

Toward Sustainable Campuses in Egypt Case Study Mansoura University

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ABSTRACT –The transitions towards sustainable universities need multiple strategies and approach that apply and implement sustainable best practices for better performance and efficiency in curriculum, research, campus buildings, and community.

The main aim of this study, is taking advantage of the valuable outcomes which results from a successful sustainable best practices and application of sustainability on the existing universities. University of Nottingham Jubilee campus in the United Kingdom is using UI Green- Metric rating system categories and strategies, which it will be useful and relevant reference and significant case studies.

The Sustainable strategies are grouped and categorized to formulate sustainable design strategies for campuses, which will be applied and performed on Mansoura University to examine and verify its sustainability level and the potentials corrective action to be taken for better performance and efficiency. This paper concludes with applied recommendations and corrective action to transform Mansoura University to become a sustainable and ecofriendly campus.

Keywords: Environmental sustainable; Sustainable campus; Mansoura University.

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1. INTRODUCTION

The Universities and Institutions of higher education are playing main role not only in teaching, research and practical sustainability but also in promoting sustainability outside institutional boundaries along with responsibility consideration and serving society to cope with existing problems, which related to a sustainable development.

Collaboration and connectedness between Universities and decision-makers are affecting positively in regional sustainability by providing knowledge and research. Moreover, stakeholders and local government are promoting universities to achieve their role, responsibility and commitments in sustainability field. [1]

Higher education institutions and universities can practically provide the most influential ideas and concepts to the society towards a transition to sustainable thinking and promoting awareness of significance of sustainability application, not only through curricula and academic research, but also through positive environmental best practices at the campus buildings that should generally aims to minimize negative impacts on the environment. [2]

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2. Sustainable Campuses

According to the Renata D et al 2015 demonstrated that the ecologically healthy society requires strong support from universities and higher education institutions. Thus the environmental education of students is the most important, as they are the main drivers for better sustainable future especially for students who will occupy most of these offices.

The contributions of high education to achieve sustainable development can be obtained via education, research, buildings behavior and community sharing. [1]

As stated by Luis V et al 2006 sustainable university is defined as "An education institutions that grants academic degrees that promotes, concern and involves, on a regional or universal level, the minimize a negative environmental, economic, societal, and health impacts generated in the use of their resources to achieve its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles". [3]

3. Environmental Sustainability Evaluation Systems

A huge number of systems have been developed to analyze buildings and its sites from the green architecture point of view. The rating systems are organized in the form of a checklist\ scorecard sheet, which gives the indication of relevant points to the buildings.

Green building rating systems are tools that helps to ensure sustainable buildings, communities and projects are

developed and promoted in an integrated manner, and that the appropriate experts are involved in the process. The goal of many of these assessment tools is to help and drive building design and construction beyond regulatory minimums. There are a several Rating systems in the World that evaluates all type of building, such as BREEAM, LEED, Estidama and Pearl; these types of rating systems were established to evaluate most type of building. On the other side, other rating system is specialized to evaluate one type of building like Ui GreenMetric is for universities building. [4]

3.1. UI GreenMetric Rating System

The Universities of Indonesia are started in 2009 to learn from acknowledged experts in the field of university ranking, hosted the International Conference on Quality of Education and World University Rankings. Although ranking system has their critics, the view about ranking at the university at the time was largely beneficial. Some ideas from the conferences were thought to be a relevant to the early thinking in developing UI GreenMetric. [5]

The main goal of UI GreenMetric is to provide the outputs

of online survey regarding the current state and policies related to Green Campus and Sustainability in all World Universities. [6]

UI GreenMetric is one of world rating system that has been taken the initiative to create a world university ranking system to assess and compare campus sustainability efforts.

The UI GreenMetric World University Ranking was established in 2010 with the intention of creating online survey of the current state and policies intended to make campuses 'greener' or more sustainable in universities around the world.

Criteria was selected that are generally thought to become an important in sustainable universities, these include the site information, the next electricity consumption because of its relation to carbon footprint, then transport, water usage, waste management and ...etc., each of this categories has an own weight as shown in Table 1 . Beyond these indicators to show university responding and policies with the issue of sustainability. [7]

Table 1: Categories used in the ranking and their weighting [7]

No	Category	Percentage of Total Points (%)
1	Setting and Infrastructure (SI)	15%
2	Energy and Climate Change (EC)	21%
3	Waste (WS)	18%
4	Water (WR)	10%
5	Transportation (TR)	18%
6	Education (ED)	18%
Total		100%

4. Analysis Study

This part of the study is to determine benefit from the successful practices and experience of sustainability at the University of Nottingham Jubilee campus, as one of the most sustainable campus in the world. Nottingham Jubilee campus is located in England, the United Kingdom extends to 65 acres, and the initial phase was opened by the Queen in 1999.

