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Article

The links between sustainability dimensions and green campus initiatives in mountain universities

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Abstract: Sustainability and green campus initiatives are widely examined in developed countries but less attention has been paid in developing countries such as Pakistan. Therefore, this study intends to examine the links between sustainability dimensions and green campus initiatives by mediating role of teachers and students' involvement. Green campus or sustainable campus or environment friendly campus is based on the principles of environmental sustainability, incorporating social, and economic and environmental dimensions. Questionnaire for assessment of sustainability was adopted and 529 responses were received from the faculty, management and servicing staff of the seven Mountain Universities of the Gilgit Baltistan and Azad Jammu and Kashmir in Northern Pakistan. Partial Least Square Structural Equation Modeling (PL-SEM) was used to analyse the data. The results indicated that energy conservation, water conservation, green transport, sustainable waste management have enhanced campus green initiatives. Teachers and students' involvement partially mediate the relationship between green transport strategies, sustainable waste management and green campuses initiatives. While on another hand, teachers and students' involvement have not mediated the links between energy conservation, water conservation and green campus initiatives. The study contributes to theory building in the area of green and environment friendly campus initiatives by enriching the understanding of the processes carrying the effect of sustainability dimensions and both teachers and students' involvement.

Keywords: teachers and students' involvement; Northern Pakistan; energy conservation; green transport

1. Introduction

United Nations in the Rio De Janeiro World Conference on environment and development, advocated education for sustainable development as early as in 1992. Universities have great responsibility for the transformation of societies for contributing to a more sustainable world (Barth and Rieckmann, 2012). Generally, a green campus is a premise, where the sustainable and environment friendly activities are combined with the teaching and learning of sustainability to develop eco-friendly practices and attitudes in the campus. While realizing the importance of education for sustainable development, the United Nations designated the period 2005–2014 as decade of education for sustainable development (ESD) to integrate teaching and learning process with the sustainable development (Chinta et al., 2022). Higher Education Institutes need to adopt green campus initiatives such as energy efficiency, clean indoor air, waste management, water conservation and healthy environment (Sonetti et al., 2021).

In the United States, George Washington University (GWU) led the initiatives to

propose Green Campus (Zhao and Zou, 2020). Similarly, Stanford University implemented Green Campus initiatives in three steps. Firstly, it introduced academicians to the detailed needs of supplies, energy, water, land, waste, management, food, life, buildings, campus development and transportation towards sustainability. Secondly, it used Sustainability Tracking and Rating System (STARS) to make comprehensive and sustainable evaluations of Stanford. Lastly, it discussed the development of the relationship between Stanford and its local communities for sustainable development. Similarly, University of Indonesia introduced UI sustainable metric world university ranking, which incorporated 6 criteria and 39 indictors to measure the sustainability of the campus. Other Programs include DEA-Green metric, STAR environmental management system (EMS), ISO 14001, and United Nations environment program (Sugiarto et al., 2022). In 2007, more than 30 famous universities joined the Sustainable Campus Network in US, Europe and Japan (Zu., 2020). Bifeng et al. (2022) compared the evaluation standards for green campus in China and United States. Universities in China has also been taking keen interest in the green campus initiatives with the support of funding from Chinese Government. Malaysian Universities preferred to adopt University of Indonesia Green-Metric (UI-GM, 2022). Out of 20 public sector universities, 17 have already adopted these standards in Malaysia (Mihiddin et al., 2023).

In developing countries including Pakistan, no organized system for assessment of sustainability in campuses and Education for Sustainable Development (ESD) has been employed. Their focus on sustainability related research is also limited and they are not serving as think tanks in this context. In this regards, Higher Education Institutes (HEIs) in Pakistan are still in the preliminary and premature stage. The involvement of teachers and students in sustainability at the campuses has been found limited. There is a need to incentivize their involvement in assessment and promoting sustainability (Habib et al., 2021). Similarly, the integration, implementation and reporting on Sustainable development (SD) was found low in HEIs of Pakistan. Universities face challenges of resources and budgets for implementation of the plans related to SD. The SD has not been holistically integrated in the curriculum and research with an organized policy framework in universities of Pakistan (Zahid et al., 2021). This research is mainly focused on assessment of sustainability initiatives of mountain universities of Northern Pakistan with emphasis on the Students Teachers Involvement (STI).

2. Literature review

The subsequent sections discuss the supported literature and theories to generate hypotheses of the study.

2.1. Various dimensions of green campus sustainability

The study of Alshuwaikhat and Abubakar (2008), reported that three factors should be considered to achieve the goals of sustainable campus. Firstly, implementation of environmental management practices (healthy campus), secondly public participation and social responsibility (campus community, partnership, justice and equity); and thirdly sustainability teaching and research in an integrated way (e.g.,

related activities). Different researchers have proposed various dimensions for sustainable campuses, which include education, research, governance and administration, operations, Outreach and stakeholders' engagements in selected Pakistani Universities. The implementation, integration and reporting of sustainable education was also assessed. It has been reported that the concept of green campus is still in embryonic stage in Pakistani higher education institutions and no dedicated budget is allocated for Green Campus Initiatives (Habib et al., 2021; Zahid et al., 2021). Green campus initiatives play a central role in promoting sustainability within education institutions (Ribeiro et al., 2021) Education institutions should adopt technologies and energy-efficient practices, such as using renewable energy sources i.e., solar etc. These practices include improving building insulation, installing energy-efficient lighting and heating systems to reduce energy consumption (Leal et al., 2019).

