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Exploring Structural Relationships in Attracting and Retaining International Students in STEM for Sustainable Development of Higher Education

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Abstract: Attracting and retaining international students has been widely discussed in higher education settings. Increasing the number of international students has become an indispensable strategy for national and global competition. This study focuses on effective strategies and international students' issues regarding satisfaction in the most popular STEM (science, technology, engineering, and mathematics) programs. We designed a structural equation modeling (SEM) method to determine the effect of institutional mediation between push factors and satisfaction factors for the development of better strategies by which to attract and retain international students. This study employed a self-designed questionnaire to collect data: 485 degree-seeking international students in STEM programs were invited and successfully participated in this study during spring 2021 in Taiwan. IBM SPSS 26 and AMOS 26 (Analysis of Moment Structure) were used to carry out the data analysis. We employed reliability, factor, and SEM analyses. This study assumed that the impact of push factors could be modified by institutional situations and result in international students' satisfaction with their learning and environment and regarding migration policy. The results revealed that the predictors, mediation, and criteria were significant at the 0.05 or 0.01 levels. The findings suggest that push factors impact international students' satisfaction when using institutional leadership and strategy. The results of the bootstrap with a generalized least-squares method showed that the SEM model fit in 2000 bootstrap samples. The effect of institutional mediation can provide useful information for STEM programs to boost their future recruitment and retention strategies. This study provides an innovative approach to the detection of issues among international students in specific programs. The design of the study can be extended to similar higher education settings. These findings can enrich our knowledge regarding attracting and retaining global students in higher education.

Keywords: higher education; international students; leadership and governance; SEM; STEM; sustainable development; sustainability

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1. Introduction

International student mobility has become a global phenomenon. According to an OECD report, international student mobility has been expanding in the last two decades. There were 6.1 million students worldwide who crossed a border to pursue studies abroad in 2019, more than twice the number recorded for 2007 [1]. This implies that the number of international students grew, on average, by 5.5% per year between 1998 and 2019 in higher education settings. Most countries realize that highly educated, mobile students may be an important source of income and can have an impact on economic performance and innovation systems. There are various countries that have attracted a large number of international students to increase the pool of qualified labor, for example, Australia, New

Zealand, the United Kingdom, and the United States [1,2]. Attracting and retaining international students has become an indispensable strategy for national and global competition. It is a crucial strategy for the sustainable development of higher education. According to Rumbley and Altbach's argument, understanding the relationship between national and global competition is key to comprehending the nature of higher education internationalization in the 21st century [3]. Uncertainty and rapid changes in technology have challenged employment, for example, new jobs created in the fourth industrial revolution and AI replacing related job opportunities [4]. This development trend has encouraged more students to participate in science, technology, engineering, and mathematics (STEM) programs, for example, the United States [5] and the United Kingdom [6], where political parties are putting forward Green New Deals. In this regard, related strategies might drive international policy, focusing on learning and teaching in high-tech or innovative technology areas. STEM might become crucial fields for students to achieve their purposes.

There are various studies addressing international students' issues, for example, lockdown issues impacting international students during the pandemic [7–9], mobility issues affecting international students [10,11], and what works for attracting and retaining international students [12,13]. The findings of previous theoretic studies did not confirm whether there were statistical relationships between the context of origins and institutional situations in the destination country. Since the contextual factors are various, study groups in specific STEM programs might confront complex institutional situations. This study focuses on international students in STEM in order to investigate what they want and how they perceive their study journey. We assumed that the factors in situational dimensions would impact specific international students, which might play a crucial role in their study journey.

During the last few decades, Taiwanese higher education has been challenged by serious demographic and environmental changes. For example, the gross enrollment ratio (GER) in higher education exceeded 50% in 1999, indicating that the universal system had arrived in Taiwan, as per Trow's definition [14]. In recent decades, the capacity of higher education has expanded rapidly. The GER in higher education hit 83.88% in 2013, which was higher than that of most other Asian countries [15]. Taiwanese higher education can accommodate a large capacity of students, including international students. Meanwhile, the expanded higher education system has been confronted with declining enrolment in the last decade. Obviously, the number of newborn babies in Taiwan has decreased from 328,461 in 1974 to 196,973 in 2016, showing a 40 percent decrease according to data from the Ministry of Interior [16]. Under this declining trend, many higher education institutes have found themselves confronted with a serious shortage in student recruitment. The Ministry of Education set an internationalized goal of attracting 130,000–140,000 inbound students by 2020 [17]. One reason for this initiative is that the government was trying to face the challenge of declining enrolment trends. Moreover, due to the COVID-19 pandemic, higher educational institutes around the world closed down or partially closed down to control the spread during this period. According to the OECD report, these measures in higher education could change international student mobility intentions in the coming years [18]. Therefore, attracting more international students might become an optimal strategy for overcoming uncertain threats and issues of over-expansion in the higher education system.

