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GREEN CAMPUS INITIATIVES IN PUBLIC HIGHER EDUCATION INSTITUTIONS BUILDINGS

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ABSTRACT

Malaysia is indeed growing the number of sustainable building projects across the country. For Higher Educational Institution (HEI) buildings, there are a few universities in Malaysia currently implementing green campus. On the other hand, the initiatives of green campus have few issues, including environment, economic, and social aspects. This study aims to highlight the green campus initiatives in HEI buildings. Data was collected through interviews and site observations on the case studies specifically at Universiti Teknologi Mara, Shah Alam, Universiti Malaya and Universiti Putra Malaysia, Serdang. The findings reveal the most initiatives that have been adopted by HEI are solar panels, sustainable transportation, and energy-efficient building designs. However, constraints such as limited finance, aging infrastructure, and community attitudes hinder progress. The study contributes to academic research on sustainable campus management by making strategic recommendations, such as improving stakeholder relationships, enhancing awareness campaigns, and utilizing smart energy systems. By addressing these concerns, the study aims to help Malaysian public HEI achieve sustainability objectives and enhance the country's commitment to global environmental goals.

Keywords: Higher Education Institutions, Green Campus Initiatives, Sustainability, UI GreenMetric

1. INTRODUCTION

Sustainable building is a structure that uses resources efficiently and reduces environmental impact. De Paula, Jyo and Melhado, (2022) stated that it is related to technology and design solutions in terms of energy, water, and materials efficiency, waste reduction, indoor air quality, thermal comfort, and health. According to IUCN & UNEP, (1991), sustainable building improves the quality of human life while living within the carrying capacity of the supporting system. Ochoa, Tim & Guilermo, (2016) mentioned high-performance sustainable buildings are considered feasible measures for creating a sustainable building industry and improving energy consumption profiles. Green building contributes to achieving international goals of sustainability, preventing climate change, promoting healthy communities, and supporting economic growth. Buildings significantly affect human performance, well-being, safety, and health, and influence students' learning about building performance in higher education (Ochoa et.al, 2016). Therefore, buildings require a lot of energy and materials, making them economically difficult to maintain.

On the other hand, Malaysia's public HEI play an important role in national sustainability initiatives (UGC, 2020). Universities require a significant amount of financial and physical

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resources in order to operate as centres of learning, research and infrastructural development. The expansion of campus environments has increased awareness of the need for sustainable structures that reduce environmental impact while improving the interior of the air quality, student health and the operational efficiency (Sugiarto et al, 2022).

Besides that, green building projects provide a realistic solution to improving the environment by implementing technological advances in the building design, energy use and waste management. In Malaysia, universities such as Universiti Teknologi MARA (UiTM), Universiti Malaya (UM), and Universiti Putra Malaysia (UPM) have implemented severe initiatives to include sustainable aspects into their campus infrastructure. These activities are consistent with international frameworks such as the United Nations' Sustainable Development Goals (SDGs).

Malaysian public HEI have developed a variety of green building initiatives to reduce the environmental impact and promote sustainable campus environments. These initiatives include solar panels, rainwater harvesting systems, natural ventilation designs and the development of green walls and roofing. Smart recycling systems, as well as green transportation programs like bike-sharing and pedestrian-friendly infrastructure have also been implemented at the institutions. These measures not only minimise the resource use but also develop an environmentally friendly culture among the students and staff. Overall, such projects that relate with the national sustainability objectives and indicate the HEI have increased commitment to attracting green campus goals.

Despite of all that has been gained, some of the issues has prevent Malaysian HEI from fully implementing sustainable building approaches. One of the most common issues is insufficient money for large-scale infrastructure renovations, especially for older structures that require considerable renovation. Furthermore, awareness and involvement levels among the learners and educators remain inconsistent which decreasing the effectiveness of existing the green initiatives. Institutional constraints such as a lack of monitoring systems, insufficient manpower and competing goals with campus development worsen the initiatives. These issues point out the importance of long-term planning, stakeholder involvement and policy integration in achieving the sustainable goals.

