An ISM Approach for the Barrier Analysis in Implementing Green Campus Operations: Towards Higher Education Sustainability

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Abstract: Although various initiatives have been undertaken by the universities worldwide to ensure that their campus operates sustainably, there are emergent barriers that pose serious challenges to the practitioners and subsequently hinder the successful implementation. The research for this paper was built upon the discussion concerning ‘campus operations’, which is one of the dominant sustainability elements in the university systems. It analyzes the barriers for green campus operations implementation through a methodological approach, which was implemented in two tiers. For identification of the barriers, a comprehensive review of the literature was performed and consulted with academic experts who have been involved in greening campus operations in the university. Next, interpretive structural modeling was used to analyze and develop a model of interactions, mutual influence, and relationship among barriers. The results revealed an eighteen-barrier interpretive structural model with eight levels. The analysis indicated that ‘lack of awareness’, ‘lack of knowledge’, ‘resistance to change’, and ‘inefficient communication’ are the dominant barriers with high driving and low dependence powers. The research findings highlighted the importance of this structural model for universities to facilitate the implementation of campus operations by removing the dominant barriers.

Keywords: campus operations; green campus; higher education sustainability; barriers; interpretive structural modelling (ISM)

1. Introduction

Higher education institutions (HEIs) have been regarded as the essential party for accomplishing sustainable development (SD) [1,2], which was outlined from the Brundtland Report as ‘Our Common Future’ to the 2030 Agenda with the 17 SD Goals as ‘Transforming Our World’ [3], due to its unique intellectual contributor to sustainable societal transitions. As such, multiple initiatives have been launched by HEIs to promote campus sustainability from international declarations on education to the creation of campus sustainable networks and assessments since the 1990s [4]. The implementation of campus operations has observed significant progress than other developmental initiatives [5,6]. It is one of the most recognized strategies for fostering sustainability in university systems as stressed in various international declarations [7]. Lozano et al. [8], based upon
a literature review of state-of-the-art studies, found that campus operations initiative in the quest for SD in HEIs was the second-highest element out of seven sustainability elements implemented. Washington-Ottombre and Bigalke [9] revealed that campus operations has contributed the highest percentage (43.7%) in the development of campus sustainability out of other modes, i.e., co-curriculum (29.9%), organizational change (22.7%), partnerships (18.4%), curriculum (15.9%), research (15.5%), and outreach (6.8%).

Although various initiatives of campus operations have widely been implemented, there are emergent barriers that pose serious challenges to the practitioners, and, consequently, hinder the successful implementation. As campus operations implementation requires systematic and continual efforts [8], it is deemed important to understand the barriers and their importance in implementation for a smooth transition. According to Hopkins [10], the analysis of key barriers is essential in this context due to the potential environmental and economic benefits of green campus building policies. This matter was also highlighted by Lozano [11], “to be aware and to understand the barriers to change and conflicts that could arise in order to take the necessary steps to prevent or to solve them (p. 793)”. Thus, this study is aimed at identifying and analyzing the barriers in campus operations implementation within a university system. The objectives of this research intend to recognize the key barrier among recommended barriers and analyze the vital and correlative relationships of those barriers using a qualitative approach—interpretive structural modeling (ISM)—which is based on the perspectives of academic experts, who were involved in green campus operations.

To this end, this study investigates the issue of campus operations implementation in Universiti Teknologi Malaysia (UTM), which is a leading innovation-driven entrepreneurial research university in engineering science and technology. It is located in Johor Bahru, Malaysia with 1145 hectares of land including 612 buildings that comprise 14 faculties, 13 hostels, and 6 administration buildings. This makes it extremely challenging to manage all of the resources and facilities. According to Blanco-Portela et al. [12], numerous schools and campuses along with diverse lecturers and students exacerbate the complexity to encourage the commitment of the academic community in developmental processes aimed at the integration of sustainability. UTM started to launch a Sustainable Campus Preservation Policy and Framework (SCPPF) since 16 March 2011. It has made many initiatives towards the implementation of campus operations and encountered many barriers simultaneously. The economic instability and volatile political environment in Malaysia have influenced campus operations implementation to a certain extent. The reduction of budget allocation has also brought more challenges to run campus operations in the system [12]. In this regard, this study is undertaken to clarify the following questions, which were fundamentally formulated to propagate the research objectives: (1) what are the key barriers to campus operations implementation? Furthermore, (2) how should those barriers be sorted towards successful implementation?

This paper has consequently attempted to make a valuable contribution towards higher education sustainability, which is a subject of increasing interest in various institutions. It concentrates on implementing ‘campus operations’ which is one of the dominant sustainability elements in HEIs, reviewing the literature that investigates campus operations implementation in terms of the barrier analysis. According to Blanco-Portela et al. [12], there is a vast amount of research on barriers to developing sustainability in companies than in HEIs. This is further supported by Hopkins [10] that there have been little empirical and theoretical studies that examine green campus operations from this point of view. Particularly, there is limited research investigating what academic experts in HEIs perceive about barriers to implementation. This demonstrates the need for state-of-the-art studies on this under-researched scope. As mentioned earlier, it is essential to acknowledge the recognition of key barriers and their level/importance to mitigate or overcome them in the implementation process [10–12]. Nonetheless, many of the educational stakeholders and decision-makers are unaware of these issues [11]. To support this body of knowledge, this study contributes to identifying key barriers in campus operations implementation by a literature review on the topic and based on academic experts’ opinions. Contextual relationships among identified key barriers are also analyzed through
an ISM-based approach to contribute to understanding their interactions and mutual correlations. More significantly, this paper proposes a systematic model of key barriers that can provide a guiding reference for planners and practitioners towards implementing campus operations by focusing on reducing or removing dominant barriers. In addition, this article also intends to contribute by inspiring investigators to widen the study of this under-researched field.