The University of Nottingham has been recognized for its green credentials taking in 2011 first place in the UI Green

Metric World University Ranking. Also in 2012, the University received at the Times Educational Awards the highest award for 'Outstanding Contribution for Sustainable Development. [8]

The environmentally-friendly nature of the campus and its buildings has a big factor in the awards that it has received; Table 2 shows analysis of the principles and strategies for environmental sustainability in the University of Nottingham Jubilee campus. [6]

Table 2: Analysis of the principles and strategies for environmental sustainability in the University of Nottingham Jubilee campus.

Nottingham University [6],[9],[10],[11]

Setting and Infrastructure (SI)

1. The campus was built on a brownfield site that previously had industrial use after contamination remediate and protective measures as fig (1).
2. The campus was located within and near existing communities and public transit infrastructure.



Fig. 1. (a) Campus site in 1978 was brownfield; (b) Evolution from industry to university campus and public space in 2012.[9]

3. Promote the pedestrian, cycling and public transportation that led to reduce parking footprint.
4. Create and commit to implement a long-term management plan for existing on-site native habitats, water bodies, and wetlands.
5. The University has won several awards for its landscaping, well-managed and environmentally sustainable green space with excellent facilities, including a Green Flag Award for University Park every year from 2003.
6. Over than 40,000 native trees and a diverse mixture of native flowering were planted in 2012.

Energy and Climate Change (EC)



The University spends over than £10 million a year to reducing its energy consumption and carbon footprint. Below are some of the strategies that were applied to do this.

Reduce energy consumption

1. Windows with single glass were changed with double glass.
2. Street lighting units on University Park were replaced with LED units.
3. Exterior lighting units were chosen to produce minimal upward illumination from the luminaire and minimal reflected light off adjacent surfaces fig (2 a).
4. Distribute temperature sensors to enhance heating control in buildings.

Renewable technologies

1. Solar electricity was installed above 10 buildings.
2. Solar water heating was installed in 3 buildings.
3. Using ground source heat pumps (extracting heat from the ground to buildings).
4. Using Lake Source heat pumps (extracting heat from Jubilee Campus Lake to heat buildings).
Using wood pellet-fired.
5. Selecting electrical appliances with high efficiency and low energy demand.
6. A bank of heat exchanger units were installed in the middle of the 3 lakes in 2010, the units function to keep the buildings cool in summer using a minimum of energy in comparison to other methods of cooling a building
7. 5250m² of Green roofs was installed to insulate and protect buildings and provide habitat on academic buildings.
8. Provide number of atria with interior plants as fig (2 b) which play a major role in enhance of ventilation and natural lighting.

	 <p>Fig. 2. (a) High efficient exterior lighting that used in campus; (b) Using atria on some building in campus.[9]</p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Waste (WS)</p>	<p>The University of Nottingham produces approximately 3,000 tons of solid waste each year. The majority of this was going to landfill, but recently they have worked seriously to reduce the waste produce and maximize recycling.</p> <p>Outside on campus, there is a range of recycling facilities to recycle glass, clothing, paper, card, plastics and cans. and also provide interactive maps to find nearest external recycling facilities:</p> <ol style="list-style-type: none"> 1. It was agreed with main contractor to recycle, campus waste. 2. New recycling bins have been installed in key areas, including building foyers and catering outlets. 3. On site recycling and further segregation by campus waste collection contractors has achieved a recycling rate of 91%. 4. Recycling approximately 500 tons of food waste generated from student accommodation. 5. Horticultural waste is recycled to produce compost or mulching materials.
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Water (WR)</p>	<ol style="list-style-type: none"> 1. Install high efficient fixtures such as low-flow toilets, showers, faucets, and moisture sensors on irrigated fields. 2. Permeable paving was used in car parking and walkable streets as shown in fig(3).  <p>Fig. 3. Permeable paving in walkable streets .[9]</p> <ol style="list-style-type: none"> 3. Collect all drainage water \ water harvesting from roofs and car parks to feeding two lakes on campus. 4. New trees are all fitted with drip irrigation. 5. Native trees are selected that requiring no irrigation and water conservation
	<p>Over the last few years the University has worked to improve transport options to encourage greener transport use as following:</p> <p>Walking and cycling encourage:</p> <ol style="list-style-type: none"> 1. Encourage walking and bicycling by providing safe, appealing, and comfortable street environments that support public health by reducing pedestrian and cycling injuries and encouraging daily physical activity. 2. Providing around 4,650 bike parking spaces as shown in fig (4 a), including a number of covered and secures cycle stores, maintenance station and showers. 3. Offers a low-cost bike hire scheme for students and staff. Bikes can be hired for one semester or an academic year fig (4b).