Thus, this study hightlight green building initiatives at selected three (3) case studies. The goals are to identify the current green campus initiatives. This study adopted qualitative data collection methods such as interviews and site observations, provides insights into best practices for improving green building projects in Malaysian HEIs.

2. LITERATURE REVIEW

2.1 GREEN CAMPUS

Sustainable building is an economical and productive system that maintains long-term potential in all dimensions. It is related to technology, design, energy, water, and materials efficiency. Sustainable building provides basic environmental, economic, and social services to communities without damaging natural resources. Researchers de Paula, Jyo, and Melhado (2022) and Huovila and Koskela (2014) agree on the definition of sustainable building.

The latest sustainable construction practices are widely different depends on how the concept of the sustainable building construction was developed in many countries (Huovila and Koskela, 1998). 90% of humans time are spent inside a building. This matter has an impact on the building environment as it influences the usability of the innovative design and materials in designing the sustainable building. For education purposes, the practices of built green building in campus play an essential role of higher education in contributing to a sustainable society, the concept of green building and what the university should do to take part to a sustainable society

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(Stough, Ceulemans, Lambrechts and Cappuyns, 2018). Thus, in this study, the initiatives taken by the public universities in Malaysia will be elaborated below.

Ahmad Afiq, Haryati, Siti, Othman, and Sedhu (2023) mentioned that green campuses improve human life and reduce ecosystem support. Universities play a responsibility in implementing eco-friendly materials and promoting sustainability culture. In higher education, sustainable buildings contribute not only to environmental goals but also to educating students on sustainable living practices (Bridgestock, 2021). Seventeen Malaysian HEI participated in the 2021 UI GreenMetric World University Rankings, highlighting a strong national emphasis on sustainable campus development (Ahmad et al., 2023). Notably, Universiti Putra Malaysia (UPM) and Universiti Malaya (UM) ranked first and second, while Universiti Teknologi MARA (UiTM) is ranked as number eight among Malaysian institutions. These rankings are based on metrics such as setting and infrastructure, energy and climate change, waste management, water usage, transportation, and education.

Table 2.1: List of Public HEI that Participate in UI GreenMetric World University Rankings.

No.	World Rank	Malaysian Rank	Institution
1	27th	1st	Universiti Putra Malaysia (UPM)
2	32nd	2nd	Universiti Malaya
3	67th	3rd	Universiti Malaysia Sabah
4	109th	4th	Universiti Utara Malaysia
5	110th	5th	Universiti Teknikal Malaysia Melaka
6	128th	6th	Universiti Malaysia Pahang
7	149th	7th	Universiti Teknologi Malaysia
8	150th	8th	Universiti Teknologi MARA Shah Alam
9	165th	9th	Universiti Tun Hussein Onn Malaysia
10	168th	10th	Univeristi Sains Malaysia

Sources: Ahmad Afiq et al, (2023) Journals of the Malaysian Institute of Planners

2.2 GREEN BUILDING INDEX

The Green Building Index (GBI) is a Malaysian certification body established in 2009 by the Malaysian Institute of Architects and the Association of Consulting Engineers Malaysia (CIDB, 2023). It promotes sustainable building practices and raises environmental awareness among developers, engineers, contractors, architects, and the public (Algburi and Faieza, 2016). Liew (2012) stated that the GBI rating tools enable developers to plan and build green, sustainable buildings that offer water, energy, and indoor environmental benefits. They also encourage recycling and greenery implementation to reduce environmental impacts.

The Green Building Index used in Malaysia is known to be used in the industry with the current situation on the environment of the building. The Green Building Index Sdn. Bhd. shows that there are six in total of the existing GBI criteria namely Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning and Management, Materials and Resources, Water Efficiency and Innovation.

