Sustainable Campus Development in the Context of a Private Higher Education Institution in Hong Kong, a Case Study at the Hang Seng University of Hong Kong

H H Y Lee
Campus Development and Management Office, The Hang Seng University of Hong Kong, Hang Shin Link, Siu Lek Yuen, Shatin, New Territories, Hong Kong

hackmanlee@hsu.edu.hk

Abstract. There was a trend of increasing private higher education institutions in Hong Kong, some higher education institutions implemented sustainable campus development despite of financial difficulties with main aim to continue the concepts and values of sustainability for the achievement of purpose of education for diffusion to the society. This paper reviewed sustainable campus development by looking at the physical environmental aspects, organizational changes and operational barriers. Moreover, different green building rating systems were discussed. It also summarized the impacts after completion of a sustainable campus development at the Hang Seng University of Hong Kong including changes in habits and behaviour, organizational re-structuring, enhancement of sustainable attributes to policy and strategic plans as well as external influences and relationships. The results demonstrated how a sustainable campus development could transform concepts, values and attitudes in relation to sustainability on individual, organizations and the society for practices.

1. Introduction
Following with the Chief Executive’s Policy Address 2009 in Hong Kong for the needs of quality private higher education, there was a trend of increasing of private higher education institutions. [1] and [2] highlighted the major changes for the public funded and self-financed private higher education institutions in Hong Kong has been shifted from a traditional model to a more diversified higher education with different strengths and specialists in responding to high demands of tertiary education needs. By taking this opportunity, some institutions implemented sustainable campus development by construction of new building facilities over the new lands with green and sustainable features.

According to [3] that common characteristic of learning outcomes from a sustainable development in higher education institutions was integrated with three components: systematic approach for holistic thinking, integration of sustainability perspectives and relevant skills adopted. Moreover, it was recommended to review stakeholders’ attitudes, values, approaches to knowledge, which contributed to address the whole educational process in a more holistic way. The organizations of higher education institutions were required to develop and maintain sustainable communities by understanding the definitions of sustainability, the relationships between sustainability and lives / values, how the actions influencing the issue of sustainability, how to utilize appropriate knowledge to change habits and behaviour. Finally, in order to achieve the purpose of education, “Changes” was the agent and crucial to apply the concepts and values of sustainability locally and globally.
2. Overview of sustainable campus development in higher education institutions

According to [7] and [9] that primary objective of sustainable campus development in higher education institutions is education, which was important and sole priority for addressing sustainable development with considerations to the planning, implementation, stakeholders’ engagement and participation, campus operations, sustainability reporting and assessment. In addition, [7] highlighted in a study of campus students’ perceptions of campus sustainability influenced by the four categories: ecological, economic/financial, institutional and energetic. [6] identified major concerns on increasing wasteful consumption and pollution, which caused knowledge and commitment gaps deteriorating the objectives of the concept of sustainability, a barrier for successfully implementation of sustainability and recommended considering students as the future leaders by adoption of incentive to stakeholders of a university to engage in campus sustainability.

2.1. Physical environmental aspects

The sustainable campus development in the 90’s was filled up with fundamental physical environmental aspects such as green buildings, renewable energy systems, organic food and farm, enriched native biodiversity, low-pollution transportation systems, bicycle paths, onsite rainwater-storage tanks, grey and black water-treatment systems, socially invested endowments, green chemistry practices, zero solid waste laboratories, green cleaning products, and low green-house gas emitting campus utilities [4]. One of fundamental environmental aspects is to optimize of maintenance operation cost by focusing on the understanding the life-cycle costing analysis on building components of which the durability was crucial to the contribution of building sustainability [5]. [6] echoed that sustainable building maintenance contributed to the reduction of life-cycle cost and carbon emission. The application of sustainable building materials could improve employment opportunities in the construction and repair and maintenance activities and improvement of durability in life-cycle as a result.