Transportation (TR)



Fig. 4. (a) Bike parking on campus; (b) Bikes for hiring on campus.[6]

Promote transportation efficiency:

1. Promotes transportation efficiency, including reduced vehicle miles traveled.
2. Providing bus services and discounted bus travel for staff and students.
3. The University organizes a travel plan, which is beneficial as part of the planning and development process and provides direction for supporting sustainable travel and reducing depending on car trips.
4. The University of Nottingham provides free bus services that run from the main campus to other colleges that located out of main campus fig (5 a).

Car sharing encourage:

1. The University has teamed up with the UK's largest car sharing network to provide a car share scheme specifically for The University of Nottingham staff and reducing reliance on single-occupancy car trips.
2. The campus is well signed from approach roads, bike routes and footpaths as fig (5 b).



Fig. 5. (a) Free bus in University of Nottingham; (b) Provide traffic signs.[6]

Education (ED)

University of Nottingham is keen for all students to be able to access education for sustainable development during their studies, and also offers research opportunities in the field of sustainability, both in the UK and out as following:

1. The University has a number of Schools/Departments which offer taught over 100 course modules and researches, in curriculum and extra-curricular activities
2. Getting involved with Students Union societies to involve volunteering in the local community, campaigning for environmental awareness, or debating global issues.
3. Establishment of the (CSET) the Centre for Sustainable Energy Technologies research.
4. Energy Homes has been developed by members of the Architecture, Energy and Environment Research Group as shown in fig (6) that aims to inform the sustainable practice of Architecture and Engineering.
5. Environment Initiative Fund established and allocated a budget of £100,000 to award to the student or staff-led sustainability projects in 2016/2017.



Fig. 6. Energy Homes on campus.[6]





5. Case study




-This case study focuses on Mansoura University campus to evaluate its sustainability.


-Mansoura University is considered as a one of the biggest university in Egypt, was founded in 1972 in Dakahlia Governorate, Egypt, at the middle of the Nile Delta. [12]

Table 3 illustrates an analysis of the current state of the University of Mansoura campus in terms of strength and weakness points in environmental sustainability criteria.

Table 3: Analyze environmental sustainability in Mansoura University.

Mansoura University	
Setting and Infrastructure (SI)	<p>Strength points:</p> <ol style="list-style-type: none"> 1. The campus was located with in and near existing communities, infrastructure and public transportation fig (7a). 2. Provides wide horticultural and green spaces, planting large number of plants and trees fig. (7b). 3. Coordinate and distribute building blocks in order to minimize the negative impact of the harsh climatic. 4. Building and university activities on campus do not have any negative effect the wildlife habitat. Wetlands, Water Bodies, and agricultural land. <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p>5. Fig. 7. (a) Mansoura University satellite map[12]; (b) green spaces.</p> <p>Weakness points:</p> <ol style="list-style-type: none"> 1. Some streets do not have separate sidewalks to Pedestrians and cyclists. 2. University campus has wide black footprint and a lot of un-shaded parking.
Waste (WS)	<p>Strength points:</p> <ol style="list-style-type: none"> 1. Mansoura university started to recycle the consumer exams paper as initial step. 2. Some of student initiatives that distribute a recycle bins to collect paper fig (9 a). <p>Weakness points:</p> <ol style="list-style-type: none"> 1. The majority of University waste has gone to landfill. 2. Traditional bins were commonly used on campus, and there is no enough sorting bins as fig (9 b). <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p>Fig. 9. (a) Student initiatives to distribute recycle bins; (b) Traditional bins.</p>

