, natural environment and disaster prevention. The related actions not only enable students to understand the importance of sustainable campus through environmental advocacy and curriculum communication, but also encourage teachers and students participate in sustainable energy-saving green University together. In order to improve the evaluation result of CYUT in green universities, this study compares the performance of the 2017 UI Green Metric World Universities ranking among National Pingtung University of Science & Technology (NPUST), National Chi Nan University (NCNU), and CYUT. From the comparison, CYUT can find out its own shortcomings and think of the future strategic directions towards a better green University and sustainable campus.

Table 1. Comparison of 2017 UI Green Metric World University quantity assessment among NPUST, NCNU, and CYUT [6]

| Dimension                  | NPUST | NCNU | CYUT |
|----------------------------|-------|------|------|
| Setting and Infrastructure | 933   | 977  | 757  |
| Energy and Climate Change  | 976   | 1049 | 1349 |
| Waste                      | 1101  | 1452 | 1527 |
| Water                      | 825   | 515  | 557  |
| Transportation             | 1162  | 1063 | 863  |
Table 1 shows that CYUT has lower scores in the dimension of Setting and Infrastructure, Water, Transportation, and Education in comparison with other two universities. However, CYUT has better performances on the project of energy and climate change, and waste. The differences are resulted from campus’ geographical environment, basic facilities, and professional areas. Although the assessment only shows the final score, the practices of Green University are obviously different. The following content will examine the differences of dimension among universities:

**Setting and Infrastructure:** In this dimension, CYUT obviously has a score lower than other schools. The assessment contains the basic campus environment and infrastructure. The campus size of other two schools is bigger than CYUT, so that the operation of the Green University field is wider in other schools. In addition, the other schools’ manpower participating in the green university is also higher than the CYUT. Since it is limited by the status quo, this dimension is less able to get better performances in the future.

**Energy and Climate Change:** Compared to other schools, CYUT has the highest score in this dimension. Reviewing the literature, we found that NPUST built a large number of solar panels into teaching of agricultural facilities, so that facilities become the key to the development of renewable energy. In addition, because of the advantages of agricultural specialty and the development of biomass, renewable energy is diverse and the power supply of the original resources in NPUST has been rationally utilized. CYUT is expected to make more use of the campus space and professional resources to develop a more diversified energy system in the future.

**Waste:** Compared to other schools, CYUT also has the highest score in this dimension. CYUT has an effective way to handle waste disposal. In addition to having new facilities, CYUT advocates campus users to maintain environmental policy is also an important key to minimize the risk of pollution. Every CYUT member has a strong intention to get together and protect the green campus environment. In this dimension, CYUT should continue its original actions.

**Water:** NCNU used the reclaimed water recovery system to create an ecological pool and create a biological habitat. It not only doubles the benefits, but also enriches the campus landscape. NPUST also introduced the conservation of the natural environment into the concept of water recycling, and set up a variety of habitat management systems for groundwater pools, lakes and ponds. In addition, the organic wastewater for agriculture is treated naturally and is used in the campus air-cooling water tower. CYUT also has a system for the recovery of reclaimed water, which will eventually use in toilets. For having a better performance in this dimension, CYUT needs to create more ecological habitats to enhance overall sustainability.

**Transportation:** Because the geographical environment of the campus is different, the transportation evaluation is obviously different. CYUT is located in the hillside, so that promoting the use of bicycles is highly impossible. Other than that, in the part of public transportation and other related transportation policies are all similar in three universities. CYUT can communicate with city government to increase the bus frequency and encourage teachers and students to take buses by the rewarding strategy.

**Education:** Participating in the Green University's higher education schools all pay more attention to and promote the development of school software system. In 2016, NPUST obtained a full score in this dimension. Its specialization in the field of the relevant environment and sustainable education courses also received the budgetary support from government. NPUST’s good performance revealed that using education as a core concept to carry on sustainable development is worthy of reference. CYUT needs to learn from that
and take systematic actions as soon as possible.

3. Results & discussion
To achieve the goal of sustainable campus development at Green University, the following content will compare the development strategies of the three universities in each dimension and take CYUT as an example to explore the future operating systems to improve the performance in each dimension.

3.1 Analysis on the development strategy of Green University
NPUST: In accordance with the goal of green and sustainable university, the following strategies can be considered including the environmental maintenance vision of the world, the effective use of waste resources, reduce of the non-environmental transport in school access, and education as sustainable development as the core, the implementation of the concept of Green University [8].
NNU: To achieve the goal of sustainable environment of ecology, energy saving, safety and health, the following strategies such as promotion of Green University White Paper, comprehensive promotion of environmental education, maintaining the campus ecology and humane environment, maintaining environmental quality, energy saving and carbon reduction, implementing campus safety and health management, and building green university management system as the framework should be considered [9].
CYUT: To achieve the goal of low carbon campus environment, the strategies such as using environmental management, energy management, safety and sanitary management, and disaster control and prevention management, positively promote the introduction of management system, improvement of facilities, promotion of sustainable activities, and planning the sustainable courses should be considered [7].

The driving factors for making better development of green university for CYUT can be divided into three dimensions, building sustainable environment, introducing management system, and promoting sustainable activities and planning sustainable curriculum. This study also proposed six strategies and six operational actions to correspond with each driving factor (see Table 2).

| Table2. Strategic development of Green University for CYUT |
|------------------------------------------------------------|
| Project and Infrastructure                                | Strategy                          | Operational Actions                                                                 |
| Setting and Infrastructure Building Sustainable Environment | Building Sustainable Environment  | Improving the impermeable pavement and making full use of the topography to create the ecological environment. |
| Energy and Climate Change Effective use of school internal energy resources | Maximizing the pollution reduction | Taking advantage of all resources as equipment for sustainable development and improving energy-saving system rationally and comprehensively. |
| Waste Introducing Management System Diversifying the Use of Water Resources | Strengthening water recycling systems and creating biodiversity habitats. |
| Transportation Building Green Transportation System         | Increasing intelligent transportation system, reducing non-green transportation access to campus. |
| Education Promoting Sustainable Activities and Planning Sustainable Curriculum | Implementing the environmental education system | Integrating sustainable development issues into interdisciplinary curricula and developing more effective environmental education venues. |

4. Conclusion
After literature comparison and discussion, this study proposes the development strategies of operating Green University for CYUT in the future. The study also pointed out the weakness of CYUT in the performances of different dimensions. The study result revealed that sustainable development could
not only rely on school facilities as the main development tools. In fact, education is the core of sustainable development. Through education, the concept of energy-saving development for green university has the possibility to spread. It is expected that 163 universities in Taiwan can work together in implementing the green university actions in the future. If we continue to use university as the core and expand to the surrounding neighborhoods, the overall green environment area will be foreseen.

5. References
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