The education institutions should also employ rainwater harvesting (RWH) systems, wastewater recycling programs and water-saving fixtures to minimize water usage and promote sustainable water management (El-Nwsany et al., 2019). Using green transport having electrical batteries in hybrid systems, collaborating with the private transport companies to develop energy efficient transport for the campuses are some of the very common initiatives employed around the world by Universities (Kourgiozou et al., 2021). Furthermore, education institutions arrange waste reduction through comprehensive recycling programs, promoting zero-waste initiatives and composting organic waste to minimize landfill contributions (Yusoff, 2018). On the base of prior authors' recommendations, it is clear that green campuses are vital in advancing sustainability through environmental stewardship, education, research, community engagement, and economic benefits. By integrating sustainable practices such as green energy conservation, water conservation, green transport and sustainable waste management into all aspects of university life, they not only reduce their ecological footprint but also prepare future leaders to address global environmental challenges. Based on the literature review of topic, various dimensions of green campus sustainability such as green energy conservation, water conservation, green transport and sustainable waste management are used in a multi-dimensional model in this study.

2.2. Green energy conservation

The increased number of higher education institutes in the world and Pakistan has enhanced energy demand in both the construction and operation of various facilities in campuses. In some studies in China, it has been revealed that per capita energy and water consumption is four time and two times more than the common residents respectively (Yuan et al., 2013). Various techniques such as energy audits, use of energy efficient appliances and renewable resources are used for energy conservation. The Chinese government implemented campus energy management systems, energy retrofits and water conservation projects, which benefited more than 200 colleges and universities through a funding of Rs. 0.6 billion Yuan (RMB) as reported by Tan et al. (2014). Some of other initiatives for energy conservation include building energy retrofitting, demonstration projects of renewable energy and public

engagement for energy conservation (Chen et al., 2019). The energy conservation initiatives at Campuses may range from simple actions like reducing energy waste to research based actions by establishing the energy research centre (Walter et al., 2019). The real time data about the energy use helps the users to control and reduce the energy uses in peak times. This has resulted into the availability of reliable energy and reduced water and energy costs (Zhao et al., 2019).

2.3. Water conservation

Water conservation is another important area for green campus development and many universities around the world have implemented various programs for reducing, reusing and recycling of water. Rainwater harvesting techniques have also been employed by many universities in Malaysia (Ayog et al., 2015). Initiatives such as installation of instant sustainable solar heaters in students' hostels were also employed in some of the Malaysian universities (Osman et al., 2014). Energy conservation related lesson, special seminars, exhibition and community walks etc. created awareness and sustainable behaviours. Similarly, universities employ effective water use policies.

2.4. Green transport

Transportation of students and staff for daily commuters from different parts of the catchment areas of campuses constitute large amount of carbon footprint as these vehicles are mostly using the fossil fuels. The mass transportation must be encouraged rather than cars and small vehicles at the campuses. In this context use of cycling inside the campuses, use of green transport using electrical batteries in hybrid systems, partnering with the private transport companies to develop energy efficient transport for the campuses are some of the very common initiatives employed around the world (Anis et al., 2018; Bond et al., 2006). Aniegbunem and Kraj (2023) analysed the transition of Internal Combustion Engines (ICE) to Petrol Vehicles and Electrical Vehicles at the University of Saskatchewan Canada. They reported that such projects can reduce the greenhouse gas emissions by 100% and the fuel cost by 88.9%. The payback period of such investment can be as low as 5 years. In such cases, the sustainability office of university can be entitled to carbon credits as additional revenue. They have also recommended that transition of university transport to sustainable options are economically, financially and environmentally feasible and must be rigorously followed by universities around the world. UI-Green Metric (UI-GM, 2022) incorporates energy and climate change at 21%, transportation at 18%, setting and infrastructure at 9% and building at 1% (UI-GM, 2022).

2.5. Sustainable waste management

Large volume of campus waste is composed of combustible part including of paper, card sheets, boards etc. Various systems can be designed to efficiently utilize these resources and minimize the waste generation. For disposal of wastes, the campuses can develop close loop relation with the local waste disposal enterprises. Universities have addressed the waste management in three ways mainly, i.e., waste management practices, waste to energy and comprehensive solid waste management.

Sustainable waste management is a precursor for the green campus. Such initiatives include use of personal reusable mugs and cups, use of bio-compostable bags, recycling and reuse of waste material etc. (Tangwanichagapong et al., 2017). The awareness of people for their choices of various consumables, their behaviours and attitudes about waste generation play a pivotal role for sustainable waste management (Jackson and Michael, 2013).

2.6. Mediating role of students' teacher and student involvement in green campus initiatives

Education for Sustainable Development (ESD) requires the involvement and empowerment of various stakeholders in the university including students, teachers, staff and service providers (Cebriána, 2018). In this context students are the main stakeholders as they are the future change leaders and proponents of sustainable approaches if they are involved and empowered (Mainardes et al., 2013). The students' involvement and satisfaction play a pivotal role in the development of sustainable campuses (Chaudhary and Dey, 2021). Similarly, teachers' involvement in sustainability teaching and practice is also critical in education for sustainable development. Zamora and Sánchez (2019), proposed a framework for teaching sustainable development goals (SDGs) in Campus, which includes five components i.e., students, student competencies, teachers, teaching methodologies and alliances with other actors. In this context the teacher engagement with partners and community for achievement of SDGs is also important for sustainability. The three components of Green Campus or sustainable university campus are shown in **Figure 1,** which are based on equity, economy and design. This model provides proper insight the green campus initiatives.