Review of Green Building Index in Malaysia, Suhaida, Chua and Peng (2011), stated that each of the criteria have different explanations which is explained as listed below:

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i) Energy Efficiency (EE)

The tropical climate and heavy cooling requirements of Malaysia make energy efficiency the most important GBI category. It focusses on optimising building orientation, reducing heat from the sun through shading and enhancing natural daylight utilisation to reduce demand on artificial lighting. Studies by Shafii and Othman (2008) and Saidur et al. (2011) show that energy-efficient design can lower total energy consumption in commercial and institutional buildings by up to 30-40%.

ii) Indoor Environment Quality (IEQ)

IEQ focusses on air quality, lighting, sound insulation and thermal comfort to create a healthy interior environment. According to Chan et al. (2009), enhancing indoor environmental quality improves the occupants' well-being, satisfaction and productivity, especially at educational institutions. Filtration systems and daylighting methods are frequently used in the designing to reduce health risks and operating cost.

iii) ***Sustainable Site Planning and Management (SM)***

This criteria promotes responsible site selection by practicing access to public transportation, community amenities and natural ecosystems. It allows in reducing site disruption, incorporating open and green spaces and ensuring effective drainage. According to Al-Tamimi et al. (2013), sustainable landscaping and site orientation can reduce the energy use while improving thermal comfort. GBI also promotes construction practices that reduce pollution and environmental damage during the building process.

iv) Materials and Resources (MR)

The criteria focus on responsible procurement, reuse and recycling of the construction materials. Reusing structural elements and obtaining local materials can help to reduce carbon footprints related to transportation. According to Begum et al. (2009), Malaysia's building industry produces an enormous amount of trash and implementing green procurement laws that can reduce construction waste by more than 20%.

v) Water Efficiency (WE)

Rainwater harvesting systems, greywater recycling, low-flow plumbing fittings and water metering are all examples of water-efficient solutions. GBI encourages reduced clean water consumption through efficient design and changes among building occupants. Syafiuddin et al. (2020) found that rainwater harvesting systems in Malaysian institutions can cut annual municipal water consumption by up to 35%.

vi) Innovation (IN)

This category finds projects that demonstrate creative ideas or methods that can go beyond the traditional ecological methods. It often involves the application of smart building technologies, integrated design techniques, stakeholder training and educational activities. According to the Green Building Index Malaysia (2023), innovation can also include biophilic design, social responsibility outreach and the integration of Internet of Things (IoT) devices for real-time monitoring.

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2.3 INITIATIVES ON GREEN CAMPUS IMPLEMENTATION IN PUBLIC HEI BUILDINGS IN MALAYSIA

All universities in Malaysia have the same or may have several differences in implementing on eco-friendly systems. The initiative on green campus implementation can save the environment of the building, people's health and safety, and the economics of the universities. All students and staff in HEI are required and allowed to play roles on saving the environment. There are few initiatives, namely solar system, recycle bin and natural ventilation that are applied in the public higher education in controlling the production of non-economical materials.

Public HEI prioritise sustainable initiatives such as:

i) Solar Systems: To reduce reliance on grid electricity and increase renewable energy consumption (Islam et al., 2010).

ii) Recycling Bin: This includes fabric recycling bins, electronic waste collection, and 3R campaigns (Ahmad et al., 2023).

ii) Natural Ventilation: Used in architectural design to reduce air-conditioning consumption (Huovila and Koskela, 2014).

iii) Water Conservation Systems: Rainwater harvesting and greywater reuse reduce the need for municipal water (Moglia and McGregor, 2017).

iv) Green Walls and Roofs: Insulate and decrease urban heat island effect (Shafique et al., 2018).

v) Sustainable Transportation: The implementation of bicycle-sharing, pedestrian lanes, and electric vehicle infrastructure (De Paula et al., 2022).

vi) Energy – Efficient Building Design: Resulting in significant savings in operational costs and environmental impact (Shafique et al., 2018).

Universities such as Universiti Putra Malaysia (UPM) and Universiti Malaysia Terengganu (UMT) are at the top of implementing these energy-efficient building practices, resulting in significant savings in operational costs and environmental impact (Shafique et al., 2018). Implementing these strategies not only results in significant energy savings but also creates a standard for sustainable construction practices that other industries can follow. This comprehensive approach to energy efficiency not only supports the universities' sustainability objectives but also demonstrates the value and advantages of green building practices on a larger scale (Huovila & Koskela, 2014).