The growth of STEM has become a prevalent phenomenon. For example, Australia has defined STEM competencies as 21st-century skills for citizens. Australia predicted that future workers will spend more than twice as much time on job tasks requiring science, math, and critical thinking, than today. STEM education can complement the development of 21st-century skills, for example, critical thinking, creativity, cultural awareness, collaboration, and problem-solving [19,20]. As the world of work changes, we will need to prepare or enhance our skills accordingly. STEM programs have become attractive at the tertiary education level. In the United States, there are various studies indicating that offering a specialized STEM program in a high school may boost the number of students majoring in a college's STEM programs [21,22]. These intentions indicate the importance of STEM and

the global trend of future development. Novel or high technological growth has driven STEM programs to become the most popular programs on campus.

The integrated STEM education in higher education has been initiated in the Teaching Excellence Project and Higher Education Sprout Project (HESP) in Taiwan. These initiatives have been integrated into the related measures in secondary education, for example, problem-centered learning, inquiry-based learning, design-based learning, and cooperative learning for specific programs [23]. The government plans to invest TWD 83.6 billion over five years in the HESP, and this project will extend to the next five years. The project encourages universities to develop their own characteristics and innovative teaching techniques for students' learning [24]. In addition, a global Taiwan sub-project of HESP provided extra money to fund the selected universities for their internationalization. According to the Essential Science Indicators (ESI) rankings, in 2020, 33% of Taiwanese universities have entered the list of the world's top one percent of research institutes [25]. Of course, this is not only in the quantitative dimension, as the quality of these institutes has reached a world-class level within higher education systems. Significantly, the number of international students studying degree programs, language learning programs, and short-term exchanges in Taiwan increased to 98,247 in 2020, while the international student enrollment was only 30,509 in 2007 [26]. Additionally, the number of international students participating in STEM has shown an increase. The growth of STEM has led to this field becoming attractive for domestic and international students. High technology has driven Taiwan to move upwards, and various universities have established AI-related programs or professional colleges. This trend might attract more international students studying in the STEM fields.

Even though the STEM programs still attracted many students, we worried that the pandemic and the issue of decline might impact enrollment temporarily or in the long run. This study argues that the expansion of higher education might shift the landscape of international students in STEM programs. We propose a structural model by which to verify the causal relationships of push factors, institutional mediation variables, and satisfaction variables. The results will confirm which relationship works. The findings can promote institutes' capabilities to recruit and retain international students in STEM. In addition, the research design and findings can enrich the knowledge related to attracting and retaining international students in similar higher education settings. For these purposes, this study explored the following research questions:

RQ1. What are the influential factors that lead to international students' satisfaction in STEM programs?

RQ2. Can STEM programs make differences to their institutional mediation in attracting and retaining international students?

RQ3. What kinds of structural models can interpret the phenomena of international students in STEM programs?

The rest of the paper is presented as follows: First, we present a literature review, which includes an analysis of the factors that impact international students' satisfaction. Second, the methodology section is presented, including instruments, samples, hypotheses, and statistical analyses. Third, the results are displayed, including the result of factor analysis, reliability analysis, structural equation modeling (SEM), and the bootstrap method. Finally, a conclusion is drawn, and we provide some suggestions for attracting and retaining international students for sustainable higher education.

2. Literature Review

The internationalization of higher education has been assumed to be a vehicle for a two-way flow of knowledge across national, cultural, linguistic, and perspective boundaries to promote social justice and global citizenship for sustainable development [19]. The traditional role of higher education has been shown to be transforming regarding the movement of students' global mobility. In this section, we focus on related theories to

interpret the phenomena of students' global mobility, factors related to students' satisfaction, and what kinds of institutional mediation can help.

