Journal of Engineering Science and Technology
Special Issue on ISSC'2016, April (2017) 74 - 85
© School of Engineering, Taylor's University

SUSTAINABLE OPERATION PRACTICES: THE CASE OF UNIVERSITI KEBANGSAAN MALAYSIA

HUSAYNI IDI KWAMI[1], ABDUL HALIM ISMAIL[2,3], ADI IRFAN CHE-ANI[3,*], HALIZAH OMAR[2], MAHARAM MAMAT[2]

[1]Department of Building, Kaduna Polytechnic, Kaduna, Nigeria.
[2]Pusat Citra Universiti, Universiti Kebangsaan Malaysia
[3]Department of Architecture, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia
*Corresponding Author: adiirfan@gmail.com

Abstract

University operations are very complex, alter the biophysical environment, and involve considerable unsustainable energy, water, transportation, waste generation, and materials consumption. Human and material resource interaction is also required in day-to-day operations. Therefore, the objective of this study is to develop indicators to assess sustainability operations in Universiti Kebangsaan Malaysia (UKM). The researchers administered a survey questionnaire to 37 sampled staff respondents from two research institutes that closely related to sustainability practices, and the result of the analyzed data showed that both p-values are greater than 0.05 at 95% level of significance. Thus, the hypothesis postulating that the mean responses of the staff regarding the sustainability of operational activities do not differ based on their institutions and experience is accepted. Study results also show that the sustainability of university operations are at a medium-to-low level, with a mean score of 2.80 or a 56% (silver) rating. This medium-to-low mean score was attributed to high water and energy consumption, high carbon footprint, and greenhouse gas emissions. UKM operational activities generate a high carbon footprint. Thus, the university must strive to improve its present silver rating to gold or platinum levels of 65%+ and 85%+, respectively. The researchers conclude that operational activities in UKM are not really sustainable, and the university must enhance its physical planning and operations management by following Malaysian Green Building Index requirements and establishing an effectively funded sustainability office for research and action planning to successfully fulfill its teaching and research functions.

Keywords: Campus operations, Footprint, Higher education, Sustainable university, Talloires declaration.

Abbreviations

AASHE	Association for the Advancement of Sustainability in Higher Education
ACUPCC	American College and University Presidents Climate Commitment
EC	Ecological campus
GC	Green campus
GCI	Green Campus Index
GHG	Greenhouse gas
HEIs	Higher educational institutions
LESTARI	LESTARI
NWLF	National Wild Life Federation
SD	Sustainable development
SERI	SERI
STARS	Sustainability Tracking and Rating Systems
SU	Sustainable university
TD	Talloires Declaration
UKM	Universiti Kebangsaan Malaysia
ULSF	University Leaders for A Sustainable Future
UN	United Nations
VOCs	Volatile organic compounds

1. Introduction

The Talloires Declaration (TD) in 1990 represented a global commitment to sustainability by higher educational institutions (HEIs). TD has 440 signatories worldwide as of 15 May 2012 [1]. The first official statement on campus sustainability was based on the 10-point action plan developed by the 1990 TD, which was in turn adopted from the United Nations (UN) Decade of Education for Sustainable Development (2005–2014) in December 2002 [1].

A university is not only a place to pursue knowledge but is also a place to nurture the personalities of graduates. Graduates eventually contribute to national growth either directly or indirectly. Thus, educating them on sustainability is significant [2,3]. An increasing number of HEIs have been incorporating and institutionalizing sustainable development (SD) principles into their curricula, research, operations, outreach, and assessment and reporting [4].

Research on sustainable campuses (SUs) began in Europe and America in the mid-1990s. The researchers maintain the use of the term "sustainable campus" in this discussion to avoid confusion with the concepts sustainable university (SU), green campus (GC), or ecological campus (EC). The issue has also been intensified by pressure from government environment-protection agencies, sustainability movements, university stakeholders, student, activists, and non-governmental organizations [5].

Therefore, an SU, GC, or EC promotes the partial or full minimization of the negative effects of university responsibility fulfillment [6]. Royse [7] states that an SU meets the needs of the present generation via ecologically sound, socially just, and economically viable operations without compromising future needs. Orr [8] encourages universities worldwide to regard their respective campuses "as

living laboratories" that allow students to learn, faculty to teach, and staff to work within a global model system.

In sum, HEIs induce systemic changes toward sustainability by simultaneously re-orienting education, research, operations, and community outreach activities either as a whole or in part amidst educational reforms toward efficiency, accountability, privatization, management, and control. These reforms may not be conducive for re-orientation [9,10].