The rest of this paper is structured as follows: a literature review presents the background of campus operations in HEIs and identifies the barriers for its implementation. The next section clarifies the research methodology and summarizes the outcomes of the study. Results and discussion are entailed in the following section. Finally, conclusions are outlined.

2. Literature Review

Sustainability is gradually being prioritized in tertiary education institutions nowadays. The increasing scientific communities and institutions are actively involving themselves in augmenting the value for both learners and HEIs to break through social, environmental and economic aspects. They are seizing the opportunity to immerse and implement this phenomenon into tertiary education frameworks in order to expedite the transition to SD [13,14]. Therefore, according to Mandaviya and Dwivedi [15], HEIs (particularly universities) are lagging behind developing this phenomenon into their system. In this sense, it is undeniable that universities are required to develop creative initiatives and leadership to succeed [16].

The significance of campus operations has been highlighted by the recognized declarations—Talloires in 1990, Halifax in 1991, Kyoto in 1993, Swansea in 1993, Global Higher Education for Sustainability Partnership (GHESP) in 2000, Abuja in 2009, and Rio + 20 Higher Education Sustainability Initiative (HESI) in 2012 [4,8]. Generally, it involves water, transport, energy, waste, food purchasing, greenhouse gases, accessibility for disabled people, and equality and diversity in tertiary education systems to cultivate SD [8]. Cortese [1], Velazquez et al. [7] and Mcmillin and Dyball [17] considered campus operations as one of the essential elements in performing sustainability within the university system. It is believed that the implementation of this sustainability element will lead to lower the financial spending of HEIs apart from benefiting the environment, directly impacting on the SD implementation in HEIs [17]. This initiative has therefore been emphasized by innumerable international institutions and enforced through centralized tactical programs in encouraging green practices. Despite prior evidence of the importance of campus operations implementation, there is always a set of barriers that hinders its successful implementation [10,12].

Barriers in Implementing Campus Operations in HEIs

To address the research purpose, this study begins initially with a comprehensive review of the literature and proceeds with an analytic-interpretive approach to finalize the research. Therefore, this section reviews the literature that investigates the campus operations implementation in terms of the barrier analysis. Based on this review and interviews done by experts, who were selectively chosen according to a systematic approach (the approach will be explained in more detail in Section 3.1), 18 key barriers were recognized. The outcomes of this initial appraisal, which are discussed below, are systematically presented in Table 1.
Table 1. Summary of the barriers classified from literature and expert’s opinions.

| Codes | Barriers                             | Description                                                                                                                                                                                                 | Source                      |
|-------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| B1    | Lack of knowledge                    | The lack of knowledge and understanding among faculty staffs and administrations in the innovation and systemic change within the institution regarding sustainable development.                                          | [10,18–24]                 |
| B2    | Lack of awareness                    | Limited environmental awareness on how to act sustainably among the university communities. For instance, investing in waste and energy reducing equipment is not worthy unless people realize its importance and understand how it should be carried out. | [18–20,22,24]              |
| B3    | Occupant’s satisfaction concerns     | The issue of occupant satisfaction and comfort is essential to avoid negative user experience regarding green buildings. For instance, within a building, there is a possibility that the rooms may be set at a specific thermal point with no appropriate thermal control elements such as an operable window or thermostat. This could lead to the thermal point of the rooms being improperly set and results in an inability to adjust to a comfortable setting by the user depending on the weather conditions. | [10,25,26]                 |
| B4    | Lack of financial resources          | Huge expenses are required for the implementation of energy-saving and waste-reducing measures. Generally, universities are only able to allocate a restricted financial budget for greening measures despite operation costs being reduced on greening initiatives. Hence, insufficient capital might not be able to support the initial expenses despite the potential of the project bringing multiple returns. | [10,19,20,27–29]           |
| B5    | Lack of proper infrastructure        | The lack of proper infrastructure has brought about an inconvenience of certain actions, with hassle-oriented actions being correlated to the poor attention span of users. E.g., the hassle of riding a green bike or crossing a busy road to reach off-campus hostels. | [20,28,30]                 |
| B6    | Lack of available resources          | Limited space and scarce resources to green/sustainable initiatives contribute to the failure in the implementation of campus operations. Moreover, sustainability projects are not considered as a top priority for the management board due to the scarce resources and limited expertise allocated for the implementation of the concept. | [12,19,31]                 |
| B7    | Lack of responsibilities             | Deficiency of responsibility by the personnel in HEIs, either to lead green campus operations or contribute ideas to developmental actions.                                                                 | [12,31]                     |
| B8    | Lack of pressure from society        | Lack of driving factors from the communities around HEIs to encourage the implementation of campus operations.                                                                                                                                               | [12,23,31,32]              |
| B9    | Lack of time                         | Insufficient time makes environmental management unnecessary and troublesome since it is not integrated into the daily schedule. It is challenging to encourage lecturers and researchers to participate in sustainable-based activities that may not be related to their majors. Such issues are also not considered as compulsory subject or knowledge in the students’ educational plan. | [12,22,23,31]              |
| B10   | Lack of engagement                   | Individuals do not actively partake in sustainability issues despite being aware of the concerns. The participation of students in campus operations activities was difficult because of their commitments in other co-curricular activities.  | [12,21,27–29,31]           |
Table 1. Cont.