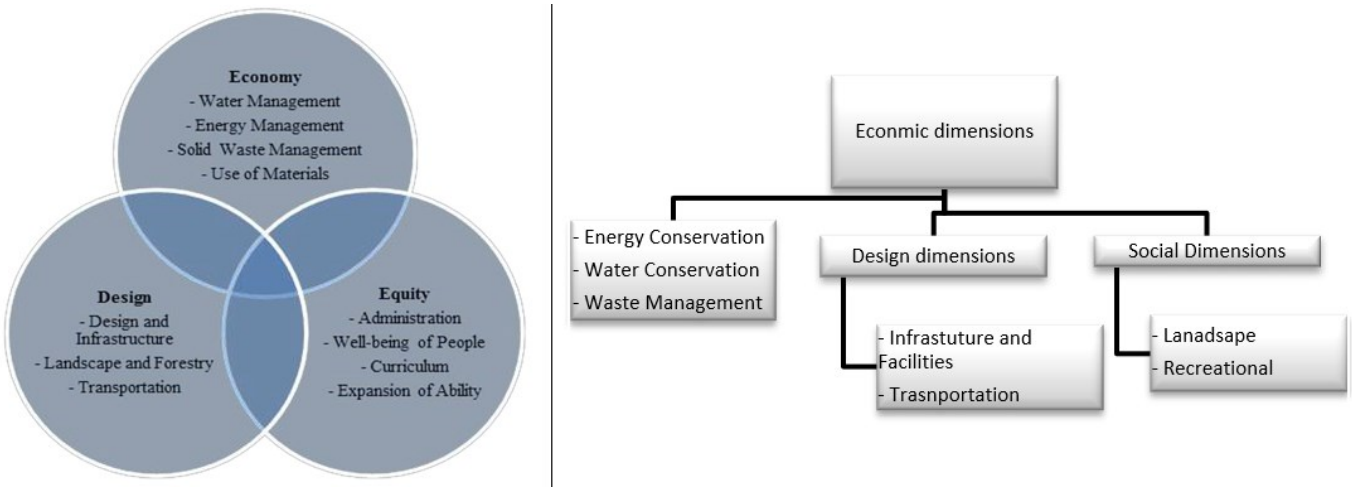

Figure 1. Model for sustainable campus.
Source: Er and Karudan (2016).

3. Hypothesis development

The hypotheses development focuses on the multifaceted approach required for achieving campus sustainability. Literature on the topics ascertains several dimensions for creating a sustainable campus, such as public participation, social responsibility,

environmental management practices and integrated sustainability educational awareness. Based on the literature review and gaps identified, this study focuses on specific areas of sustainability such as energy conservation, water conservation, green transport, and sustainable waste management as essential components for green campus initiatives. On the base of contingency approach, the teacher students' involvement is used as mediating variables between energy conservation, water conservation, waste management and green transport and green campus initiatives.

On the base of aforementioned studies, this study proposed the following hypotheses.

H1: There is significant relation between energy conservation green campus initiatives.

H2: There is significant relation between water conservation strategies and green campus initiative.

H3: There is significant relation between green transport and green campus initiative.

H4: There is significant relation between sustainable waste management and green campus initiative and green campus initiative.

H5: There is significant relation between student teacher involvement and green campus initiative.

H5a: Teacher students' involvement mediates the relationship between energy conservation strategies and green campus initiative.

H5b: Teacher Students involvement mediates the relationship between water conservation strategies and green campus initiative.

H5c: Teacher students' involvement mediates the relationship between green transport strategies and green campus initiative.

H5d: Teacher students' involvement mediates the relationship between sustainable waste management and green campus initiative.

4. Methods

For this exploratory predictive investigation, a quantitative survey was carried out from the seven mountain universities of Gilgit Baltistan and Azad Jammu and Kashmir in Northern Pakistan. The region is faced with multitude of environmental related challenges due to its fragile eco-system. These challenges include climate change impacts, urbanization, floods, slides, earthquakes and other natural and man induced disasters. The livelihood practices of the related communities are highly unstainable. The seven universities in the region provide education and research opportunities to more than 45,000 students and can play a pivotal role in the development and capacity building of the mountain communities for developing their behaviors and practices towards more sustainable societies. The results from the research will be shared with the leadership of the universities for framing and implementing policies for developing sustainable campuses in the region. This can be the sources of education for the students and teachers as well as model for the associated communities to follow.