Sustainable operational practice entails the effective physical planning and management of the daily university operations and activities to minimize negative footprints on the environment and the community. The three sustainability spheres (people, economy, and environment) must be considered in the policies, visions, and targets of physical and academic planning in institutions to benefit present and future generations. Sustainable operational activities in a school encourage the sustainability concept and are a teaching tool. Sustainable site planning and landscaping provide outdoor learning environments for students; a good building envelope design increases student and teacher comfort levels; integrated efficient lighting and high building-environment quality improves student performance; and the banning of idle buses or delivery trucks emitting greenhouse gas (GHG) emissions near buildings reduces the amount of harmful emissions and improves air quality in and around the school.

Using green supplies and materials helps minimize possible sources of toxins, allergens, and other harmful pollutants, such as volatile organic compounds (VOCs) and formaldehyde [11]. Heating, cooling, and ventilation systems must be designed and maintained properly to run quietly and efficiently, therefore preventing noisy distractions to student learning and contributing greatly to the sustainability status of the school. On-site renewable energy sources, such as photovoltaic systems, can encourage student interest in alternative energy sources [12]. Reduced life cycles, pollution, landfill waste, and operating and maintenance costs yield social, economic, and environmental benefits in combination with energy and water efficiency. Other benefits include improved health of students and staff, reduced absenteeism, and improved indoor air quality.

Green Campus Index (GCI) is a sustainability index that consists of indicators that require various tiers of information to establish the meeting of specified objectives, according to [13]. These indicators are the yardsticks against which sustainability objectives are measured. An indicator or index acts as concept measure and is either devised or existing [14]. Thus, GCI is a sustainability assessment index, indicator, or tool that evaluates sustainability progress or failure in university operations environmentally, socially, and economically. Institutions and organizations measure the progress and failure of their sustainability initiatives given the increase in global campus sustainability awareness. University sustainability assessment frameworks are widely used by an increasing number of universities that are combating climate change and pursuing sustainability. Waheed et al. [13] report that the evaluation of sustainability in various facets of life is increasingly important. Traditionally, different multi-criteria decision-making methods have been used in sustainability assessment, and various campus sustainability assessment frameworks with various geographical, regional, environmental, and organizational features have been developed. The two main purposes of these frameworks are to rank the

overall performances of campuses as per survey results and voluntarily track their progressions toward sustainability goals.

However, international university sustainability ranking systems remain controversial and underutilized mainly because the concept and goal of sustainability are subjective among HEIs and widely accepted ranking framework and criteria are lacking [15].

Indices, assessment criteria, indicators, frameworks, or benchmarks help institutions understand their sustainability objectives, identify problem areas, develop improvement strategies, and build commitment [16]. Bell [17] considers SD indicators to be a means to an end and not ends in themselves; thus, integrating indicators is either positive or negative. Cross-institutional assessments can identify and provide benchmarks of leaders and best practices, communicate common goals, experiences, and methods, and measure SD progress. Ideal assessment tools identify the most important attributes of an SU, measure factors aside from eco-efficiency, assess processes and motivations, and are calculable, comparable, and comprehensible to multiple stakeholders [18]. However, a universal index that incorporates all indicators into a single numeric coefficient may be misleading. Therefore, several experts believe that a group of indicators covering different dimensions is scientifically preferable.

School indicators help schools understand their current sustainability performance, set goals, and measure progress; learn from and collaborate with one another via common school sustainability indices; identify areas for improvement for prioritization by decision makers; utilize the physical campus as a supportive teaching tool; and communicate the sustainability efforts of schools, according to Smith [19].

However, school indicators are difficult to develop and implement. Empirical data and assessment initiatives lack comprehensiveness, standardization, and rating and ranking benchmarks [18]. Certain indicator selection criteria for campus SD were listed in 1995. Various campus organizations and rating systems have been developed to accurately evaluate the socio-economic and environmental effects of institutions. However, few frameworks that evaluate the contributions of these organizations to sustainability have been developed [20].

Each organization has its own strengths and weaknesses. However, the researchers has determined that the lack of comprehensiveness is a common shortfall of campus sustainability assessment frameworks, such as Association for the Advancement of Sustainability in Higher Education (AASHE), which uses the Sustainability Tracking and Rating Systems (STARS) rating tool; ULSF; and National Wild Life Federation (NWLF). All these organizations aim to "reduction of our footprints on the future", as depicted in Table 1.