2.2. Organizational changes

[8] concerned with that achievement only on sustainability results in relation to physical environmental aspects was not holistic without extension of sustainability’s awareness to the next generation and recommended to align with the objectives, organizational change management and curriculum development, which were required from the strategic direction of senior management of higher education institutions. In addition, [8] suggested to develop a clear strategy and policy with application of sustainable development indicators together with identified feasible actions for assessment and improvement plans if the indicators could not be met. Campus sustainability campaign could be more focused towards organizational change together with a master planning for implementation as advised by [4]. Moreover, when higher education institutions considering management change after sustainable campus development, it was worth investigating destabilizing factors in relation to political, financial, human resource, technological or others, which could influence on the whole sustainability processes. [4] also recommended to create a new organizational position to manage with sustainable campus development from master planning to implementation.

2.3. Operational barriers

The sustainable campus development could not be implemented successfully without adequate financial and human resources as well as organizational leadership. In a worldwide survey conducted by [10] that there were several inter-related elements within higher education institutions’ organizational system during the implementation of sustainability including commitment, integration into sustainable policies and strategies, signing a declaration, charter or initiative, formulating of short, medium and long terms plans for its implementation, and ensuring the sustainable development was implemented successfully throughout the institutional system. However, [11] revealed that sustainability could only be achieved by overcoming operational barriers and challenges with understanding the roles, concepts as well as the perceptions of sustainability from the stakeholders of institutions. The operational barriers were mostly related to the aspects of financial resources, information, human resources, commitment, initiatives and participation, wrong conceptualization of organizational structures and resistant to change.
3. Overview of green building rating

The assessment of green building rating consisted of both quantitative and qualitative criteria. The energy and water uses were in quantitative criteria while indoor environmental quality was descriptive quality data. [14] identified seven key credit criteria for rating tools including site, energy, water, indoor environmental quality, material, waste and pollution and management, in which the “Energy” was most widely considered and then following with indoor environmental quality and water. For a holistic approach of rating, the assessment methods could be further improved by incorporating other considerations such as reporting strategy, education alignment and stakeholders’ awareness, cost optimization, and how rating was attributed to the relationships of stakeholders. [17] listed a comprehensive set of performance criteria for a wide range of sustainability elements covering master planning, building design and construction, post construction and operation as well as fit-out and with nine major assessment aspects including community, site, green building attributes, management, materials and waste, energy use, water use, indoor/outdoor environmental quality and innovation and additions.

[12] reviewed rating systems in different countries including Hong Kong with identification on various impacts of the certification of green building on original design of green aspects due to changes on environmental parameters from the operational and maintenance phases after building occupation. The assessment has been shifted from individual building to considering neighbourhood, which was echoed by the Leadership in Energy and Environment Design (LEED), Building Research Establishment’s Environmental Assessment Method (BREEAM), Comprehensive Assessment System for Building Environment Efficiency (CASBEE) and Hong Kong Building Environmental Assessment Method (HK- BEAM), Green Mark Scheme (GMS) and Assessment Standard for Green Building (ASGB). [13] compared of site planning and design among LEED, BREEAM, HK- BEAM, GMS and ASGB with HK- BEAM allocated with the highest weights on site planning and design in which cultural heritage and neighbourhood daylight factors were addressed.

[17] indicated that a building only constructed with green walls and solar panels to beautify and protect the environment might not be sufficient meeting with criteria for classification as green building unless a building with reduction of environmental impacts, enhancement health by life-cycle analysis, optimizing efficient use of energy, installation of renewable energy and eco-friendly materials to minimize carbon footprint and emission, reducing the production of waste, preventing pollution, enhancing indoor environmental quality through natural ventilation and lighting. [15] and[16] revealed that there was a trend to incorporate building information modelling (BIM) for simulation of the environmental performance in terms of light pollution, energy performance, reduction of CO2 emission, renewable energy system, energy efficient building layout, thermal comfort, interior and external lighting and other green features, which could enhance the effectiveness of rating tools with successful implementation for certification.