| Codes | Barriers | Description | Source |
|-------|----------|-------------|--------|
| B11   | Lack of support from top management of the university | The top management of an institution does not provide adequate attention, support the project and allocate financial or technical resources to implement it and/or assign personal time to attend to campus operations matters. | [10,12,31,33] |
| B12   | Resistance to change | Generalized restraint to revise any behavior and culture that have been cultivated in the institution. Reluctant to move from routines, and change towards more responsible actions. This attitude is commonly possessed by different social circles among academic communities composed of students, lecturers, administrative staffs, and service personnel. | [12,18–21,23,31,34] |
| B13   | Complex bureaucracy | The progress of the implementation may be decelerated by the government’s interruption on budget reduction, complicated paperwork procedure, slow processing, and the requirement for guarantees from various departments for approval of resources. | [12,18,24,31] |
| B14   | Insufficient of long-term planning, systematization and continuity | A planning process for organizational changes is required to meet the needs of individuals, groups, company and also their respective attitudes. For instance, the high turnover of personnel will undoubtedly decelerate any action since it requires long periods of time to equip new staff with relevant knowledge and skillsets. | [12,31] |
| B15   | Inefficient communication | Communication channels in institutions are ineffective. In the event that progress slows down due to ineffective communication, the university leaders of sustainability have no choice, but to reiterate the project’s objectives to the individuals involved at all levels. | [12,18,19,28,29,31] |
| B16   | Big scale of the institutions | Numerous schools and campuses along with diverse students and lecturers exacerbate the complexity to encourage the commitment of the academic community in developmental processes aimed at the implementation of campus operations. | [12,31] |
| B17   | Lack of priority | Campus operations projects are usually not formally acknowledged as part of institutional planning, unlike other projects that are being prioritized. Hence, the resources allocated for their implementation are restricted. | [10,12,17,31,34] |
| B18   | Lack of legal regulations | The implementation of green campus operations initiatives is not backed up by governmental authorities. As a result, it is simply coordinated voluntarily by activists and initiated with individual actions or small projects; however, their efforts are unable to amend the framework and practices of the institution due to insufficient legal supports. | [12,17,18,31,34,35] |
Due to the specific structures and characteristics of HEIs, it is arguable whether campus operations can be successfully implemented, as it is unavoidable that obstacles may arise in the process of implementation. From the interview with experts in UTM CS operations, lack of knowledge is the biggest issue in the implementation of campus operations. The root cause of this factor goes back to the non-academic staff especially among the supporting staff who are involved in implementing green campus operations at UTM. These staffs are usually not highly educated, acting as demand targets for their institutional offerings. According to Nicolaides [18] and Viebahn [34], the difficulties in motivating the university staff with insufficient knowledge is also considered as a barrier. Most of the facilities management directors discovered that limited understanding of sustainability among faculty staff and administration complicates the execution of an integrated implementation approach [10]. People involved must be well-educated to ensure the success of green campus operations because a lack of environmental knowledge results in a predominant non-environmental mindset on campuses [20]. Thus, the lack of relevant information/knowledge and apt method to incorporate it into individual activities have been regarded as a hindrance [21]. A survey from the University of Gavle, Sweden, revealed that lack of knowledge in integrating environmental management into individual activities restricts the accomplishment of sustainable development initiatives in campus [22]. Hence, it is believed that a lack of knowledge among these university staffs creates resistance to the implementation process [23].

Environmental awareness is essential as most people have very limited knowledge on how to act sustainably. In order to succeed in a shift towards an environmentally sustainable culture, students must be aware of how their decisions and behaviors on campus can make an impact on their institutions’ environmental ‘footprint’ [20]. In the quest for sustainable universities in South Africa, Nicolaides [18] found a lack of senior management awareness in an environmentally-friendly institution. However, the progress on the integration of sustainable development initiatives on campus will be decelerated if people are unaware of environmental issues [22]. Due to a lack of awareness, many stakeholders have not yet championed the implementation of green campus operations [24].

Occupant’s satisfaction concerns can also instill a negative impact on university buildings and subsequently generate new obstacles in the integration of campus operations [10], e.g., issues such as quality of living and level of occupant’s contentment. There is limited research on this barrier, as pointed out by References [25,26], who investigated whether or how the indoor environmental quality of sustainable buildings contributes to occupant’s satisfaction. The institutional integrated sustainability initiatives coupled with sustainable infrastructures usually involve a huge allocation of money [20,27,28]; thus, financial limitations are restraining HEIs to implement sustainable campus operations initiatives among institutional facilities design [29]. According to Reference [19], plenty of budding sustainable initiatives would progress slowly or become obsolete if there is little financial support.

Moreover, lack of proper infrastructure has a disastrous impact on sustainable campus operations implementation. This barrier is related to the inconvenience of certain actions, with less convenient actions being much less likely to be engaged in [28,30]. For instance, the lack of recycling places to recycle materials such as glass and batteries, the hassle of riding a green bike or the inconvenience of taking a walk during high traffic zones to get to and from off-campus apartments serves as barriers to achieve campus sustainability [28]. Furthermore, limited space available for necessary development in campus operations initiative also became an obstacle to the successful implementation [20]. The long-term returns of green investments are worthy; however, the upfront costs required for green infrastructure and for developing sustainability initiatives are also high. Blanco-Portela et al. [12] discussed that lack of allocated resources to the sustainable initiative in terms of economic and personnel resources contributes to the failure of campus operations implementation. Besides, he also discovered that there is a lack of responsibility by the personnel in HEIs, either in terms of taking leading roles in sustainability activities or suggesting new actions.

According to Ferrer-Balas et al. [23,32], lack of driving factors from the community around the campus regarding environmental concerns will also dwindle the university initiative on campus
operations. Many investigations have considered the lack of external pressure as a key barrier since it can play a pivotal role in implementing the required institutional changes [12]. This is especially during the development of higher education sustainability through local acts which are approved by governmental rules and regulations; however, the lack of such external support becomes a barrier to implementation, addressing the need for more external pressure to encourage the incorporation of sustainable practices in HEIs [31].