In Table 1 below, 5 rating from an established organizations were compared in terms of websites, brief descriptions, rating tools used, and strengths and weaknesses. The researchers critiqued the 5 campus indicators provided and modified STARS [21] to develop UKM operation sustainability indicators. STARS is the first professional higher-education association in the campus sustainability community and has the largest number of member institutions [22]. STARS also assesses the sustainability performance of an institution more substantially than other current systems. STARS boasts an open development

process, fully transparent methodology, high-quality data, and community governance. It is intended for all types of institutions and has been positively rated.

STARS [21] has identified three main indicators, namely, education and research; operations; and planning, administration, and engagement, to facilitate meaningful HEI SD. Campus operations constitute nine indicator subsections, namely, Buildings, Climate, Dining Services, Energy, Grounds, Purchasing, Transportation, Waste, and Water. Each subsection can obtain two credits per tier for a total of 100 score points. The researchers have developed 20 modified questionnaire items/indicators based on the nine subsections discussed in Table 1 to reflect the peculiarity of the study area and easily validate the sustainability of the operations at UKM. Each item is scored using a five-point Likert scale; the maximum score is 100 points (20 x 5) and the minimum is 20 points (20 x 1).

UKM is one of four research-based institutions in Malaysia. The numerous activities in the university demand much from daily operations, and these operations may have negative consequences on the community, such as high energy and water consumption, waste generation, GHG emissions, and interactions between material and human resources. Minimizing these negative processes is therefore important to facilitate economically acceptable and environmentally friendly operations that are socio-culturally responsive to the community.

All of the stakeholders are required to participate in all operation aspects because they are responsible for generating sustainable footprints. Thus, the staff of the Institute for Environment and Development (LESTARI) and the Solar Energy Research Institute (SERI) are sampled because these staff members are directly involved in operational activities that promote sustainability in the university.

SD in Malaysia was initiated in 1995 when LESTARI developed a work program for its inaugural year. LESTARI has represented the SD interests of the Malaysian government in multilateral organizations, the Asian Development Bank, the Economic and Social Commission for Asia, and the United Nations Pacific [22].

Therefore, the objective of this study is to develop and validate benchmark indicators that determine the sustainability level of operations in UKM, as well as areas that require attention. This ready-made index can also be published by the university as part of its sustainability report to organizations for assessment rating and ranking.

Table 1. Strength and weakness rating system for SUs.

	Name, website, established year
	AASHE, www.aashe.org, 2006
Description	Association of colleges and universities that promotes sustainability in all sectors of higher education by education, communication, research, and professional development. Its mission is to empower HEIs to lead sustainability transformation. This association produces e-bulletins and e-newsletters about green campus news, events, and opportunities.
Total no.	STARS, 3 categories

categories	
Strengths	Most widely used with over 250 members as of 2012. Most comprehensive, comparable, and transparent Web-based system tool. Online assessment is free for registered institutions. Detailed explanations of categories, the scoring process, and reporting fields are included in its technical manuals. The scale is absolute and not relative to others, thus encouraging cooperation among schools. Voluntary self- reporting framework
Weaknesses	Complex assessment procedure. Registration and participation costs
ULSF, www.ulsf.org/, 1990.	
Description	The secretariat to the signatories of the TD in 1990, which number over 400 colleges and university presidents from more than 40 countries as of 2012. It focuses on sustainability in teaching, research, operations, and outreach through publications, research, and assessments. The tool it uses is a questionnaire with 22 questions requiring responses on a scale of 1to 5 and open-ended paragraph answers.
Total no. categories	Sustainability Assessment Questionnaire, 7 categories.
Strengths	A pilot study and strategic planning tool. A conversational and teaching tool. Probing questions from different perspectives identify weaknesses and goals are set to address sustainability. Emphasizes (cross-functional) sustainability as a process.
Weaknesses	No comparison or benchmarking mechanisms Difficult to complete for large universities academically oriented.
American College and University Presidents Climate Commitment (ACUPCC), www.presidents climatecommitment.org, 2007	
Description	A pledge by college and university presidents on behalf of their institutions to pursue climate neutrality on campus. Over 675 schools and nearly 40% of all HEIs in 50 U.S. states have committed to measuring, reporting, and reducing emissions, as well as developing and implementing climate-neutral plans.
Total no. categories	Campus Carbon Calculator.
Strengths	Partners with AASHE_and Second Nature_and was launched by eco America. Activities rewarded under ACUPCC also appeared