4. Implementation of sustainable campus development in Hang Seng University of Hong Kong

In order to meet with the needs and demands of university education in the 21st century, the Board of Governors of the Hang Seng University of Hong Kong, a private higher education institution, had determination with foresight to significantly transform the physical campus in the last seven years through a massive and ambitious with aims to create a well-designed modern university campus that promotes academic learning, interactive teaching and learning activities, closely interactions among members of the university community and an active student life. Particularly, the university’s main goal was to embrace modern environmental-friendly concepts that could contribute to conserving the environment for future generations. It was the belief in transforming young generation to environmental protection as their 2nd nature and has introduced proactive environment design with architectural planning / design, featuring advanced building services technology such as district cooling and chilled ceiling air conditioning system by radiation.
4.1. Vision and mission for campus expansion projects

With clear vision and mission to transform the university to meeting with green building certification, the planning and construction of campus expansion project for two academic buildings, one sports and amenities centre and a residential college since 2011 till 2015. The projects were under the management of a steering committee to control and monitor the construction processes with respect to time, cost and quality from conceptual design to practical completion. The total construction cost for sustainable campus development was HK$1,530M contributing 44,308m² in gross floor area. With a very tight project budget, the construction of residential colleges with HK$200M (50% on construction cost including furniture, fixtures and equipment) donated by the charities of the Hong Kong Jockey Club. Moreover, in order to achieve sustainability on construction and facilities management after occupation, Building Information Modelling (BIM) was adopted for long term application with respect to operational facilities management.

4.2. Green and sustainable features

The design of sustainable campus development was adopted with a consistency approach for common green features design incorporation of architectural fins, low-e glass for curtain wall, high-insulating double-glazed fenestration and all classrooms, lecture theatres and other function rooms at perimeter zones for new buildings. An organic farm was provided in the roof of sports and amenities centre. For building material procurement, contractors ordered from regionally manufactured material.

Apart from the green roof design, high emissivity roofing system with 90% roof coverage and 53% green coverage, it was adopted to use heat recovery pumps in the indoor swimming pool and energy efficient chillers, fans and pumps in air-conditioning system. For minimizing the spare cooling loading capacity of the chillers, district cooling and chilled ceiling system were installed. There were extensive use of daylight sensors and occupancy sensors for teaching and non-teaching facilities. For the indoor air quality, excellent class was achieved. The projects adopted purchasing large quantity of bamboo furniture and fixtures, which were recognised as environmental friendly products. Overall, there was 28% operating energy saving for the new buildings in the main campus.

Figure 1. HK-BEAM Plus “Platinum” Achievement

Figure 2. District Cooling System

Figure 3. Chilled Ceiling by Radiation
There was 32.8% annual operating energy saving in the residential colleges, with 4.3% energy contributed from the photovoltaic panels installed at all roofs to the common areas. Recycling systems for both rainwater and greywater were adopted for reducing of fresh water consumption, which could save by 54.8% in non-potable water. In order to encourage the residential life interactions among students, masters, tutors, outdoor greenery with roof gardens were constructed.

### Figure 4. Photovoltaic (PV) Panels in Resident Colleges

### Figure 5. Acoustic Bamboo Wall Panel

#### 4.3. HK-BEAM assessment and appeal

For meeting with the HK-BEAM “Platinum” achievement, a minimum score of 75 was required. One academic building and residential colleges received overall scores of 76.7 and 79.8 respectively after the final assessment, and therefore, “Platinum” was awarded. However, another new academic building and sports and amenities centre received overall scores of 73.1 and 74.1 respectively. With only a very little gap of score differences of 1.9 and 0.9 respectively, the building services engineering and environmental consultants had confidence for appeal with supplement of additional engineering data/information in the system design. Eventually, these two buildings were successfully appeal for HK-BEAM “Platinum”. Table 1 summarized the credits on different aspects granted as well as the scores after appeal.