2.1. Interpretation of Push–Pull and Spatial Theory

Reviewing the student mobility literature, we found Ravenstein's push–pull theory as a traditional approach by which to explain international student flow [27,28]. Lee focused on migration issues with positive and negative signs representing push and pull factors, respectively. Between the places of origin and destinations, impact factors may include environmental factors, economic and social factors, and intervening obstacles [29]. Previous studies have addressed various issues of international student mobility; for example, Souto-Otero et al. indicated positive individual motivations for studying abroad [30], and some studies have discussed the obstacles embedded in student mobility [31,32]. Mazzarol and Soutar argued that when deciding to study internationally, students might go through four distinct stages: clarifying their intention to study abroad, choosing a country in which to study, selecting a type of institute, and choosing a city [33]. To interpret the mobile phenomena, we can classify the push factors into a negative domain, which international students confront in their original countries. Whereas the pull factors can be interpreted as an attractive domain, which may be provided by the destination countries. The related push factors may include employment opportunities (PS1), living conditions (PS2), family-related reasons (PS3), and political reasons in the original countries (PS4).

Moreover, there are several overlapping perspectives across the spatial, mobility, and network theories [34]. For example, Massey [35] and Soja [36,37], post-structural spatial scholars, emphasized how space is constructed and changed by human activity within it and how human activity is altered and shaped by spatial arrangements, such as the concept of the local and the global. Larsen recommended an analysis using the spatial, network, and mobility theories to achieve internationalization in higher education [34]. The spatial theory provides a holistic approach by which to analyze global mobility phenomena. In this sense, the spatial theory may provide a window through which to view complex student global mobility. When international students integrate their learning and life with domestic students on campus, the phenomenon may accelerate the effect of "internationalization at home" [38].

2.2. Institutional Mediation

Institutional mediation could be a crucial factor impacting international students' travel and retention decisions. This study considered the notion of satisfaction in total quality management, which implied that customers' satisfaction is a critical indicator of quality assurance in companies [39]. Institutional mediation refers to the realities of higher education internationalization, which may include leadership in institutes and strategies related to psychological or financial security for students. At the institutional level, leadership may include student affairs (IL1), treatment of international students without differences (IL2), and decision-making mechanism (IL3). Enhancing international campus affairs can attract more international students; therefore, related strategies may include a clear international strategy on campus (IS1), funding opportunities for international students (IS2), and encouraging international students are engaged in learning (IS3) or academic activities (IS4) [8,40,41].

2.3. Factors Impacting Satisfaction

Previous studies have indicated that life satisfaction is a significant indicator by which to evaluate how well international students have adjusted to their new studying situation [42,43]. Studies have shown that exposure to an unfamiliar environment can cause anxiety, confusion, and depression, leading to insomnia and physical illness [44]. These experiences have been observed among international students experiencing loneliness or isolation [45–47]. After overcoming negative factors, they will be able to enjoy the journey of their study. The major task for international students is learning on campus.

Successful learning experiences can bring about international students' satisfaction, which may include the program design, teaching and learning process, and reasonable assessment. Learning satisfaction could be a crucial factor for the retention of international students. Moreover, institutional mediation has become an influential factor impacting international students' travel decisions, for example, leadership in institutes, internationalized strategies, the learning environment, and travel restrictions for international students. Beyond the institutional level, a government's policy can make a difference, for example, China has initiated a "Study in China" program to increase the number of inbound international students [48], and Taiwan has a scholarship for excellent international students. In addition, friendly migration policies could be an influential factor for attracting international students. Recently, the government has released a migration policy for international students in STEM fields. Selected STEM graduate students could get permanent residency and work in high technological companies. Even though there are complaints that universities have become corporate organizations that seek to generate profit [49], it is not surprising that international education is increasingly being integrated into migration marketing strategies, such as those pertaining to permanent residency [50]. Travel restrictions for international students and deterioration of the determinants that condition international mobility may be taken into account [51]. In this study, we consider the satisfaction factors, including learning processes (S1), campus environment (S2), academic programs (S3), and migration policy (S4).

3. Method

This study was conducted using the following procedures. First, we employed self-designed questionnaires as instruments to collect the data. Second, we proposed an SEM model to test what works for attracting and retaining international students in STEM programs. Third, we presented the characteristics of the target samples. Finally, we addressed the related verification process to confirm our evidence from the data.