	in STARS. Addresses global warming to benefit students and the school community
Weaknesses	Non-universality because it is restricted to the U S
	Higher Education 21's Sustainability Indicators
Description	A UK-based project that determines the footprint of HEIs on the environment_and monitors the success of these institutions. It recognizes sustainability as a social, economic, and ecological process
Total no. categories	
Strengths	Process orientation that surpasses eco-efficiency . Has a small set of indicators. Recognizes sustainability explicitly and strategically
Weaknesses	Difficult to measure and complete. Indicators may not represent the most important issues
	College Sustainability Report Card
Description	It aims to provide free information to institutions. Its rating system emphasizes policy and operations of endowment transparency, investment priorities, and shareholder engagement
Total no. categories	9 categories
Strengths	A comprehensive, accessible, and comparative Web-based tool with benchmark indicators for participating schools
Weaknesses	Does not address the issues of sustainability content in education and research. Addresses community engagement only on the surface

2.Methods

A descriptive survey questionnaire was employed to identify operation components that are sustainable. The mean, standard deviation, t-test, and ANOVA results can be obtained using Excel and SPSS. Thus, the descriptive survey could be used to analyze and draw conclusions from the responses of a large number of respondents. A five-point Likert scale, in which 5 denotes Strongly Agree and 1 corresponds to Strongly Disagree, was used because of its wide coverage [14]. A total of 37 respondents from UKM were sampled; 8 out of 23 (35%) and 7 out of 14 (50%) respondents from LESTARI and SERI, respectively, responded.

The mean scores of the respondents were categorized into three groups. Mean scores of 1.0 to 2.4 represented low sustainability; mean scores of 2.5 to 3.4 denoted medium-level sustainability; and mean scores of 3.5 to 5.0 corresponded

to high sustainability. A five-point, closed-ended Likert scale was used to measure all of the items in the research questionnaires, and respondents could choose the most suitable answer from among five options. Twenty questionnaire items were used to assess the sustainability of operations in UKM. A maximum of 20 x 5 = 100% score points or a minimum of 20 x 1 = 20% score points determines the acceptability of UKM operational sustainability, as in the STARS rating. A score of 25% to 43% is a bronze rating, a score of 45% to 64% is silver, a score of 65% to 84% is gold, and a score of 85%+ is platinum, based on the STARS 2010 rating levels. These rating levels validated the sustainability of UKM operations in each questionnaire item as presented in Table 2.

3. Results and Discussion

Sustainability in UKM is analyzed based on the 20 questionnaire items shown in Table 2. The aggregate mean score of all of the responses is 2.8, which denotes medium-level sustainability. This average is calculated from 16 medium-level sustainability, 3 low sustainability, and 1 high-sustainability mean scores.

The descriptive analysis result shows that the sustainability of operational activities in UKM is medium-level (2.80). The three items that were rated low or were rejected in terms of sustainability are "Infrastructural process is based on Malaysian Green Building Index approval", "observes sustainable physical infrastructure development", and "Dining Services initiates a consumer food-waste compost project and encourages recycling". Sixteen out of the 20 items received medium-level sustainability mean scores. Green spaces management in UKM was the only item to obtain a high sustainability rating. However, the medium-level sustainability rating can be segregated further to determine skewness. Medium-to-low levels denote rejection, and medium-to-high levels correspond to acceptability). Fourteen items, including reduction in GHG emissions and carbon foot print, water and energy conservation management, green business purchases, dining, and hazard minimization, were categorized as medium-to-low level; whereas indoor air quality, campus transport, waste reduction, ecological conservation management, and harmony between the natural and built environment were considered medium-to-high level.

Table 2. Descriptive analysis of sustainable operational practices.

Item statements regarding UKM operational activities according to 37 respondents	Mean	Level	Score %
Infrastructural process is based on Malaysian Green Building Index approval (design, construction, and operation)	2.00	Low	40
Indoor air quality is sufficient for healthy living (free from odor and VOCs)	3.00	Med.	60
Observes sustainable physical infrastructure development	2.43	Low	49
Is involved in programs that reduce GHG emissions on campus (toxic materials, radioactive waste)	2.50	Med.	50
Activities reduce carbon footprint (unsustainable development)	2.93	Med	59
Uses clean renewable energy sources (e.g., solar, biomass energy) in operations	3.07	Med	61