The lack of engagement of the stakeholders was attributed to issues of convenience and lack of time (but not a lack of interest); however, sustainable practices would add additional tasks to their existing job responsibilities [28]. Time constraint is always an issue for lecturers to initiate or participate in the sustainable development program. It is challenging to encourage lecturers and researchers to partake in the environmental activities which may not be related to their major field and henceforth, creates a barrier to foresee and monitor future environmental consequences [22,23]. Not only that, but it is also tough to motivate students to involve in green campus operations initiatives due to their busy academic schedules which restrict them to participate in other activities [12,21]. However, students are being highlighted as the most valuable stakeholders in advancing the sustainability of campuses and beyond [16,36]. The implementation of SD in campus operations is often considered as a burden as there will be extra activities and works to be participated and carried out by the campus community [27–29]. According to Sammalisto and Arvidsson [35], the lack of support from top management regarding sustainability initiatives will hence become a crucial internal barrier in campus operations implementation. In short, sustainable development can be extremely challenging when the central management board of the educational institution neither supports the project, provides attention nor allocates resources to implement it [10,12].

Another hindrance is the attitude of the HEIs community to conserve their current way of life because the implementation of campus operations would depreciate the knowledge (or skills presently required) and might need to make changes in which may oppose social customs, fashions, taste and the habits of everyday life [21]. Many investigators and practitioners directly link failures of a change process with ‘resistance to change’ [19]. The employees involved in environmental management programs are used to work in “comfort zones” and are reluctant to change, making it arduous for sustainable initiatives implementation [18,23]. This attitude is commonly possessed by different social circles among academic communities composed of students, lecturers, administrative staffs, and service personnel. The attitude of “we’ve managed it that way, and it works, hence it is not necessary to change” induces serious restraint to the accomplishment of any sustainable-oriented efforts [12].

This resistance may take place due to the existing complex bureaucracy and rigid structures [31]. HEIs’ operational system is inflexible; the approval of any changes involves complicated steps and procedures [12]. The academic framework is remarkably rigid, with the fixed syllabus and lack of a comprehensive strategy or space for transverse actions. Any transverse actions amidst faculties and departments require effort and are expensive, even for courses. Nicolaides [18] also mentioned that in the university, the total count of the faculty amounts to an estimated 1500 independent entrepreneurs. Gather all these independent entrepreneurs together with operations managers reporting to several different vice presidents, and chaos may ensue. The complex hierarchy of HEIs resulting from these diverse departments’ differing levels of autonomy can be considered as a barrier in implementing campus operations [24].

Lozano [11] recommends a planning process for organizational changes towards sustainability that meets the needs of individuals, groups, company and also their respective attitudes. Blanco-Portela et al. [12] explained that the high turnover of personnel will undoubtedly decelerate any action since the admission of a new staff requires to be started from the initial stage before rising up the corporate ladder. Generally, the project will be disoriented following the withdrawal of the responsible person(s) from the institution, signifying the fact that the project was not institutionalized. All resources and efforts regarding the project are hence lost. The enrollment of a new chancellor will eventually arise
problems in which years allocated resources and endeavor will be lost since all project efforts are unfamiliar to new staffs and simultaneously receive no cohesion for that particular project.

Another concern was related to the lucidity of the communications whereby staff from institutional planning and facilities’ services are being negligent in some of the ongoing sustainability strategies on campus [28,29]. It appears due to the absence of a bonding relationship connecting environmental and sustainable knowledge between the groups in the institution [18]. The deficiency of assertive communication within the academic communities of numerous schools and campuses along with a large number of lecturers and students poses a barrier, which increases the complexity to encourage the commitment of the academic community in the developmental processes aimed at the incorporation of sustainability in HEIs. This results in the isolated actions and duplicity of resources and efforts [12].

Campus operations and facilities management are predominantly considered as the physical operation of the university and having mere relevance to curriculum or research [17]. The project of institutionalization in sustainability is usually not formally acknowledged as part of institutional planning. Hence, the resources allocated for the implementation are unfortunately restricted. Concurrently, the implementation of sustainable tertiary education was restrained whilst other projects are being prioritized [12]. Sustainability was considered as ‘low priority’ due to the limited funds allocated to public universities, the political instability of governments, and social catastrophe, hence resulting in the impoverishment of resources for its implementation [10].

According to Viebahn [34], there are no legal regulations for economizing measures regarding the ecological use of resources (e.g., traffic reduction, water and energy-saving, nature protection, green construction technology) which is carried out on a spontaneous basis. Consequently, their actions are unable to amend the structures and practices of the institution [12]. This increases the difficulty level for implementing green/sustainable practices [35]. Therefore, according to References [11], it is essential to acknowledge the presence of these barriers, which influence the implementation of green campus operations, and their level to mitigate or overcome them. This study has accordingly identified eighteen barriers, as described in Table 1, based on literature and discussions with academic experts. To move towards analyzing the vital and correlative relationship of these barriers and developing a structural model of them, a methodological approach was applied which will be explained in detail below.

3. Methods

To achieve the research purpose, this study employed a qualitative approach, i.e., interpretive structural modeling (ISM); the philosophical foundation for developing this application into complex situations as a communication tool was presented by Warfield [37]. ISM has been broadly utilized since its initiation, from the early literature on the policymaking [38–41], up to its wide use in recent managerial and developmental research [16,42–49].