On the other hand, green building practices in public HEI can reduce greenhouse gas emissions and carbon footprints by implementing energy and water efficiency measures. These practices include energy-efficient lighting, appliances, HVAC systems, water-saving fixtures, and rainwater harvesting systems (Huovila et.al, 2014). Waste management and recycling initiatives promote environmental sustainability by reducing waste generation and encouraging material reuse (Shafique et al., 2018). Renewable energy sources like solar power and biofuels reduce reliance on fossil fuels, resulting in cleaner energy production and lower carbon emissions (Islam et al., 2010). Green practices also protect natural ecosystems and biodiversity by incorporating green roofs, walls, and sustainable landscaping, creating habitats for local flora and fauna, and fostering a healthier environment (Shafique et al., 2018).

Institutions can save a lot of money in the future by reducing the energy and water consumption. Implementing environmentally friendly systems and green building practices in Malaysia's public HEI has significant economic benefits. Institutions can save a lot of money in the future by reducing the energy and water consumption. Furthermore, these initiatives improve the property value and marketability of the campus, attracting the responsible students

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and staff (Lim, Wong, Tan and Yap, 2024). Early investments in sustainable technologies and practices also promise long-term cost savings and potential return on investment, help to achieve the financial sustainability in the education sector (World Green Building Council, 2020).

Additionally, the benefits on green building in public HEI buildings significantly enhances the health and wellbeing for the occupants. Improved indoor air quality and thermal comfort means improved respiratory health and general comfort (Lim et.al, 2024). Access to green areas improves both physical and mental health by creating conditions that reduce stress and encourage physical exercise (Barton & Pretty, 2010). Furthermore, these green environments improve learning and productivity spaces for students and staff, which leads to higher academic and professional outcomes (World Green Building Council, 2020).

However, despite the clear benefits, implementing green building initiatives in Malaysian public HEI comes with issues. One of the most issues is a lack of regular funding, particularly for renovating older buildings with energy-efficient technologies or incorporating renewable energy systems (Ahmad et al., 2023 ; Ali & Al Nsairat, 2009). Furthermore, low awareness and technical expertise among staff and students may prevent the proper usage and maintenance of green infrastructure, lowering the effectiveness of it (Suhaida, Chua, & Peng, 2011). Institutional disagreement to change, outmoded rules and a lack of integrated sustainability planning all limit the implementation of environmentally friendly systems in universities. Resolving these issues involves stronger government incentives, improved education and training, and long-term policy alignment with the national sustainability goals.

3. METHODOLOGY

This study chooses a qualitative research approach. For qualitative research method, it involves interviews and site observation. This method provides a detailed understanding of participants' perspectives and experiences. The data collected were analysed using Thematic Content Analysis, which includes discovering, sorting, and interpreting common patterns in interview transcripts and observation records. Responses were grouped to identify the significant topics such as green campus initiatives, issues, and stakeholder participation. This method allows the researcher to identify trends and important ideas across all three institutions while maintaining the depth of qualitative findings.

The case study focusses on three Malaysian public universities from the UI GreenMetric 2021 World University Ranking which are Universiti Teknologi Mara (UiTM), Shah Alam, Universiti of Malaya (UM) and Universiti Putra Malaysia (UPM), Serdang. There are five (5) senior representatives from the green centre of the selected university who participated in the semi-structured interview and site observation. Interview questions were chosen to fulfil the research objectives and obtain detailed perspectives from the informant. The interviews were recorded with the participants' consent and transcribed properly for analysis.

To gain a thorough understanding of the green initiatives conducted at the universities, it is necessary to investigate the goals, planning procedures, and implementation methodologies. This involves investigating the main green campus initiatives that have been implemented, the rationale for their implementation, and the specific projects and programmes in which important parties are involved. Examining the technologies and methods used to improve energy efficiency and reduce waste is critical, as is knowing how the university encourages community engagement and participation.