Building processes, such as lighting and heating, are energy efficient (design, construction, operation, and maintenance)	3.00	Med	60
Offices/laboratories practice energy conservation (mattering and heating and ventilation sensors)	2.71	Med	54
Generates environments that complement nature (green roofs that reduce the urban heat island effect)	3.00	Med	60
Manages green spaces (soft landscapes in open spaces and recreational gardens)	3.79	High	76
Integrates pest management practices, such as pesticide control and biodiversity	2.57	Med	51
Facilitates ecological management through native plants and the wild habitat conservation	3.07	Med	61
Effective water management (water harvesting, xeriscaping, permeable paving, gray water utility, and water mattering)	2.79	Med	56
Practices green eco-purchasing of units, such as computers, cleaning supplies, and paper	2.71	Med	54
Follows vendor codes of conduct and purchases green business products to meet local, social, and environmental needs	2.86	Med	57
Dining Services initiates a consumer food-waste compost project and encourages recycling	2.21	Low	44
Minimizes hazardous and electric waste, such as chemicals, through proper management, such as e-waste contaminant recycling	2.50	Med	50
Observes sustainable waste-reduction management practices (smart printing and paper and plastic waste recycling)	3.14	Med	63
Implements sustainable food programs to conserve water and energy (local, organic, and fair-trade products from biodegradable sources)	2.64	Med	53
Utilizes a sustainable campus-fleet transport system (car-pooling, clean fuel vehicles, hybrid cars, biking, and walking)	3.00	Med	60
Average mean score rating	2.80	Med	56

The 56% score attributed to UKM in Table 2 represents a silver grade according to the STARS rating. However, UKM must improve on the 14 items that scored less than the high-level scores of 3.5 and 4.25 to attain the target gold and platinum ratings, respectively.

USLF [1] supports the research findings above and report that most institutions do not "score high" because very few, if any, institutions practice sustainability in all of these dimensions. Sustainability is not a major focus of the academe or of the wide economy in which higher education functions. Jiang et al. [23] determined that eco-campus construction initiatives in the universities are very weak and are limited to simple greening and beautification. Institutions lack understanding regarding ecological construction.

A null hypothesis Ho was set to determine significant differences in the mean responses of the respondents. The responses of the two groups were 82nalysed based on their institutional units and experiences via a t-test (Table 3). The p-value level of significance (probability value) is 0.05 or 95% confidence level; if

the computed p-value is greater than 0.05, Ho is accepted because variance homogeneity is present, but if the computed p-value is less than the table value of 0.05, the Ho is rejected and the HA is accepted because homogeneity of variance is absent.

Table 3. T-test of LESTARI and SERI staff responses based on their institutes and years of experience.

Independent Samples Test								
		Levene's test for equality of variances		***T*-test for equality of means**				
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Institute	Equal variances assumed	.007	0.934	1.026	12	0.325	0.40208	0.39172
	Equal variances not assumed			1.033	11.2	0.323	0.40208	0.38910
Experience	Equal variances assumed	6.084	0.039	-1.055	8	0.322	-0.43750	0.41462
	Equal variances not assumed			-.895	3.7	0.426	-0.43750	0.48899

Ho postulates that the mean responses of UKM operational staff with respect to sustainable and green campus activities do not differ significantly.

The Levene's test results depicted in the table above shows that the sample group displayed variance homogeneity across dependent variables. The p-values of LESTARI and SERI staff in terms of differences in institute and in years of experience (over and below 10 years) were 0.325 and 0.426, which are both greater than 0.05 and are thus significant. The hypothesis is therefore accepted, and no significant difference is detected in the mean responses of operational staff regarding sustainability practices in the university.

4. Conclusions

The sustainability of the operational activities in UKM are at a medium-to-low (reject) level, with a mean score of 2.80 or 56%. This score corresponds to a silver grade; therefore, UKM must improve on most of its operational activities to achieve the target gold (3.5+; 65% to 84%) and platinum rankings (4.25+; 85%+). The physical planning and development processes in UKM are ranked very low. This research aims to enrich understanding regarding the modus operandi of UKM with respect to sustainability. The developed assessment framework can be used as a benchmark to assess future sustainability operations in other universities

as well. The developed and validated indicators determine the areas of progress and failure in UKM; therefore, the community can develop improvement strategies. These indicators also serve as a data source reference guide to sustainable campus operations for students, staff, and researchers. The mean score of 2.80 or 56 % mid-to-low sustainability level signifies the high footprints of UKM operational activities on the environment, as well as other negative socio-economic consequences. Other negative effects, such as high GHG emissions, unsustainable buildings, and wasteful services, affect human comfort and health along with the environment, and additional resources (financial, human, and material) resources are required. Therefore, UKM must minimize the negative health, environmental, economic, and socio-cultural effects it generates while fulfilling its teaching, research, and outreach partnership functions to improve and maintain sustainability in school operations. Developmental processes must be in line with the Malaysian Green Building Index, and sustainability offices must be set up and supported. These offices can thus develop research and action plans to reduce GHG emissions and implement programs to educate the university community on energy and water conservation and alternative transportation.