According to Sage [41], the ability to transform complex articulated models into clear and evident models is the main advantage of ISM. The important characteristics of ISM thoroughly enumerated by [42]: this methodology is interpretive as the judgment of the group will define whether and how the various elements are related; it is also structural based on the correlation whereby an overall structure is extracted from the complex set of variables; it is a modeling technique as the specific relationships and overall structure are portrayed in a digraph model; it contributes to impose order and direction on the complication of relationship among different elements of a system; and it is predominantly intended as a group learning process, as it is applied by individuals. Thus, it allows researchers to establish a plan of the relationships between many elements associated in a sophisticated manner as a system [46]. Five main steps for performing this methodological approach are taken out in this research, the following sections address these steps and the results adhered.
3.1. Identification of Barriers and Qualified Experts

To move towards identifying the key barriers and developing contextual relationships among barriers, the use of experts’ opinions was recommended in the ISM methodology. This methodological approach does not provide any systematic manner in choosing qualified experts [16,46] while the prejudice of the person, who is judging the under-studied obstacles, drives the final outcome. To fill this gap, this study has applied the flexible point system proposed by Hallowell and Gambatese [50] for the qualification of experts’ panelists (Table 2). This point system is based on the relative time commitment required to successfully complete each of the achievement or experience. For the sake of meeting a minimum level of qualification by referring to the point system (Table 2), it is advised that panelists score at least one point in four different achievement or experience categories and a minimum of 11 total points to ensure the balance of academic and professional experience [50].

Table 2 shows the panelists’ qualification scores for this qualitative research, which exceed the recommended level. Consequently, based on the literature review and exclusive interviews done by the experts, from the recognized twenty-two barriers, eighteen barriers were approved, as described in Table 1.
Table 2. The qualified experts’ profile.

| Achievement/Experience                  | Points (Each) | Exp1 | Exp2 | Exp3 | Exp4 | Exp5 | Exp6 | Exp7 | Exp8 | Exp9 | Exp10 | Exp11 | Exp12 |
|-----------------------------------------|---------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| Professional registration               | 3             | YES  | YES  | YES  | YES  | YES  | YES  | NO   | YES  | YES  | YES   | YES   | NO    |
| Year of professional experience         | 1             | 18   | 30   | 22   | 8    | 5    | 19   | 10   | 5    | 20   | 10    | 9     | 18    |
| Conference presentation                 | 0.5           | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES   | YES   | YES   |
| Member of a committee                   | 1             | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES   | YES   | YES   |
| Chair of a committee                    | 3             | NO   | YES  | NO   | NO   | NO   | YES  | NO   | NO   | YES  | NO    | YES   | NO    |
| Peer-reviewed journal article           | 2             | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES   | YES   | NO    |
| Faculty member at an accredited university | 3           | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES  | YES   | YES   | YES   |
| Writer/editor of a book                 | 4             | NO   | NO   | NO   | YES  | YES  | YES  | YES  | NO   | NO   | YES   | YES   | NO    |
| Writer of a book chapter                | 2             | YES  | YES  | YES  | YES  | YES  | YES  | YES  | NO   | YES  | YES   | YES   | NO    |
| Advanced degrees:                       |               |      |      |      |      |      |      |      |      |      |      |      |      |
| BS = 1                                  |               | PhD  | PhD  | PhD  | PhD  | PhD  | PhD  | PhD  | PhD  | PhD  | PhD   | PhD   | PhD   |
| MS = 2                                  |               |      |      |      |      |      |      |      |      |      |      |      |      |
| PhD = 4                                 |               |      |      |      |      |      |      |      |      |      |      |      |      |
| Total Points                            |               | 33.5 | 48.5 | 37.5 | 27.5 | 24.5 | 41.5 | 29.5 | 23.5 | 33.5 | 29.5   | 31.5  | 29.5  |
3.2. Creation of Structural Self-Interaction Matrix (SSIM): Constituting the Conceptual Relationships

During an interview, the contextual correlation for each obstacle and the existence of a connection between any two obstacles (i and j), the associated direction of the relationship is inquired using a ‘will influence’ type, which indicates that one obstacle will influence another obstacle. The results of this survey developed the structural self-interaction matrix (SSIM), as shown in Table 3. According to the ISM methodology, the four symbols stated below were applied to represent the direction of relationships between two barriers (i and j):

- **V**: Barrier i will influence barrier j, e.g., Barrier 1 (B1) will influence Barrier 3 (B3), thus the relationship is denoted as ‘V’ in the SSIM;
- **A**: Barrier i will be influenced by barrier j, e.g., B1 will be influenced by B2, thus the relationship is denoted as ‘A’ in the SSIM;
- **X**: Barrier i and j will influence each other, e.g., B1 and B12 will influence each other, thus the relationship is denoted as ‘X’ in the SSIM;
- **O**: Barriers i and j are unrelated, e.g., there is no relationship between B1 and B9, thus the relationship is denoted as ‘O’ in the SSIM.

| Barrier i | B18 | B17 | B16 | B15 | B14 | B13 | B12 | B11 | B10 | B9  | B8  | B7  | B6  | B5  | B4  | B3  | B2  |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| B1       | O   | V   | V   | A   | V   | V   | X   | V   | V   | O   | V   | V   | V   | V   | V   | V   | A   |
| B2       | O   | V   | V   | V   | V   | V   | V   | V   | V   | O   | V   | V   | V   | V   | V   | V   | V   |
| B3       | A   | A   | A   | O   | O   | O   | O   | O   | O   | O   | A   | O   | A   | A   | A   | A   | A   |
| B4       | A   | A   | A   | A   | A   | A   | A   | V   | V   | V   | V   | V   | V   | X   | V   | V   | V   |
| B5       | A   | A   | A   | O   | A   | A   | A   | O   | V   | O   | V   | O   | V   | A   | O   | O   | O   |
| B6       | O   | O   | A   | A   | O   | A   | A   | O   | V   | V   | V   | V   | V   | V   | V   | V   | V   |
| B7       | O   | A   | A   | A   | A   | A   | A   | A   | A   | A   | O   | O   | V   | V   | V   | V   | V   |
| B8       | O   | O   | A   | O   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   | X   | O   | O   |
| B9       | O   | O   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   | V   | O   | A   | A   |
| B10      | A   | O   | A   | A   | O   | O   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   |
| B11      | A   | V   | A   | A   | V   | X   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   |
| B12      | V   | V   | V   | X   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   |
| B13      | O   | V   | O   | A   | V   | O   | A   | V   | O   | A   | V   | O   | A   | V   | O   | A   | V   |
| B14      | A   | X   | A   | A   | A   | X   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   | A   |
| B15      | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   |
| B16      | O   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   | V   |
| B17      | O   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