The respondents included faculty, management and services staff from these universities. The three categories of respondents constitute strong internal

stakeholders of the universities and have a direct impact on the implementation of sustainable practices within the university environment. The given categories of respondents' involvement are crucial for the successful development and implementation of policies aimed at sustainability. Previous research has shown the importance of involving these groups in similar studies (Habib et al., 2021; Zahid et al., 2021). The diverse roles and responsibilities of these respondents provide a comprehensive perspective on the current practices and potential areas for improvement. The given participants were selected based on their roles within the universities, ensuring they have the necessary insight and experience to answer the questions raised in the survey. Management provides insights into policy and administrative aspects; faculty members bring academic and research perspectives. While services staff offer practical views on the day-to-day operations and their sustainability. This mix categories of the participants ensures that the survey captures a holistic view of the sustainability challenges and opportunities within the universities. For confirmation to ensure the validity of the responses, the questionnaires items were pre-tested with a small group of respondents from each category. Feedback from this pre-test was used to refine the questions for clarity and relevance.

For analysis of the responses, Structural Equation Modeling (SEM) is used, which is based on Partial Least Square-Structural Equation Model (PLS-SEM). This is normally recommended to predict a theoretical model when large number of constructs, indicators and model linkages exist (Hair et al., 2019). Due to its wide scope of application, PLS-SEM has gained popularity for use in marketing, strategic management, tourism and hospitality, and healthcare (Ali et al., 2018; Hair et al., 2014). The findings of this study will be shared with the executive management of the universities for framing and implementing policies for developing sustainable campuses in the region. These green sustainable campuses can serve as sources of education for students and teachers are as models for associated communities to follow.

4.1. Measurement

Energy Conservation: for assessment of energy conservations strategies, the attributes like, including it in the courses and curriculum, design of buildings for harnessing the natural lighting and ventilation, use of light sensors, effective energy use policy, use of renewable energy sources at the campus, energy audits, use of light sensors etc. are considered. The 05-items scale are used which Samuelson and Biek (1991) develop with a greater 0.70 values.

Water Quality and Conservation Strategies: For assessment of water quality and conservation strategies, use of efficient irrigation systems, reuse of water and engagement of internal and external stakeholders for water conservation were assessed. The 03-items scale are used which Addo *et al*. (2019) develop with a greater 0.70 values.

Green Transportation (GTR) Strategies: Use of green transportation, encouraging of use of bikes, dedicated bike tracks, regular transport audit, community engagement for green transportation were included in the assessment of green

transportation strategies at the campuses. The 03-items scale are used which Zhang *et al*. (2020) develop with a greater 0.70 values.

Sustainable Waste Management (SWM) Strategies: Use of various waste management options like encouraging use of zero or low waste products, waste management audits, paper waste reduction strategies, cafeteria waste management etc. have been assessed in the mountain universities. Selection of the products with low waste, reuse of waste material and encouraging the community for waste reduction, reusing and recycling both inside and outside the campus were also assessed. The 04-items scale is used which Muniandy et al. (2021), develop with a greater 0.70 values.

Teachers and Students' Involvement: Teachers and students' involvement (STI) in terms of their motivation to teach sustainability, model behaviour of faculty for students and society are important attributes of sustainable campus. Various tools used for encouragement of students for exhibiting sustainability in their behaviours and various events used for promoting sustainability internally and externally, were assessed. The 04-items scale are used which Dagiliūtė et al. (2018) develop with a greater 0.70 values.

Green Campus Initiatives: For assessment of sustainable campus, three dimensions namely social, economic and design were used. Existence of Green team, involvement of different stakeholders in green teams, their empowerment, implementation of their recommendations, regular monitoring and evaluations are important aspects of the green campus. Green teams and green committees and their regular meetings play pivotal role in the green campus initiatives. The 04-items scale are used which Emanuel and Adams (2011) develop with a greater 0.70 values.

4.2. Study area

The Northern Areas of Pakistan comprise the administrative region of Gilgit Baltistan (GB), Azad Jammu and Kashmir (AJK) and Northern Khyber Pakhtunkhwa (KP). The GB and AJK are part of the Kashmir region. This is a mountainous region and hub of tourism, having the three mighty ranges of Himalaya, Karakoram and Hindukush (KHK). The region is home to the world largest deposit of snow after poles and often called "**Third Pole**". These glaciers provide water resources to the 70% of the population in Pakistan (Chetri et al., 2012). The political map of Pakistan and Northern Areas are shown in **Figure 2**. This area is subject to severe ecological challenges including climate impacts, natural disasters, food insecurity and shrinking livelihood. The fragile ecosystem of the region, bring heavy responsibility on the universities to develop sustainability in education, practices and behaviors both inside and outside the campuses. The huge tourism influx dominated by the domestic tourists, in the region also create severe challenges for the ecosystem. Hence green campus initiatives become inevitable for sustainability of the society and their livelihood. In this context, the current research plays a pivotal work in this direction, which will open more dimensions of research.