Researcher will also look at how these programmes were planned and developed, what technology and techniques were employed, and how the university encourages community involvement. This includes in investigating the strategies used to set up solar energy systems, water conservation actions and recycling programs. However, issues such as insufficient

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finance, a lack of technical knowledge and uneven stakeholder engagement frequently limit the success and adaptability of these initiatives. Many institutions deal with infrastructure challenges, particularly when upgrading older facilities to meet the green specs. Finally, the cases of successful projects that demonstrate the real benefits and accomplishments of the campuses dedication to developing a sustainable campus environment.

4. ANALYSIS AND FINDINGS

This chapter analyzes and interprets data on green campus initiatives in Malaysian public HEI. It connects qualitative data from interviews and site observations with thematic content analysis to identify structures, concepts, and findings reflecting the initiatives, issues, strategies, and aspirations of selected universities' green centers, including Universiti Teknologi Mara (UiTM), University of Malaya (UM), and Universiti Putra Malaysia (UPM).

According to Ahmad et al. (2023), green campus initiatives are increasingly being implemented by HEI worldwide to promote sustainability, reduce environmental impact, and improve resource consumption. Malaysian HEIs have adopted this trend by implementing zero-waste initiatives, energy-saving technologies, and community involvement strategies. These initiatives align with Malaysia's national policies (MS:1525, 2019), such as the Low Carbon Cities Framework (LCCF), aiming for a sustainable future through education and infrastructure development. Research on sustainability programs in Malaysian HEIs involves sustainability officers, campus management personnel, and academics, providing a comprehensive view of the implementation process and assessment of sustainability programs.

4.1 THE INITIATIVES OF GREEN CAMPUS IN PUBLIC HEIs

According to the interview and site observation findings, institutions such as UiTM Shah Alam, UM and UPM have implement programs such as solar panel installations, energy efficient lighting and rainwater harvesting systems. These devices reduce energy usage and reliance on non-renewable sources while also encouraging sustainability on the campus. Additionally, recycling initiatives and natural ventilation designs help to reduce debris along with improving the air quality.

4.1.1 FINDINGS FROM INTERVIEW

i) Universiti Teknologi Mara, Shah Alam (UiTM)

UiTM has made impressive attempts to implement green building initiatives the campus such as:

a) Solar System

According to the respondents, UiTM has installed the solar-powered lighting systems that have been placed at certain bus stops to cut energy costs and serve as control renewable energy demonstrations. This effort also supports the national goal of increasing solar adoption in institutional infrastructure (Islam et al., 2010).

b) Recycle Bin

Other than the regular recycle bin for paper, aluminium and plastic, fabric recycling bins, UiTM collaborated with Kloth Care to install fabric recycling bins in the campus. The Recycle@UiTM initiative is a strategic move to enhance awareness among students and staff about the 3R concept (reduce, reuse, and recycle) which promotes green behaviour change (Ahmad et al., 2023).

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c) Green Wall and Natural Ventilation

The design attempts to lower indoor temperatures while complying to GBI requirements for energy efficiency and indoor environment quality (Suhaida et al. 2011). For example, Faculty of of Built Environment includes natural ventilation systems.

d) Water Conservation System

A rainwater harvesting system near the DATC building was identified as an essential element for reducing water consumption and promoting landscaping. The respondents highlighted its low maintenance advantages and efficacy in lowering reliance on municipal water (Shafique et al., 2018).

ii) Universiti of Malaya (UM)

UM has been recognised as a leading of green campus in Malaysia as it has implemented various effective initiatives:

a) Solar System

UM's rooftop solar panels are particularly for encourage research while reducing dependency on traditional power. The institution incorporates photovoltaic systems into parking buildings and select rooftops to promote energy savings and instructional value (Saidur et al., 2011).

b) Recycle Bin

According to respondents, recycling bins are strategically positioned and colour-coded throughout the campus. NGO collaborations also funded specialised bins for fabric and e-waste, demonstrating the GBI's goal of sustainable materials management (Begum et al., 2009).