Energy and Climate Change (EC)	<p>According to Engineering Management, 2015 Mansoura University consume a large amount of electric power during the year, it Consumed over (2,600,000) K watt.</p> <p>Strength points:</p> <ol style="list-style-type: none"> 1. Some of faculties building include courtyard component that acts like a thermostat, which controls the temperature as fig. (8 a). 2. The most of building windows are oriented to the north. 3. University had initiative to plant on roofs of building; the first one was done in faculty of Agriculture and university pharmacy fig (8 b). <div style="display: flex; justify-content: space-around;">   </div> <p style="text-align: center;">Fig. 8. (a) Courtyard component in Engineering. Faculty ; (b) Green roof on university pharmacy.[12]</p> <p>Weakness points:</p> <ol style="list-style-type: none"> 1. Most of windows are single-glazed. 2. Existing street lighting is not High efficient types. 3. Mansoura University does not depend on renewable energy. 4. Most electrical appliances are not highly energy efficiency and don't have energy star certified.
Water (WR)	<p>Strength points:</p> <ol style="list-style-type: none"> 1. Most of trees in campus are Native trees that don't need a lot of irrigation water. 2. Using non potable water in landscape irrigation <p>Weakness points:</p> <ol style="list-style-type: none"> 1. Flooding irrigation is used to irrigate plants and trees in campus that one of the most wasteful irrigation type and causing soil erosion fig (10). 2. Use a low efficient plumbing and irrigation fixture. 3. There is no Storm water collected system. <div style="text-align: right;">  </div> <p style="text-align: center;">Fig. 10. Flooding irrigation.</p>
Transportation (TR)	<p>Strength points:</p> <ol style="list-style-type: none"> 1. Providing some of bike parking spaces behind faculties gates see fig (11 a). 2. Small buses paths pass next to the university gates. 3. Providing discounted bus travel available for staff and students that run from the Mansoura University to Cairo and Alexandria. <p>Weakness points:</p> <ol style="list-style-type: none"> 1. Pedestrians and cyclists encourage is not enough so as to overlap the pedestrians and bikes with car traffic paths and there are no separate sidewalks fig (11 b). 2. Campus doesn't have enough bike services. 3. Campus streets don't have enough street trees and shading structures. 4. No enough awareness and encouragement for carpooling usage.

Transportation (TR)	 <p>Fig. 8. (a) Bike parking behind faculties ;(b) Overlap the pedestrians and bikes with car traffic paths.</p>
Education (ED)	<p>Strength points:</p> <ol style="list-style-type: none"> 1. There are Limited attempts to integrate environmental and sustainable topics in graduate and postgraduate course, only in the architecture department. 2. Simple photovoltaic and wind power generation have been installed in engineering faculty as education and research tools. <p>Weakness points:</p> <ol style="list-style-type: none"> 1. Lack of awareness programs of the importance and applications of sustainability to campus occupations staff and students. 2. Lack in conferences, seminars, and workshops at the university for sustainable awareness in the community.

6. Conclusions and Recommendations

Good practices have been identified for environmental sustainability in many of the strength points. However, some of them need to be developed and in additions to realize benefit from the principles of environmental sustainability and to achieve a competitive environmental feasibility, on the other hand weakness points were emerged requires finding appropriate solutions to be converted toward magnitude points in accordance with the following recommendations:

1. **Setting and Infrastructure:** Provide separate sidewalks to Pedestrians and cyclists, use of green roofs, all of them to reduce runoff and to relieve the heat island effect, and maintaining open space that exceeds building footprint.
2. **Energy and Climate Change:** encourage renewable energy systems using photovoltaic and wind power generation, orient the new buildings along east-west axis to provide shading, replacing glass windows with Double skin glazing, also using LED in street lighting and Reducing light pollution through effective design of outdoor lighting.
3. **Waste:** A comprehensive waste management plan has to be implemented during construction, recycling campus waste materials and distribute sorting bins on campus.
4. **Water:** Using more efficient irrigation system in campus such as a drip irrigation system and efficient plumbing and rainwater harvesting through a cistern, which can be utilized for irrigation during summer months.
5. **Transportation:** Encourage pedestrians and cyclists through providing bicycle storage and changing rooms, as well as walking paths in conjunction, planting more street trees and shading structures installing, providing alternate means of transportation and provide features for vehicle Sharing users.
6. **Education:** Embedding Sustainability Curriculum Program, making some campaigning for environmental awareness and debating global issues, encourage and fund sustainable research, establish center for sustainable energy and technologies research.

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