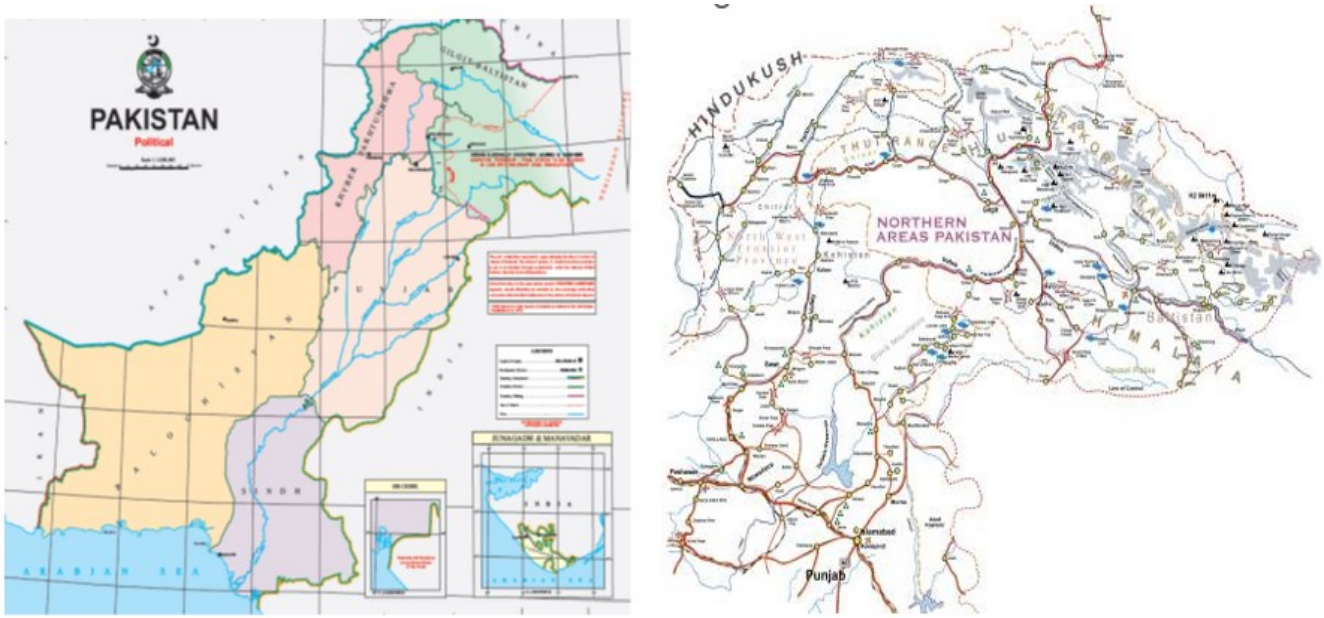

Figure 2. Political map of Pakistan and northern areas (Survey of Pakistan, 2020).

4.3. Sample procedure and participants

Table 1. Profile of the participants.

Control variables	Frequency	Percentage
Gender		
Male	428	81.1
Female	101	19.1
Profession		
Academic	333	62.1
Management	145	27.42
Serving staff	51	9.65
Experience/Year		
<5–10	195	36.96
11–16	276	52.27
17 and above	58	10.1

Seven mountain universities were selected with two in Gilgit Baltistan (GB) and five in Azad Jammu and Kashmir (AJK) of Northern Pakistan. These universities provide education to about 45,000 students in the region. A five pints Likert scale questionnaire was adopted from previous studies. A non-probability convenience sampling techniques were used. In addition, 529 responses were received (refer to **Table 1**). The respondents of the survey included, 81.1% males and 19.1% females. Similarly, respondents included 62.1% academics, 27.42% management staff and 9.65% serving staff from the universities studied. The work experience of the respondents varied from 1 year to 17 years and more. Majority of the respondents 52.27% have served universities for 11 to 16 years, which shows that the respondents are quite familiar with the university teaching and learning, governance and various

strategies adopted by their HEIs about sustainable campus development. Majority of the respondents were from Karakoram International University. One of the obvious limitations of sampling is its relevance to the mountain universities only and it cannot be generalized for other universities.

5. Results and discussions

The subsequent headings present the results of the measurement and structural path coefficient, followed by a discussion of the findings.

5.1. Measurement model

Table 2. Factor loadings of the constructs.

Constructs	Items	Ladings	Alpha values	C.R.	AVE	VIF
Energy conservation			0.845	0.860	0.684	
	EC1	0.769				1.538
	EC2	0.837				1.994
	EC3	0.889				2.488
	EC4	0.807				1.980
Water conservation			0.769	0.769	0.685	
	WE1	0.853				1.771
	WE2	0.827				1.628
	WE3	0.802				1.444
Green transport			0.729	0.734	0.648	
	GT1	0.779				1.424
	GT2	0.816				1.446
	GT3	0.820				1.443
Sustainable waste management			0.786	0.825	0.625	
	SWM1	0.863				2.115
	SWM2	0.880				2.521
	SWM3	0.834				2.058
	GCI1	0.757				1.137
Teachers and students' involvement			0.728	0.731	0.546	
	TS11	0.748				1.777
	TS12	0.747				1.248
	TSI3	0.696				1.253
	TSI4	0.763				1.832
Green campus initiatives			0.836	0.843	0.605	
	GCI1	0.757				1.600
	GCI2	0.703				1.541
	GCI3	0.846				2.204
	GCI4	0.827				2.082
	GCI5	0.749				1.571

This exploratory study employed PLS-SEM for model testing. Before conducting the structural path analysis, it is crucial to evaluate the reliability and validity of the constructs. Each variable must be checked for reliability and validity, with constructs showing reliability values above 0.7 considered reliable. **Table 2** presents the measurement model's results, including factor loadings, alpha, AVE, and C.R. values for all constructs. Factor loadings ranged from 0.696 to 0.889, with a significance level of 0.01. Alpha values varied from 0.729 to 0.863, which are considered good. AVE values, ranging from 0.546 to 0.685, exceeded the 0.5 threshold. Additionally, C.R. values for all constructs ranged from 0.731 to 0.860, surpassing the recommended value of 0.6, indicating high internal consistency. The study's measurement model is illustrated in **Figure 3**.