c) Green Wall and Natural Ventilation

The Faculty of Built Environment and Sustainability Science Research Cluster (BeSS) uses wall greening, natural light and ventilation strategies in its design. According to UM's respondents, the building serves as a sustainability showcase and a paradigm for green campus concepts (De Paula et al., 2022).

d) Water Conservation System

Rainwater is collected from the rooftops, which is filtered and reused especially for toilet flushing and agriculture. The respondents highlighted a 30% drop in municipal water usage upon its implementation (Syafiuddin et al., 2020).

e) Sustainable Transportation

UM promotes carbon-free transport via OBIKE and designated pedestrian pathways. These programs promote healthier lifestyles and lower emissions, aligning with worldwide green campus goals (World Green Building Council, 2020).

iii) Universiti Putra Malaysia (UPM)

UPM is an environmentally innovative university as it has substantial facilities to assist to green initiatives:

a) Solar System

UPM's Solar Panel Farm near the Engineering Faculty and Hospital zone meets a significant amount of energy consumption. This huge infrastructure displays long-term renewable energy production (Shafii & Othman, 2008). It is also known as *Solar Panel Farm*.

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b) Recycle Bin

The Coca-Cola cooperation has sponsored Recycle@U campaign that promotes plastic waste management and recycling practice. According to the respondents, these programs promote responsibility while also reducing wastewater pollution.

c) Green Wall and Natural Ventilation

The Faculty of Design and Architecture (FRSB) has a vertical garden that not only provides insulation but also promotes biodiversity and visual comfort. The adoption of such green features is supported under GBI's Sustainable Site and IEQ categories (Shafique et al. 2018).

d) ***Water Conservation System***

Bukit Expo Lake was defined as a dynamic reservoir that helps with drainage and agriculture. The system contributes greatly to landscape sustainability across the campus (Syafiuddin et al., 2020).

e) Sustainable Transportation

Bicycle and pedestrian lanes are included into the campus layout to encourage low-emission mobility. The university intends to reduce car dependency, which is consistent with the UI GreenMetric's transportation requirements (UI GreenMetric, 2022).

4.1.2 Findings From Site Observation

i. Universiti Teknologi Mara, Shah Alam (UiTM)

a) Solar System

The solar panel system installed on the bus stop roof at UiTM Shah Alam is an outstanding example of incorporating renewable energy into campus infrastructure. This unique design not only decreases reliance on traditional energy sources but also provides a long-term solution for powering the bus stop's lighting and other amenities.

Figure 4.1: Solar Panel System Found as Bus Stop

b) Recycle Bin

Recycle bins, including fabric bins branded by Kloth Care, were positioned near lecture halls and dormitories. These bins encourage students and staff to dispose of unwanted fabrics responsibly, preventing them from ending up in landfills.

Figure 4.2: Recycle Centre in UiTM, Shah Alam

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c) Green Wall and Natural Ventilation

The green wall is located in the Faculty of Built Environment, at the stairs to the café, with adds a touch of natural beauty to the campus environment. The circular structure and central void allow for continuous air circulation, reducing the need for mechanical cooling.

Figure 4.3: Natural Air Ventilation Spotted in Faculty of Built Environment, UiTM Shah Alam

d) Water Conservation System

A functioning rainwater collection system was located at the DATC building, with signage promoting water-saving practices.

Figure 4.4: Water Conservation Spotted Beside DATC, UiTM Shah Alam

ii. Universiti of Malaya (UM)

a) Solar System

This renewable energy solution helps reduce electricity consumption and supports UM's commitment to sustainability and eco-friendly practices across the campus.

Figure 4.5: Solar Panel spotted in UM

b) Recycle Bin

Color-coded waste separation bins were consistently found across faculty buildings and student areas. The recycling bins found at the University of Malaya (UM) are designed for paper, aluminum, glass, and fabrics, which promotes efficient waste segregation across the campus.