3.3. Development of the Final Reachability Matrix

After attaining the SSIM, it must be converted to an initial reachability matrix (binary matrix) using numbers 0 and 1. Therefore, the initial reachability matrix is developed based on SSIM and using the rules of substitution, as follows:

- If the cell (i, j) is determined by ‘V’ in the SSIM, the relevant cell in the matrix of the initial reachability would convert to number 1 and the cell (j, i) would convert to number 0.
- If the cell (i, j) is determined by ‘A’ in the SSIM, the relevant cell in the matrix of the initial reachability would convert to number 0 and the cell (j, i) would convert to number 1.
- If the cell (i, j) is determined by ‘X’ in the SSIM, both the cells (i, j) and (j, i) would convert to number 1 in the matrix of the initial reachability.
- If the cell (i, j) is determined by ‘O’ in the SSIM, both the cells (i, j) and (j, i) would convert to number 0 in the matrix of the initial reachability.
In pursuit of these rules, the statement of the transitivity rule claims that if barrier A influences barrier B, and barrier B influences barrier C; then, essentially, barrier A influences barrier C. The process of examining these relations have not been considered in the initial reachability matrix. To fix this issue, it is essential to form the final reachability matrix. In doing so, a mathematical relationship was progressed, as shown in Table 4. In this final reachability matrix (Table 4), it is notable that the summation of each row shows the driving power of each obstacle, which indicates how much each barrier can influence other obstacles. Apart from that, the summation of each column shows the dependence power on each barrier, in which how much each obstacle can be influenced by others [46]. Accordingly, B2 with driving power 18 (higher) and dependence power 1 (lower) is found to be the dominant barrier.

Table 4. Final reachability matrix.

| Barrier | B18 | B17 | B16 | B15 | B14 | B13 | B12 | B11 | B10 | B9 | B8 | B7 | B6 | B5 | B4 | B3 | B2 | B1 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|
| B1      | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 17 |
| B2      | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 18 |
| B3      | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| B4      | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| B5      | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| B6      | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| B7      | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| B8      | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| B9      | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| B10     | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| B11     | 0   | 1   | 0   | 0   | 1   | 1   | 0   | 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 12 |
| B12     | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 17 |
| B13     | 0   | 1   | 0   | 0   | 1   | 1   | 0   | 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 12 |
| B14     | 0   | 1   | 0   | 0   | 1   | 1   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 10 |
| B15     | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 17 |
| B16     | 0   | 1   | 1   | 0   | 0   | 1   | 0   | 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 12 |
| B17     | 0   | 1   | 0   | 0   | 1   | 1   | 0   | 0   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 10 |
| B18     | 1   | 1   | 0   | 0   | 1   | 1   | 0   | 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 13 |
| Dependence Power | 5 | 10 | 5 | 4 | 10 | 8 | 4 | 8 | 16 | 16 | 17 | 14 | 13 | 13 | 15 | 1 | 4 |

3.4. Level Partitions and Formation of ISM-Based Model

From the final reachability matrix (Table 4), for each barrier, reachability sets and antecedent sets are extracted. The reachability set composes of that particular barrier itself and also other barriers that may influence it, whereas the antecedent set is made up of the barrier itself and the other barriers that may influence it. Subsequently, the intersection of these sets is acquired for all the barriers and levels of different barriers are verified. The barriers with the same reachability and the intersection sets occupy the top level in the ISM hierarchy. The top-level barriers are those barriers that will not lead the other barriers above their own level in the hierarchy. Once the top-level barrier is recognized, it will be removed from consideration. Then, the same process will be repeated to identify the barriers in the following level. This process is continued until the level of each barrier is obtained. Table 5 shows the eighteen barriers along with their reachability sets, antecedent sets, intersection sets, and levels. The level identification process of these barriers is completed in eight iterations. As illustrated in Table 5, ‘occupant satisfaction concerns (B3)’, ‘lack of pressure from society (B8)’, ‘lack of time (B9)’ and ‘lack of engagement (B10)’ were found at level I. Hence, they would be located at the top of the ISM model. This iteration further continues until the levels of each barrier are identified. These recognized levels help in creating the ISM-based model. Thus, the final structural model is developed from the final reachability matrix (Table 4) and based on the level partitions (Table 5), as shown in Figure 1.
Table 5. Level partitions for the barriers.