5.2. Discriminant validity

To evaluate the multicollinearity issue, the discriminant validity of all constructs is presented (refer to **Table 3**). The results indicate that the square root of the Average Variance Extracted (AVE) for each construct exceeds the correlations with other latent constructs, suggesting sufficient discriminant validity.

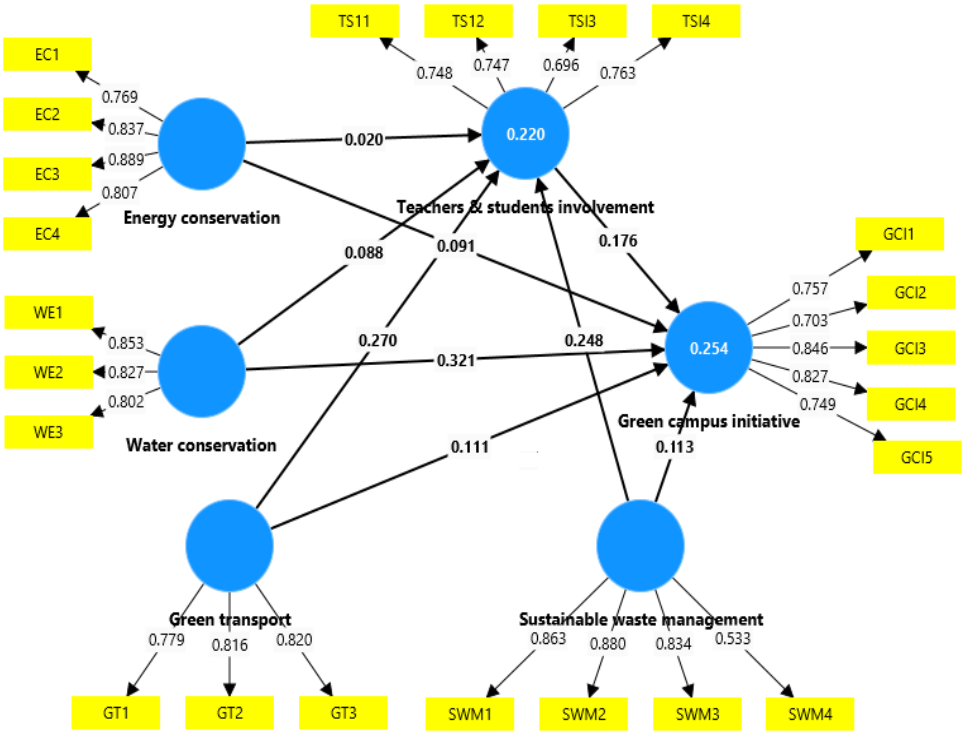

Figure 3. Measurement model of the study.

Source: Authors own creation.

The HTMT approach for establishing discriminant validity, Kline (2011) and Henseler et al. (2015) recommended the decision rule is that all inter-associations between the construct of interest and the remaining constructs should be less than 0.85 (r < HTMT 0.85). All reported values were below the HTMT 0.85 threshold, confirming discriminant validity. A multi-collinearity test was conducted using the Variance Inflation Factor (VIF). According to Hair et al. (2010), VIF values should not exceed 10. The VIF values in this study, as shown in (refer to **Table 4**), range from

1.137 to 2.521, which is acceptable.

Table 3. Discriminant validity of constructs.

Constructs	**Fornell-Larcker criterion**					
	1	2	3	4	5	6
1 Energy conservation	0.827					
2 Green campus initiative	0.224	0.778				
3 Green transport	0.202	0.322	0.805			
4 Sustainable waste management	0.021	0.205	0.316	0.790		
5 Teachers and students' involvement	0.104	0.318	0.386	0.361	0.739	
6 Water conservation	0.286	0.440	0.386	0.315	0.276	0.827
	HTMT Criterion					
1 Energy conservation						
2 Green campus initiative	0.257					
3 Green transport	0.262	0.405				
4 Sustainable waste management	0.135	0.264	0.414			
5 Teachers and students' involvement	0.203	0.382	0.520	0.455		
6 Water conservation	0.351	0.541	0.517	0.421	0.349	

Table 4. Coefficient of determination R^2 values.

Constructs	R^2	**Result**
Green campus initiative	0.254	Moderate
Teachers and students' involvement	0.220	Moderate

5.3. Coefficient of determination

The coefficient of determination (R^2) in the measurement model indicates, that energy conservation, water conservation, green transport, sustainable waste management, and the involvement of students and teachers together account for only 25.4% of the total variance in the green campus initiative. Additionally, energy conservation, water conservation, green transport, and sustainable waste management explain 22.2% of the variance in the involvement of teachers and students (refer to **Table 4**).