| Building                        | Aspects                                      | Accepted (✓) | Score after appeal |
|---------------------------------|----------------------------------------------|--------------|--------------------|
| Academic building               | (i) Provision of recreational facilities     | ✓            | 76.9               |
|                                 | (ii) Material aspect                          | ✓            | Platinum           |
|                                 | • Flexible engineering services              | ✓            |                    |
|                                 | • Structural adaptability                     | ✓            |                    |
|                                 | (iii) Energy use                              | ✓            |                    |
|                                 | • Commissioning plan                          | ✓            | 75.3               |
|                                 | • Indoor environmental quality                | ✓            | Platinum           |
|                                 | • Local exhaust and natural lighting          | ✓            |                    |
| Sports and amenities centre     | (iv)                                         | ✓            |                    |

However, the following aspects could not be granted after appealing due to the following reasons.

- Modular and standardized design: due to the irregular shape and facilities loading in various floors, the design of structural beams could not be in consistency dimensions. Moreover, the luminaires and air-conditioning designs were of less than 50% in same models.
• Water Efficient Appliance: the calculation to demonstrate water saving through the use of swimming pool cover could not be comprised in terms of seasonal temperature differences and the back-wash water saving assumption.

• Security: With the open campus design, there was no provision in security fence in the campus, therefore no credit was granted.

• Access for Persons with Disability: The barrier free access design was complied with obligatory requirements with two items for enhancement, which was not complied with minimum of 3 different enhance provisions.

4.4. Impacts after sustainable campus development

The university campus mixed up with old and new building facilities after completion of sustainable campus development in 2015. Over the past three years, it was observed that the overall impacts not only focused on the new green features in the physical environments, it also impacted significantly on the organizational structure and individuals in terms of learning and growth for practicing of developed values and concepts in sustainability including changes of habits and behaviour, organizational re-structuring by establishing a working group on sustainability with members from students’ representatives, academic and administrative units. With these on-going initiatives in participating with promotions and campaigns in relation to sustainability, it maintained and improved a good relationship with the neighbourhood society.

4.4.1. Habits and behaviour

With collaboration and participation from the students and staff in campus life, one of the most obvious impacts was reduction in consumption of utilities particularly for electricity and water usage, which contributed to annual saving by 3.5%, 5% and 7.5% of total utilities charges in 2016, 2017 and 2018 respectively. The university adopted a self-finance model for operation of the residential colleges, the students and staff understood the importance for balancing both operating and capital expenses as well as the life-cycle of building and building services systems. In annual discussion of increasing for residential fees, resident students and staff adopted a proactive approach by identifying potential energy saving opportunities for the campus management’s consideration. With popularity of organic green farming, one of the green activities, students proposed to install food waste disposal recycling machines in order to complete a food recycle process. Although these initiatives resulted in optimization of the operating expenses in the residential colleges, the positive influences provided the essential foundation for achieving the primary objective in sustainable education developed for the future leader of next generation as highlighted by [7], [9] and [14].

4.4.2. Organizational re-structuring

Since sustainability was not a one-off strategic goal but a long-term continuous objective, a formal working group on “Energy Conservation and Sustainability” was established in 2015, chaired by a vice president with members from the Green Society of student representative, academic and administration offices for formulating sustainable policies and strategy for implementation. In the long-term strategic planning, the university aimed to establish a unique habitat office to look after all hard and soft sustainable elements for a cycle of ecology, i.e. trees, insects, birds and fish in the campus environment. These results agreed with the similar views as mentioned in [4], [9], [10] and [11] for organizational changes with master planning, policies and strategies in sustainability. Besides, “Institute for Youth Sustainability Leadership” was also established, and the university was the first private university to attain the United Nations’ 17 sustainable development goals, which could fill up gaps of the commitment in sustainability as argued in [7].