| Barriers | Reachability Set | Antecedent Set | Intersection Set | Levels |
|----------|------------------|----------------|------------------|--------|
| B3       | 3                | 1,2,3,4,5,6,7,11,12,13,14,15,16,17,18 | 3                | I      |
| B8       | 8,9,10           | 1,2,4,6,7,8,9,10,11,12,13,14,15,16,17,18 | 8,9,10           | I      |
| B9       | 8,9,10           | 1,2,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18 | 8,9,10           | I      |
| B10      | 8,9,10           | 1,2,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18 | 8,9,10           | I      |
| B7       | 7                | 1,2,4,5,6,7,11,12,13,14,15,16,17,18    | 7                | II     |
| B4       | 4,5,6            | 1,2,4,5,6,11,12,13,14,15,16,17,18      | 4,5,6            | III    |
| B5       | 4,5,6            | 1,2,4,5,6,11,12,13,14,15,16,17,18      | 4,5,6            | III    |
| B6       | 4,5,6            | 1,2,4,5,6,11,12,13,14,15,16,17,18      | 4,5,6            | III    |
| B14      | 14,17            | 1,2,11,12,13,14,15,16,17,18             | 14,17            | IV     |
| B17      | 14,17            | 1,2,11,12,13,14,15,16,17,18             | 14,17            | IV     |
| B11      | 11,13            | 1,2,11,12,13,15,16,18                    | 11,13            | V      |
| B13      | 11,13            | 1,2,11,12,13,15,16,18                    | 11,13            | V      |
| B16      | 16               | 1,2,12,15,16                               | 16               | VI     |
| B18      | 18               | 1,2,12,15,18                               | 18               | VI     |
| B1       | 1,12,15          | 1,2,12,15                                  | 1,12,15          | VII    |
| B12      | 1,12,15          | 1,2,12,15                                  | 1,12,15          | VII    |
| B15      | 1,12,15          | 1,2,12,15                                  | 1,12,15          | VII    |
| B2       | 2                | 2                                           | 2                | VIII   |

Figure 1. Interpretive structural modelling (ISM)-based model for barriers.

3.5. MICMAC Analysis

According to Sharma [51], MICMAC which is the abbreviation for Matriced’ Impacts croises-multiplication applique’ and classification (cross-impact matrix multiplication applied to classification), is developed from the multiplication properties of matrices. MICMAC analysis was initially introduced by Godet in 1986 [52], with the aim of examining the driving power and dependence power of enablers. This analysis is carried out to distinguish the main enablers (referred to in this paper as ‘barriers’) that drive the model in a variety of classes [46]. The driving power and dependence power for each barrier are tabulated in Table 4, which was obtained from the final reachability matrix by summation of rows to analyze driving power and summation of columns to
study dependence power. The barriers are categorized into four clusters, as presented in Figure 2, based on both their driving and dependence powers.

- **Autonomous barriers**: Quadrant I shows the autonomous barriers. This quadrant does not have much influence on the model; therefore, if the barriers are located in this area then they will be virtually isolated since they are relatively disconnected from the model [46]. Based on the analysis, there are no observable barriers in this quadrant. It shows that none of the identified barriers have weak dependence and driving powers, indicating that all the barriers are relatively linked to each other.

- **Dependent barriers**: Quadrant II shows the dependent barriers, containing those barriers that have weak driving power but strong dependence power. As shown in Figure 2, barriers in this category are ‘occupant satisfaction concerns (B3)’, ‘lack of financial resources (B4)’, ‘lack of proper infrastructure (B5)’, ‘lack of available resources (B6)’, ‘no assumption of responsibilities (B7)’, ‘lack of pressure from society (B8)’, ‘lack of time (B9)’ and ‘lack of engagement (B10)’. 

- **Linkage barriers**: Quadrant III shows the linkage barriers (Figure 2), including those barriers that have both strong driving and dependence powers. They are also considered unstable whereby any action on them will have an impact on other barriers as well as themselves [46]. ‘Lack of priority (b17)’ and ‘lack of long-term planning, systematization and continuity (B14)’ fell into this quadrant.

- **Independent barriers**: Quadrant IV shows the independent barriers, involving those barriers that have strong driving power but weak dependence power. In this study, as illustrated in Figure 2, there are eight independent barriers including ‘lack of knowledge (B1)’, ‘lack of awareness (B2)’, ‘lack of support from top management of university (B11)’, ‘resistance to change (B12)’, ‘complex bureaucracy (B13)’, ‘inefficient communication (B15)’, ‘large size of the institutions (B16)’ and ‘lack of legal regulations (B18)’—’B2’, ’B1’, ’B12’, and ’B15’ were found to be the dominant barriers with high driving power among them.

![MICMAC Analysis](image-url)
Following the MICMAC analysis, ‘B2’ was found to be a significant barrier with a driving power of 18 and a dependence power of 1 (higher driving power and lower dependence power). Therefore, as presented in Figure 2, it was located at a place corresponding to a driving power of 18 and a dependence power of 1. In the same way, the rest of the factors were positioned corresponding to their driving and dependence powers. Each of the driving power and dependence power of barriers was shown in Table 4. The final full ISM model shows the details of barriers relationship, as illustrated in Figure 1. The ISM model indicates that the ‘lack of awareness (B2)’ is a very essential barrier as it appears at the base of the ISM hierarchy. ‘Occupant satisfaction concerns (B3)’, ‘lack of pressure from society (B8)’, ‘lack of time (B9)’ and ‘lack of engagement (B10)’ are the obstacles in which the effectiveness of the campus operations implementation depends.

4. Results and Discussion

“The appearance of barriers to change and implementation is inevitable. It is important to recognize their existence and their level to be able to reduce or overcome them [11]”. This research was therefore aimed at identifying and modeling key barriers for the sake of successful implementation of campus operations and further analyzing the interactions and correlations among them. To do so, an ISM-based approach was developed based on academic experts’ opinions to realize contextual relationships among identified barriers so that practitioners consider them for reducing or removing. Clear visualization of these relationships was expressed in the ISM hierarchy model (Figure 1). This, along with MICMAC analysis, provides valuable managerial insight and implications about the relative importance and the relations between the key barriers.

MICMAC analysis, as shown in Figure 2, presents that the autonomous barrier does not exist. An autonomous barrier has a weak driving power and dependence power, thus does not have any impact on the system. It indicates that all barriers play essential roles in campus operation implementation, as the autonomous barrier was completely absent from this analysis. Therefore, all identified barriers should be taken by the management into careful consideration.