3.1. Instruments

We designed three measurements to test the structural model. In this study, the latent variables included push factors, institutional mediation, and satisfaction. There were 15 observed items falling under three domains: push factors with four items, institutional mediation with three items in institutional leadership and four items in international strategies, and satisfaction with four items. To collect data on the perception of international students in STEM programs, all items in the questionnaire were designed using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The 3 domains and 15 observed items are listed in Table 1. The codes of the instruments are presented in Table 1, i.e., PS1 to PS4, IL1 to IL3, IS1 to IS4, and S1 to S4. The proposed items are throughout the literature review.

3.2. A Testing Model for SEM

Based on the literature review and our innovative SEM model, we developed hypotheses to test. We assumed that institutional mediation might play a significant role in the structural relationship. Considering that the notion of push factors [27–32], institutional leadership and international strategies [8,40,41], and satisfaction [42–45,51] may exist in a structural relationship in SEM. The proposed testing model for SEM is displayed in Figure 1.

Table 1. Definitions of observed items.

Domains/Observed Items	Definitions of Observed Items
Push factors/	
PS1:	It is difficult to find employment opportunities in my country
PS2:	I have experienced poor living conditions in my country
PS3:	For family reasons, I have decided to study abroad
PS4:	In my country, I have political reasons to study abroad
Institutional mediation/	
Institutional leadership (IL)	
IL1:	I experienced that my university has strong leadership for student affairs
IL2:	My university's policy is indifferent to the treatment of international students
IL3:	I experienced that my university has a collegial decision-making mechanism
International strategies (IS)	
IS1:	I experienced a clear international strategy on campus
IS2:	My university provides various learning opportunities or funding for international students
IS3:	My university encourages recruitment of international students
IS4:	My university encourages international students to attend conferences abroad and provides funding support
Satisfaction/	
Learning (S1):	I am satisfied with my learning process
Environment (S2):	I am satisfied with my campus environment
Academic_friendly (S3)	I am satisfied with the academic program that I participated in
Migration_policy (S4):	I am satisfied with the migration policy in the destination country

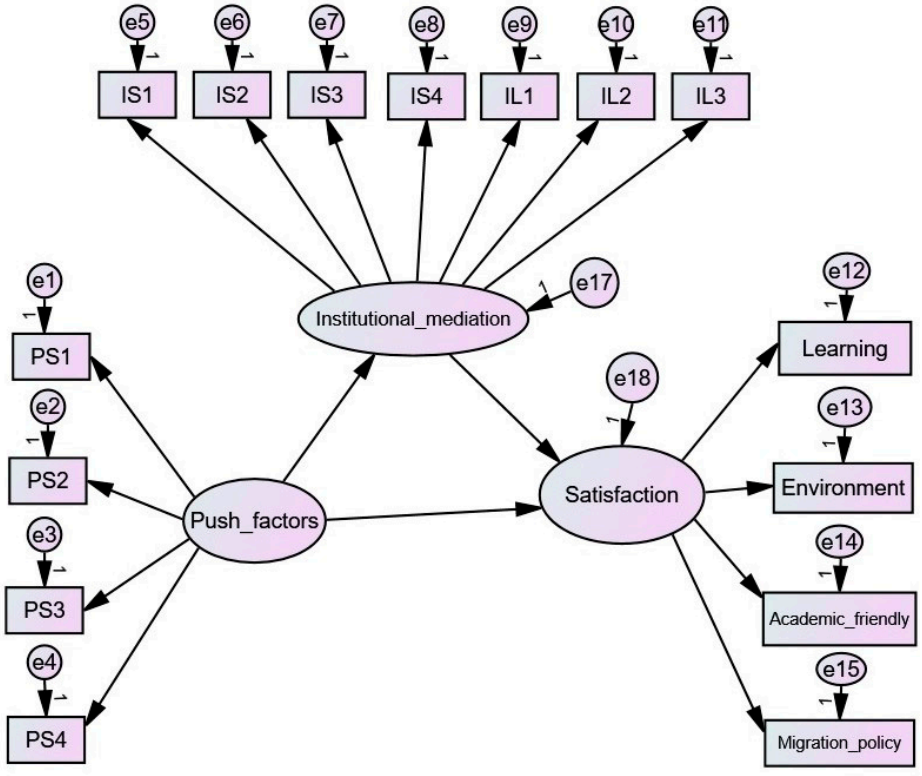

Figure 1. The proposed model for testing in SEM.