4.4.3. Enhancement of sustainable attributes to policy and strategic plans

The primary influence was the review of university procurement policy by incorporating green procurement policy for purchasing environmental friendly products such as bamboo furniture, wall acoustic panels in new and improvement projects. Moreover, all available building information data in the building information modelling (BIM) could be used for facilities management (FM) application for operational management efficiency. With
all eyes catching on the new built facilities after sustainable campus development, old facilities became unattractive. In order to minimize the gaps of the dilemma, life-cycle analysis of building services and building fabrics was conducted, which had direct impacts on devising maintenance strategy and polices for optimization of facilities operation and upgrading as well as improvement of the old facilities. For the university’s Five-year Strategic Plan 2018–2023 that there was one strategic focus area in relation to sustainable campus and resources management, which required a more long-term strategic planning in terms of conducting facilities improvement for sustainable development and improving administrative and support processes for operational efficiency. The impacts agreed with the conclusions highlighted in [5] and [6].

4.4.4. External influences and relationship. The university organized the first international conference HSMC Symposium on Sustainability and Bamboo for the promotion of environmental awareness and sustainability as well as the product manufactured from bamboo in 2015. The symposium attracted public sectors, academia, practitioners, and professional bodies including UNESCO, iiSBE, Construction Industry Council, Friends of the Earth, students from post-secondary institutions and secondary schools. Subsequently, there were numbers of conferences, workshops, seminars and campus visits related to green and sustainability. The campus management office also organized workshops and seminars in relation to organic vegetable planting, valuable tree saving (incense tree) and green arts. In order to align with the Earth Hour by world green organizations, the university developed its’ own HSMC Quarterly Hour for increasing frequency of the green campaigns. In terms of commitment in sustainability as highlighted by [11] and [14], the university participated in relevant green campaigns on a regular basis including Green Building Awards, Energy Saving Championship, 4-T Charter (Target, Time, Transparency and Together) in energy saving opportunities. In addition, facilities in the sustainable campus could be used by the neighbourhood for maintaining and improvement for better relationships with nearby residents and society including bicycle parking, covered seating areas, podium gardens with gymnasium facilities, arts exhibition. Table 2 summarized the impacts after completion of sustainable campus development.

| Habits and behaviour | Contribution to utilities reduction |
|----------------------|-----------------------------------|
|                      | Awareness of life-cycle costing for building management |
|                      | Proactive in identifying energy saving opportunities |
| Organizational re-structuring | Working Group on Energy Conservation and Sustainability |
|                      | Habitat Office to look after sustainability and ecology |
|                      | Institute for Youth Sustainability Leadership |
| Enhancement of sustainable attributes to policy and strategic plans | Green procurement policy |
|                      | Utilize BIM data for FM applications |
|                      | Life-cycle analysis for optimization of maintenance cost |
|                      | 5-year Strategic Plan for sustainable campus and resources management |
| External influences and relationships | Conferences, symposiums, workshops, seminars and green campus visits |
|                      | Quarterly Hour for switching off lightings |
|                      | Green campaigns and charters |
|                      | Facilities sharing by the neighbourhood |

5. Conclusions
This paper summarized results after implementation of sustainable campus development in a private higher education institution and provided an indication of positive influences on habits and behaviour, organizational re-structuring, enhancement of sustainable attributes to policy and strategic plans and external influences and improvement of external relationships. In order to obtain more in-depth views
and opinions, it was recommended to follow [7] to obtain an in-depth analysis on how the sustainable performance could be measured in a medium period, i.e. 2 to 3 years after implementation of sustainable campus development. Moreover, it could be followed up with [13] on the in-depth study on identification of appropriate ways for reporting on sustainable projects and how they were related with different stakeholders internally and externally, which would provide an in-depth understanding on relationships among developed values, concepts, attitude for further development of strategical, tactical and operational skills for better management of a sustainable campus.

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