5.4. Direct structural path coefficients

The results of the structural path analysis are shown in **Table 5**. The structural path coefficient values of energy conservation ($\beta = 0.091$, $t = 2.400$, $p = 0.016$) shows a significant effect on green campus initiatives which supported H_1, which that there a significant relation between energy conservation green campus initiatives. Operational and environmental costs of energy are always very high and energy conservation efforts leads to green campuses both in terms of environmental and financial impacts (Ana et al., 2021). The results are consistent with earlier researches. They reported that the energy saving and energy conservation in the construction and operation of campus plays an important role in promoting sustainable campuses (Adame and Salau, 2021; Faghihi et al., 2015; Fachrudin and Fachrudin, 2021; Zhu et

al., 2021). However, besides energy conservation, sustainability of the campus must also be based on construction of physical facilities and sustainable management planning, which provides a clear direction for the future green campus construction policy.

Table 5. Structural path coefficient.

Relationships	***β* values**	***t* values**	***p* values**	**Decision**
Direct effects				
Energy conservation → Green campus initiatives	0.091	2.400	0.016	Supported
Water conservation → Green campus initiatives	0.321	6.487	0.000	Supported
Green transport → Green campus initiatives	0.111	2.198	0.028	Supported
Sustainable waste management → Green campus initiatives	0.113	2.567	0.019	Supported
Teachers and students' involvement → Green campus initiatives	0.176	3.411	0.001	Supported
Indirect effects				
Energy conservation → Teachers and students' involvement → Green campus initiatives	0.003	0.411	0.681	Not supported
Water conservation → Teachers and students' involvement → Green campus initiatives	0.015	1.512	0.130	Not supported
Green transport → Teachers and students' involvement → Green campus initiatives	0.048	2.651	0.008	Supported
Sustainable waste management → Teachers and students' involvement → Green campus initiatives	0.044	2.933	0.003	Supported

The structural path coefficient values of water conservation ($\beta = 0321$, $t = 6.487$, $p = 0.00$) have shown a significant impact on green campus initiatives, which supported H2. This means that there is significant relation between water conservation strategies and green campus initiative. Campus operations involve excessive use of water in drinking, research, cleaning and washing and irrigation activities. Water conservation strategies as part of the green campus initiatives have been largely advocated by governments and societies. Pakistan is becoming a water scarce country due to unsustainable use of surface and ground water (Zhang et al., 2021). Universities can provide good examples to the societies by deploying water conservation strategies and technologies. The earlier studies have shown that water conservation also reduces the energy consumption and carbon footprint to create sustainable university campus. The observation of this study is in line with the earlier research by Finlay and Massey (2012) and Parece et al. (2013).

The path coefficient values of green transport strategies ($\beta = 0.111$, $t = 2.198$, $p = 0.028$) have shown a significant effect of green campus initiatives which supported H3, which shows that there is significant relation between green transport and green campus initiative. Transportation serves as a connection between the city, communities and campuses. At times, it burdens universities for high demands of parking, traffic congestions and accidents, besides the environmental and financial costs (Mohammed et al., 2022). The green and environment friendly transport with little or no emissions plays an important role in the Green Campus development (Renata et al., 2018; Wellbrock et al., 2021). The use of green transport systems within green campus initiatives not only supports eco-friendly/green environment but also

enhances the quality of life for faculty, staff and students. These practices contribute to a more sustainable, healthier, and vibrant campus community.

The structural path coefficient values of sustainable waste management (β = 0.113, t = 2.567, p = 0.019) shows a significant effect of green campus initiatives which supported H4, which means that there is significant relationship between sustainable waste management and green campus initiatives. The solid waste, in most of the universities in Pakistan and around the world is collected, sorted and then dumped in the landfills, which creates air and land pollution. The sustainable waste management and use of material with little waste are becoming more important considerations in the green Campus development. Additionally, the well-integrated system of sustainable waste management into green campus initiatives contribute to environmental, economic, and social benefits. The findings are in line with earlier researches (Renata et al., 2018; Sonetti et al., 2016; Tangwanichagapong et al., 2017).

The path coefficient values of teachers students' involvement (β = 0.176, t = 3.411, p = 0.001) shows a significant effect on green campus initiatives which supported H5, which means that there is significant relationship between the students teacher involvement and green campus initiatives. University students are in their prime young age and can be motivated to participate in the green campus initiatives, through their involvement and empowerment. It has been observed that the Green and Clean Campus Societies of the students play a pivotal role in greening the campus (Renta et al., 2018). The teachers and students' community can create a culture of sustainability on campus, leading to significant positive impacts on the environmental greenery. These results are compatible with earlier studies by Alshuwaikhat et al. (2008) and Schoolman et al. (2016).

5.5. Indirect structural path coefficient

The indirect structural path coefficient values of teacher and students' involvement (β = 0.003, t = 0.411, p = 0.681) not mediated the links between energy conservation and green campus initiatives which has not supported H5a, which means that there is no mediating effect of students teachers involvement (STI) on the relationship between energy conservation and green campus initiatives. This shows that there is direct relationship between the STI and energy conservation Energy conservation strategies involving students and teachers have far-reaching impacts on the green Campuses (Fissi et al., 2021).

The indirect structural path coefficient values of teacher and students' involvement (β = 0.015, t = 1.512, p = 0.130) not mediated the links between green water conservation and green campus initiatives which has not supported H5b. This means that teacher Students involvement does not mediate the relationship between water conservation strategies and green campus initiative, rather there is direct relationship between the two constructs, which has already been explained These results are comparable with the earlier research by Abu Qdais et al. (2019).