Based on our testing model of mediation effect, the null hypotheses of the research questions were:

Hypothesis 1 (H1). *There is no relationship between push factors and institutional mediation variables.*

Hypothesis 2 (H2). *There is no relationship between push factors and satisfaction variables.*

Hypothesis 3 (H3). *There is no relationship between institutional mediation and satisfaction variables.*

Hypothesis 4 (H4). *Push factors will not, through institutional mediation variables, impact satisfaction variables.*

If the statistical significances reject the null hypotheses, the result will confirm that a causal relationship exists in the model. Since there were three latent variables, this was a mediation model design with a structural equation model. If the mediation effect exists, the indirect effect will be significantly larger than that of the direct effect. Institutional mediation was assigned as a mediation effect in the model.

3.3. Research Targets and Samples

According to the statistics of international students from the Ministry of Education, the number of international degree students in Taiwan was 52,714 in 2020 [25]. This research targeted international students majoring in STEM in Taiwan. Since the international students were enrolled in different higher education institutes, this survey used an online sampling technique during spring 2021. We considered the distribution of international students in science, technology, engineering, and mathematics programs. The participants were invited on a department basis. Given the limitations of online sampling, the distributions were not expected to pass normality testing. Considering the research ethics, all participation was voluntary. If anyone felt uncomfortable, they were able to withdraw immediately. After deleting in-completed questionnaires and non-degree seekers, we received 485 valid questionnaires from international students in STEM programs. The distribution of the samples showed that 55.7% were male and 44.3% were female. A total of 27.8% were studying for a bachelor's degree, 36.5% for a master's degree, and 35.7% for a doctoral degree in STEM. Most of the international students in STEM were from Asian countries (76.9%); this figure is also reflected in the similar distribution of international students in Taiwan. The details of the distribution of the international students in the samples are listed in Table 2.

Table 2. The distribution of 485 samples in STEM.

Classification		Frequency	Percent
Gender	Male	270	55.7
	Female	215	44.3
Origin	Asia	373	76.9
	Oceania	13	2.7
	Africa	16	3.3
	Europe	14	2.9
	America	42	8.7
	China	27	5.6
Degree-seeking	Bachelor's	135	27.8
	Master's	177	36.5
	Doctoral	173	35.7

3.4. Data Transformation and Statistical Analyses

After considering the data structure, we employed IBM SPSS 26 and AMOS 26 (Analysis of Moment Structure) to conduct the data analyses in this study. To verify the structural relationship, we conducted a reliability analysis, factor analysis, and SEM in order to obtain meaningful evidence. First, reliability was used to estimate the internal consistency of the instrument before moving the data sets into the SEM; a Cronbach's alpha > 0.6 can be used as an index of convergent validity for a measure to fit SEM [52]. Second, we considered that the factor loadings of the observed items should be larger than 0.50 [53,54]. Third, the overall model fit in SEM was assessed using the common goodness-of-fit indices, including Chi-square minimum (CMIN), ratio of Chi-square to degrees of freedom (χ^2/df < 5.0), number of distinct parameters (NPAR), goodness-of-fit index (GFI > 0.90), adjusted goodness-of-fit index (AGFI > 0.90), parsimonious goodness-of-fit index (PGFI > 0.50), root-mean-square residual (RMR < 0.08), and Akaike Information Criterion (AIC = $\chi^2 - 2 \times df$; it tended to be smaller) [55–58]. If the estimated values in the SEM model fit the ideal criteria, this demonstrates an acceptable goodness-of-fit between the hypothetical model and the sample data. In this case, the hypothetical model was supported.

The following steps were utilized to estimate the effect of mediation. First, we used type I error and statistical power to evaluate the effect of mediation [59–61]. Second, we followed Shrout and Bolger's recommendation to apply the bootstrap method to estimate the effect of mediation [62]. The bootstrap method is a process of using resampling to achieve the mean of the effect of mediation (r11*β1). We used AMOS to conduct the bootstrapping. In this study, the bootstrap sample was larger than the original dataset. We selected the number of bootstrap samples as 2000. In the mediating effect test, Z = point estimate/standardized error (SE). When Z > 1.96, this represents that there is a mediation effect between the variables. When performing the bootstrap, we selected percentile confidence intervals or bias-corrected confidence intervals at 95% confidence level as justified criteria [63–65]. In the bootstrap process, the histogram provided an estimate of the shape of the distribution of the sample mean. Based on the histogram, we examined how much the mean varied across the target number of bootstrap samples.