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Figure 4.6: Recycle Bin That are Used in UM

c) Green Wall and Natural Ventilation

BeSS featured large windows and exterior greenery. The building's strategic layout allows for maximum daylight exposure and airflow, promoting a sustainable and eco-friendly environment for students and staff.

Figure 4.7: Green Wall & Natural Light Ventilation Spotted in Fakulti of Built Environment, UM

d) Water Conservation System

The rainwater collected and recycled with filtration at the University of Malaya is used for various purposes, including cleaning and watering plants across the campus.

Figure 4.8: Rainwater Harvesting System with Filtration in UM

e) Sustainable Transportation

OBIKE docks were seen in high-traffic pedestrian zones. The installation of shared lane markings and informative sign poles enhances safety and awareness, ensuring both cyclists and pedestrians can navigate the campus more easily and efficiently.

Figure 4.9: OBIKE & Bicycle lane in UM with Pedestrian Sign Pole

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iii. Universiti Putra Malaysia (UPM)

a) Solar System

The solar panel system farm that are installed at the lake in Faculty of Engineering in UPM is an outstanding example of incorporating renewable energy into campus infrastructure.

Figure 4.10: Solar Panel Farm Founded at UPM

b) Recycle Bin

The Recycle@U campaign at UPM is coordinated mostly by the Faculty of Science as an important project to promote recycling and waste disposal on campus.

Figure 4.11: Recycle@U Campaign Collaboration with CocaCola

c) Green Wall and Natural Ventilation

This vertical garden improves air quality by absorbing CO2 and releasing oxygen, resulting in a healthier environment. Large windows and skylights allow natural light to enter inside the building and decreasing the need for artificial lighting during the day.

Figure 4.12: Green Wall & Natural Ventilation Founded at UPM

d) ***Water Conservation System***

Bukit Expo Lake was landscaped with signage detailing its rainwater harvesting role. UPM's use of rainwater reduces the reliance on treated water and promote sustainable farming practices in the campus's agricultural areas.

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Figure 4.13: Lake in Bukit Expo for Rainwater Harvesting System

e) Sustainable Transportation

Bicycle lanes and covered walkways were strategically positioned across campus. These lanes encourage students and staff to ride bicycles for transportation to helps in lowering the campus' carbon emissions.

Figure 4.14: Bicycle Lane and Pedestrian Lane in UPM

HEIs have successfully implemented green campus initiatives to reduce environmental impact. According to Shafique et al., (2018), these initiatives cover a range of sustainability issues, including pollution reduction, water conservation, and green roofing. These examples demonstrate the potential of purposeful, well-supported projects to achieve sustainability outcomes in Malaysian HEIs.

4.2 CRITICAL ISSUE ON GREEN CAMPUS INITIATIVES

Campus sustainability informants reveal institutional and operational hurdles, including funding difficulties, technical issues, and miscommunication among stakeholders. According to de Paula et al. (2022), these issues are exacerbated by outdated buildings and lack of strategy. Institutional commitment, policy frameworks, and stakeholder participation are crucial for improving sustainability activities in HEI (Ochoa et al., 2016).

i. Universiti Teknologi Mara, Shah Alam (UiTM)

a) Limited Budget Allocation for Green Initiatives

According to the UiTM respondent, most green initiatives are sponsored internally or through corporate social responsibility (CSR) partnerships. However, there is no set or allocated funding for large-scale green building projects like solar farm expansion or water treatment upgrades. This leads to uncertainty and delays in long-term green infrastructure planning.

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b) Lack of Community Awareness and Participation

Despite of the visible improvements such as solar-powered bus stops and fabric recycling bins, the UiTM coordinator stated that student and staff involvement is still low. Many people are ignorant of the existence and purpose of these efforts. The lack of ongoing awareness efforts and involvement in student orientation reduces the effectiveness of the campus sustainability initiatives.

c) Maintenance and Monitoring Constraints

Some facilities, such as rainwater collection systems and green walls, did not receive constant maintenance due to staffing or technical restrictions. Green installations' real-time performance is difficult to analyse without the dedicated monitoring systems or IoT connectivity. This restricts data collecting for measuring success and improving future programs.