References

1. Association of University Leaders for a Sustainable Future (2016). The talloires declaration 10 point action plan. Retrieved December, 9 2016, from http://www.ulsf.org/pdf/td.pdf.
2. Shah, M.M. (2008). Sustainable development, reference module in earth systems and environmental sciences. *Encyclopedia of Ecology*, 3443-3446.
3. Hopkins, E.A. (2016). Barriers to adoption of campus green building policies. *Smart and Sustainable Built Environment*, 5(4), 340-351.
4. Lozano, R. (2010). Diffusion of sustainable development in universities curricula: An empirical example from cardiff university. *Journal of Cleaner Production*, 18(7), 637-644.
5. Alshuwaikhat, H.M.; and Abubakar, I. (2008). An integrated approach to achieving campus sustainability: Assessment of the current campus environmental management practices. *Journal of Cleaner Production*, 16(16), 1777-1785.
6. Velaquez, I.; Munguia, N.; Platt, A.; and Taddei, J. (2006). Sustainable university: What can be the matter?. *Journal of Cleaner Production*, 14(9-11), 810-819.
7. Royse. J. (2003). *Campus sustainability: A class presentation NRC 471 at College of Agriculture*. Natural resources conservation and management, University of Kentuckey.
8. Orr, D.W. (2002). *Nature of design: Ecological culture and human intention*. Toronro: Oxford University press.
9. Too, L.; and Bajracharya, B. (2015). Sustainable campus: Engaging the community in sustainability. *International Journal of Sustainability in Higher Education*, 16(1), 57-71.
10. Wals, A.E.J. (2014). Sustainability in higher education in the context of UN DESD: A review of learning and institutionalization processes. *Journal of Cleaner Production*, 62(1), 8-15.

11. United Nation Environment Program (2007). Assessment of policy instrument for reducing GHG emission from buildings. Retrieved December, 9 2016, from http://www.unep.org/pdf/policytoolbox.pdf
12. Ohio Energy Project (2000). *Energy smart schools: Creating a sustainable learning environment in Ohio*. Ohio energy smart schools program booklet, Ohio.
13. Waheed, B.; Khan, I.F.; and Veitch, B. (2011). Developing a quantitative tool for sustainability assessment of higher education institutions: An application of DPSEEA framework. *International Journal of Sustainability in Higher Education*, 12(4), 355-368.
14. Bryman, A. (2008). *Social Research Methods* (3rd ed). New York: Oxford University press.
15. Shi, H.; and Lai, E. (2013). An alternative university sustainability rating framework with a structured criteria tree. *Journal of Cleaner Production*, 61, 59-69.
16. Andrew, N. (2002). *Improving the campus sustainability assessment process*. Western Michigan University.
17. Bell, S.; and Mores, S. (2003). *Measuring sustainability: Learning from doing*. Verginia: Earth Scan publications.
18. Shriberg, M. (2002). Institutional assessment tools for sustainability in higher education: Strengths, weakness and implications for practice and theory. *International Journal of Sustainability in Higher* Education, 15, 153-167.
19. Smith, J.D. (2012). *School sustainability rating systems: Strengths, limitations and future prospects*. MSc Thesis. University of Michigan.
20. Rosani, C.D.; and Jabbour. C.J.C. (2013). Evaluating sustainability of an indian university in green universities and environmental higher education for sustainable development in China and other emerging countries. *Journal of Cleaner Production*, 61, 54-58.
21. Sustainability tracking assessment and rating systems - STARS (2010). Version 1.0 *Technical Manual*. January 2010, Lexington, KY. Retrieved November 24, 2011, from http://www.aashe.org/files/documents/STARS/Technical_Manual_Changes.pdf
22. Wright, T. (2012). *Higher education commitments to sustainability: From understanding to action*. Canada and USA Regional report, Global University Network for innovation report, Higher education in the world.
23. Jiang, X.; Zheng, B.; and Wang, H. (2010). The research on eco-campus evaluation index system and weight. *WSEAS Transaction on Environment and Development*, 6(12), 793-803.