4. Results

In this section, we demonstrate how the international students' data in STEM programs were transformed to fit the SEM model and how the proposed SEM model was verified. First, we display the descriptive statistics of the push factors, institutional mediation, and satisfaction. Then, we present the reliability and factorial loadings of the measures. Finally, the results of the SEM testing and bootstrapping are addressed.

4.1. Descriptive Statistics of Push Factors, Institutional Mediation, and Satisfaction

Table 3 displays the descriptive statistics of the observed items for push factors, institutional mediation, and satisfaction. Regarding each factor with the different observed items, this study calculated the mean of the factor with its number of observed items. The means of the push factors, institutional mediation, and satisfaction were 2.95, 3.82, and 3.69, respectively. Based on Kline's definition, when the value of skewness is larger than ±3, it belongs to absolute skewness [66]. In this study, we found the values of skewness and kurtosis to fit the requirements of a normal distribution. The results of the descriptive statistics suggest that the data can be transformed and estimated as parameters in an SEM.

4.2. Construct of Measurement

In this study, we judged the construct of measurement for international students according to the following criteria: first, we tested the correlation of the items; second, we tested if the items possess internal consistency (Cronbach's alpha > 0.6); third, the acceptable variance was explained, and usually, the explained variance of the variables was >50%. The construct of measurement should demonstrate that the removal of any item

does not change the essential nature of the underlying construct. The results of testing the constructs are presented as follows.

Table 3. Descriptive statistics of push factors, institutional mediation, and satisfaction.

Observed Items	N	Mean	Std. D.	Skewness	Kurtosis
Push factors					
PS1	485	2.79	1.106	0.106	−0.687
PS2	485	3.64	1.112	−0.574	−0.335
PS3	485	2.81	1.148	0.088	−0.810
PS4	485	2.58	1.108	0.310	−0.552
Institutional mediation					
IL1	485	3.93	0.834	−0.622	0.534
IL2	485	3.69	0.815	0.043	−0.443
IL3	485	3.63	0.856	−0.362	0.280
IS1	485	3.87	0.902	−0.711	0.334
IS2	485	3.94	0.962	−0.897	0.552
IS3	485	4.03	0.783	−0.781	1.159
IS4	485	3.67	0.995	−0.565	0.061
Satisfaction					
Learning	485	3.79	0.831	−0.305	−0.010
Environment	485	3.85	0.824	−0.301	−0.255
Academic_friendly	485	2.93	1.152	−0.013	−0.955
Migration_policy	485	4.01	0.827	−0.584	0.197

First, Table 4 shows the correlation matrix of push factors, institutional mediation variables, and satisfaction variables. The results revealed that most items with Pearson's correlation were significant at the 0.05 level, which fit in order to test them in the SEM. We considered whether the selected items had high correlations. When the selected items with high correlations measured a similar concept, this could lead to a multi-collinearity problem, and one or more items needed to be eliminated. The results indicated that there was no such problem in the selected items. In this study, the mean of the inter-item correlations was 0.414.

Table 4. Correlation matrix of push factors, institutional mediation, and satisfaction.

Observed Items	PS1	PS2	PS3	PS4	IL1	IL2	IL3	IS1	IS2	IS3	IS4	L.	E.	A.
PS1	1.000													
PS2	0.405													
PS3	0.250	0.273												
PS4	0.292	0.311	0.414											
IL1	−0.020	0.189	0.047	0.072										
IL2	0.011	0.141	0.009	−0.009	0.331									
IL3	0.080	0.214	0.110	0.121	0.471	0.403								
IS1	0.048	0.178	0.098	0.075	0.639	0.348	0.543							
IS2	0.067	0.124	0.136	0.071	0.415	0.332	0.474	0.528						
IS3	0.046	0.165	0.083	0.070	0.421	0.303	0.433	0.503	0.507					
IS4	0.091	0.165	0.105	0.113	0.456	0.295	0.499	0.489	0.512	0.504				
Learning	−0.095	0.105	0.022	0.075	0.435	0.246	0.381	0.424	0.329	0.318	0.343			
Environment	−0.086	0.208	0.031	0.064	0.379	0.315	0.427	0.433	0.344	0.311	0.347	0.634		
Academic_friendly	0.105	0.099	0.186	0.132	−0.072	−0.048	−0.035	0.005	−0.060	−0.073	0.019	−0.141	−0.044	
Migration_policy	0.006	0.175	0.058	0.134	0.267	0.211	0.388	0.350	0.297	0.309	0.279	0.287	0.350	−0.047