As illustrated in Figure 1, the ISM hierarchy model included eight barriers—‘Occupant satisfaction concerns’, ‘lack of financial resources’, ‘lack of proper infrastructure’, ‘lack of available resources’, ‘no assumption of responsibilities’, ‘lack of pressure from society’, ‘lack of time’ and ‘lack of engagement’—at the top of the ISM hierarchy (level I, II and III), which were regarded as dependent barriers (see Figure 2). Therefore, high priority measures should be considered by management to identify the root cause of these barriers. For this purpose, a full understanding of the dependence of these barriers on other level barriers in the ISM should be taken by the management into account.

Two barriers, i.e., ‘lack of priority’ and ‘lack of long-term planning, systematization and continuity’ fall in the linkage quadrant, indicating that they have strong driving power as well as strong dependence power. These barriers are influenced by lower-level barriers, and, in turn, impact on other barriers in the model (Figure 1). The management should devote consistent attention to these barriers, which are relatively unstable since any effect on these two barriers will affect others as well as themselves.

At the bottom of the ISM hierarchy model, there are eight independent barriers involved; namely ‘lack of knowledge’, ‘lack of awareness’, ‘lack of support from top management of the university’, ‘resistance to change’, ‘complex bureaucracy’, ‘inefficient communication’, ‘large size of the institutions’ and ‘lack of legal regulations’. These barriers have strong driving power on other barriers and weak dependence power (Figure 2). Among them, ‘lack of awareness’, ‘lack of knowledge’, ‘resistance to change’ and ‘inefficient communication’ with highest driving power and lowest dependence power were found to be dominant barriers, which have respectively been located at the levels VIII and VII of the ISM model (Figure 1). Hence, to implement campus operations successfully, the management must focus on these barriers due to having high driving power and should formulate strategies/approaches to reduce or overcome them.
5. Conclusions

Campus operations initiative is one of the essential initiatives in developing higher education sustainability. The barriers that hinder the implementation of this sustainability element pose serious challenges for both technical experts and managers of HEIs. The present study has identified some of the major barriers according to a literature review on the topic and based on academic experts’ opinions. It has also analyzed the identified barriers in terms of their contextual relationships using a qualitative approach, i.e., interpretive structural modeling (ISM). Investigation on barriers in implementing green campus operations is only confined to a handful of research studies, especially when compared to a large number of scholarly publications contributed to developing sustainability in other types of organizations/industries. Therefore, this research is among the limited number of studies, which contributes to advancing the body of knowledge in the field of campus operation implementation through the barrier analysis.

The results revealed an eighteen-barrier interpretive structural model with eight levels, which were assessed by: (1) ‘lack of awareness (B2)’ which was emerged as the most dominant barrier that stimulates the chain reaction of other barriers in the process of implementing campus operation; (2) ‘lack of knowledge (B1)’, ‘resistance to change (B12)’ and ‘inefficient communication (B15)’ which were influenced by B2, suggesting the urgency to concentrate on solving these dominant barriers; (3) ‘large size of the institutions (B16)’ and ‘lack of legal regulations (B18)’; (4) ‘lack of support from top management of university (B11)’ and ‘complex bureaucracy (B13)’; (5) ‘lack of long-term planning’, ‘systematization and continuity (B14)’ and ‘lack of priority (B17)’; (6) ‘lack of financial resources (B4)’, ‘lack of proper infrastructure (B5)’, and ‘lack of available resources (B6)’; (7) ‘no assumption of responsibilities (B7)’; and (8) ‘occupant satisfaction concerns (B3)’, ‘lack of pressure from society (B8)’, ‘lack of time (B9)’, and ‘lack of engagement (B10)’, which were occupied at the top of the ISM hierarchy (level I), indicating that these barriers are comparatively easy to eradicate. In addition, the MICMAC analysis indicated that some barriers within the ISM-based model—B2, B1, B12, B15, B18, B16, B11, and B13—fell into the category of independent criteria, representing a substantial contribution of each barrier for hindering campus operation implementation. These findings include the following implications:

• Academic implications—contributing a theoretical and practical knowledge to the implementation of campus operations in terms of the barrier analysis. It may strengthen the cutting-edge studies towards developing higher education sustainability, which is a subject of growing interest in various institutions. Although an extensive literature is available on the campus operations’ barriers, fewer prior investigations have been reported to understand the interactions among the barriers. This research develops contextual relationships among identified key barriers through an analytic-interpretive approach.

• Practical implications—presenting a systematic model of key barriers for implementing green campus operations, which could make it generally applicable in higher educational establishments throughout Malaysia as well as other parts of the world. It provides a guide for planners and practitioners in higher education systems towards implementing campus operations by focusing on reducing or eliminating important barriers. As illustrated in the model, ‘lack of awareness’, ‘lack of knowledge’, ‘resistance to change’, and ‘inefficient communication’ have the strongest driving power and the weakest dependence power which lie at the bottom of the model hierarchy, implying that they have the highest level of importance in achieving the targeted performance measures in campus operations implementation. This can help the management in deciding on the priority and focusing on those barriers that hinder successful implementation.

This study involves some limitations, which suggest directions for future research. The ISM-based model has been developed with eighteen barriers for the implementation of campus operation only in one of the Malaysian universities. Further research can address more barriers; therefore, the future scope of this study can be widened in the identification of the more essential barriers in HEIs in
various countries by multi-criteria decision making (MCDM) techniques such as interpretive ranking process and analytical hierarchy process for better insights. Moreover, the model is based on the ISM methodology, which has its own limitations, e.g., it is highly dependent on the judgments of the expert team. To address this issue, it is also recommended the validity of this model is tested through a structural equation modeling (SEM) method.

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