ii. Universiti of Malaya (UM)

a) Aging Infrastructure in Existing Buildings

The sustainability officer at UM stated that many of the older academic buildings were built decades ago with no considerations for energy efficiency or renewable technologies. Renovating these structures to meet green construction requirements is expensive and sometimes structurally impossible. As a result, green upgrades are mostly concentrated on newer facilities, leaving a gap in implementation.

b) Dependence on Experimental Projects and Short-Term Funding

Many of UM's successful green initiatives (such as solar panels and rainwater collecting) began with research grants or short project money. However, following the pilot phase, there is typically a shortage of funds to scale or sustain these systems. This leads to cut off progress beyond the initial display outcomes.

c) Social Barriers Among Users

Despite having the most advanced sustainability programs, the UM response highlighted that some students and staff to continue to reject behaviour changes such as waste separation or responsible energy use.

iii. Universiti Putra Malaysia, Serdang (UPM)

a) Conflict in Development Priorities

According to the UPM respondent, ongoing campus development for academic and research facilities often takes first place over environmental aims. Green initiatives are frequently included only if they are consistent with the master plan's development timeframe and budget. This may limit the flexibility and breadth of green building implementation.

b) Limited Human Resources for Sustainability Oversight

Although UPM has developed significant green infrastructure, such as solar panels and green walls, the staff in charge of managing and monitoring sustainability is rather

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modest. This inhibits the institution's ability to perform audits, analyse data, and monitor campus in wide involvement on a consistent basis. As a result, maintaining and tracking efficacy becomes challenging.

c) Need Better Collaboration Among Stakeholders

While some projects, such as Recycle@U with Coca-Cola, require an external collaboration, the UPM respondent stated that the importance of more involvement from faculty, student unions and administrative personnel. Without shared ownership of green goals across divisions, sustainability might become isolated within a single office or unit.

4.3 SUMMARY OF THE INITIATIVES AND CRITICAL ISSUES ON GREEN CAMPUS INITIATIVES

Based on interviews and site observations at UiTM, UM, and UPM, the three highest green building initiatives that are discovered were solar energy systems, rainwater harvesting, and recycling initiatives. To reduce the reliance on conventional electricity and encourage renewable energy, all three public HEI have installed solar panels, which range from rooftop panels to photovoltaic-powered public facilities. Rainwater harvesting machines were frequently seen where the collected rainwater is used for irrigation and toilet flushing, thereby helps in reducing water consumption. Furthermore, campus recycling efforts, such as particular recycle bins for fabric and electronic waste, were actively introduced and promoted through partnerships with organisations such as Kloth Care and Coca-Cola which promote the sustainable waste management practices among the university populations.

On the other hand, three primary issues were encountered in the implementation of green construction programs at UiTM, UM, and UPM. First, financial constraints remain as a chronic issue because the universities frequently lack dedicated or ongoing funding for massive upgrading or renewable energy projects, instead of relying on short-term grants or CSR support. Second, low stakeholder participation and awareness among students, staff, and faculty affects the effectiveness of green infrastructure because many users are uninformed of the efforts or do not actively participate in the sustainable initiatives. Third, architectural and operational constraints, such as old buildings with limited technical staff and a lack of monitoring systems have prevent the consistent implementation, maintenance and evaluation of green initiatives across the campus.

5. CONCLUSION

The study analysed green campus initiatives at Malaysian public HEI, with a focus on Universiti Teknologi MARA (UiTM), the University of Malaya (UM), and Universiti Putra Malaysia (UPM). It highlighted amazing progress achieved by the universities in initiating green projects such as solar energy, water conservation systems, and sustainable transportation. The report made practical recommendations such as improving the stakeholder relationships, implementing smart energy management systems and raising the community knowledge and engagement.

Based on the findings and analysis of this study, numerous areas deserve an additional investigation to improve the understanding and implementation of green campus programs in

public HEI. While this study effectively identified the major goals, critical issues, and practical recommendations, additional research could provide additional insight into the sustainability of such activities.

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