The structural indirect path coefficient values of teacher and students' involvement (β = 0.048, t = 2.651, p = 0.008) mediated the links between green transport strategies and green campus initiatives which supported H5c. The relationship between the green transport and green campus initiatives is better

explained by the TSI. This means that STI in the green transport initiatives in the campus can lead to sustainable campuses. The findings are the consistent with the study of Atherton and Giurco (2011). Finlay and Massey (2012) and Ribeiro et al. (2021) found that sustainable green transport system is so much essential for sustainable development.

The structural indirect path coefficient values of teacher and students' involvement ($\beta = 0.044$, $t = 2.933$, $p = 0.003$) mediated the links between sustainable waste management and green campus initiatives which is supported H5d. Hence, the teacher and student involvement has further explained the relationship between the sustainable waste management and green campus initiatives. The green transport involves no or very little greenhouse gases emissions and hence the carbon footprint of the transport is possibly minimum (Genta et al., 2019; Moreira and Rutkoskwi, 2021; Shankar and Khandelwal, 2017; Zhang et al., 2011).

6. Practical implications

The research findings have provided the basic principles for developing green campuses in the mountainous region of Pakistan. The results showed that the green campus initiatives have direct relationship with the strategies related to energy conservation, water conservation, green transportation and sustainable waste management at the campuses. The research findings provide many practical implications for the leadership and policy makers in higher education sector of Pakistan. Firstly, this research endorsed that universities in Northern Pakistan can formulate and implement policies that focus on energy conservation, water conservation, green transportation, and sustainable waste management. Secondly, this research accentuates the importance of involving both students and teacher in sustainability-oriented initiatives. These initiatives include forming committees or task forces that include these stakeholders to continuously examine and promote green campus activities. Thirdly, proper budget allocations are necessary for green campus initiatives to guide university administrations in financial planning and resource allocation. Fourthly, universities in Northern Pakistan can implement training and development programs and seminar based on the study's findings to educate the campus community about sustainable policies, procedures and practices.

7. Theoretical implications

The results are theoretically significant in two ways. Firstly, it provides the conceptual model for Green Campus initiatives based on the earlier research. Secondly, the new geographical context of mountainous region in achieving green campuses have been illustrated. Further explanations are given as follows:

Firstly, this research contributes to the literature on the topic by validating the mediating role of teacher and student involvement in the success of green campus initiatives, by supporting existing theories on stakeholder involvement in sustainability practices.

Secondly, this empirical research design and tests a conceptual framework linking various dimensions of sustainability such as energy, water, transport, waste with green campus outcomes, enriching the existing theoretical models of sustainable

campus development procedures.

Thirdly, this research study adds a new geographical and cultural context to the literature, allowing for cross-cultural comparisons in future research.

Fourthly, the results of this research support and expand the scope of education for sustainable development theories by highlighting practical ways to integrate ESD into university operations and culture.

Fifthly, methodological approach of this empirical study provides a blueprint for future research to examine the impact of specific sustainability practices and policies in higher education institutions.

8. Conclusion

In conclusion, results of the study indicated that energy conservation has significant and positive relationship with the Green Campus initiatives. Energy saving and conservation also reduces the carbon footprint of the Green Campuses, as already reported by Zhu et al. (2021). Water Quality Assessment and Conservation has also positive relationship for the Green Campus Initiatives. Such strategies also reduce the energy consumption (Parece et al., 2013). Transport used in the campuses for various operations and consume large volumes of fossil fuels leading to Greenhouse Gases emission and global warming. To cater with such situations, environment friendly and green transportation has been used, which has shown positive relationship with the Green Campus Initiatives. The use of green transport is becoming more popular in University Campuses across the world to reduce the carbon footprint of campuses (Renata et al., 2018). The Sustainable Waste Management, paper use reduction, reuse of waste material and using products with less packing are more useful in developing green Campuses. This study has also shown positive relationship between Waste Management and Green Campus initiatives. Lastly teachers-students' involvement mediates the links among in the various green transport and sustainable waste management mediates the links for sustainability at the campuses. While another hand teachers-students' involvement are not mediated the links among energy and water conservation. The results are partially consistent with the study of Konbr et al. (2023) claimed that transformative role of teachers and students paly important role in the development of the green campus initiatives.

9. Limitations and future directions

This empirical research has certain limitations. Firstly, it attentions solely on mountain universities in Northern Pakistan, which limits the generalizability of the findings to other regions or types of universities. Therefore, further/future studies should be conducted on other universities, including various institutional types e.g., urban universities and other different geographical areas. Secondly, this is cross-sectional study and sample size of this research study is relatively small, particularly given the diversity of university populations. The disproportionate representation from Karakoram International University could skew the results. Therefore, future studies can focus on longitudinal research approach to investigate that how Green Campus initiatives evolve over time and the long-term impact of these initiatives. Thirdly, this study focuses on a developing context, mountain northern Pakistan. Same research

with universities in other developing countries can provide a broader context and identify unique versus common challenges and strategies.

More in-depth and detailed impact assessments of specific initiatives water conservation projects, green transportation on green campus initiatives should be conducted to provide clearer evidence of what works best in different contexts. It is suggested for future studies to examine the role of university governance and policy frameworks in supporting or hindering sustainability initiatives, which can provide valuable recommendations for institutional change.

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