Second, the reliability analysis for the measurement showed that Cronbach's alpha was 0.788, and Cronbach's alpha based on the standardized items was 0.809 among the 15 items. On the push-factor scale, the total variance explained for the four items was 49.325%, and Cronbach's alpha was 0.657. On the institutional mediation scale, the total

variance explained for the seven items was 53.106%, and Cronbach's alpha was 0.656. On the satisfaction scale, the total variance explained for the four items was 47.228%, and Cronbach's alpha was 0.370. This was not satisfactory for the satisfaction scale. After deleting Academic_friendly, we found that the total variance explained for the three items on the satisfaction scale was up to 62.266%, and Cronbach's alpha was 0.688. The result of the satisfaction scale suggested that the three-item construct was better than the four-item construct.

Third, the related information for Cronbach's alpha of a deleted item is displayed in Table 5. We found that Academic_friendly was abnormal. It also demonstrated that the deletion was corrected.

Table 5. Items' total statistics and information for Cronbach's alpha if the item is deleted.

Observed Items	Scale Mean If Item Is Deleted	Scale Variance If Item Is Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha If Item Is Deleted
PS1	50.38	48.099	0.192	0.252	0.795
PS2	49.53	45.134	0.395	0.292	0.777
PS3	50.36	46.648	0.274	0.230	0.788
PS4	50.58	46.653	0.290	0.250	0.786
IL1	49.24	45.622	0.528	0.482	0.767
IL2	49.47	47.469	0.368	0.227	0.778
IL3	49.54	44.617	0.605	0.460	0.761
IS1	49.29	44.018	0.621	0.562	0.759
IS2	49.22	44.446	0.538	0.430	0.764
IS3	49.14	46.159	0.517	0.398	0.769
IS4	49.50	43.854	0.563	0.426	0.762
Learning	49.38	46.760	0.424	0.470	0.775
Environment	49.31	46.220	0.479	0.491	0.771
Academic_friendly	50.24	50.542	0.024	0.087	0.811
Migration_policy	49.16	47.057	0.399	0.229	0.776

4.3. Testing of the Structural Equational Model

The result of the SEM, with the generalized least-squares method (GLS), indicated that the CMIN was 185.604, and the degree of freedom was 71. In this study, the value of χ^2/df was 2.614 (χ^2 = 185.604; df = 71); this implied a good fit (2.614 < 3.00) of the testing model. The SEM revealed that the NPAR (the number of parameters) was 34, implying that the model was moderately complex. The results revealed that the model-fit indices (GFI, AGFI, PGFI, and RMR) exceeded the acceptance levels (GFI = 0.945 > 0.90, AGFI = 0.921 > 0.90, PGFI = 0.657 > 0.50, RMR = 0.0630 < 0.08). In this study, the value of AIC tended to be small (AIC = 253.604). Based on the results of the SEM, this study showed the recommended values for the model fit. The model suggests that the significant standardized coefficients are push factors → institutional mediation (0.232) and institutional mediation → satisfaction (0.732). The mediation effect of push factors through institution to satisfaction was 0.169. Table 6 displays the standardized coefficients in the paths and p-values. The results revealed that there were three null hypotheses that were rejected, which implied that a causal relationship existed in the model.

Table 6. The estimated and standardized coefficients and significance of p-values.

Hypotheses			Standardized	p
H1: Institutional mediation	←	Push factors	0.232	*
H2: Satisfaction	←	Push factors	−0.030	-
H3: Satisfaction	←	Institutional mediation	0.732	*
H4: Satisfaction ← Institutional mediation	←	Push factors	0.169	*

Note: * $p < 0.05$.

The results of the null hypotheses tests are as follows:

Hypothesis 1 (H1). *There is no relationship between push factors and institutional mediation variables (rejected);*

Hypothesis 2 (H2). *There is no relationship between push factors and satisfaction variables (accepted);*

Hypothesis 3 (H3). *There is no relationship between institutional mediation variables and satisfaction variables (rejected);*

Hypothesis 4 (H4). *Push factors will not, through international mediation variables, impact satisfaction variables (rejected).*

Based on the verified information, the findings suggested that the institutional mediation effect existed in this model. The details of the structural relationships in SEM are displayed in Figure 2.

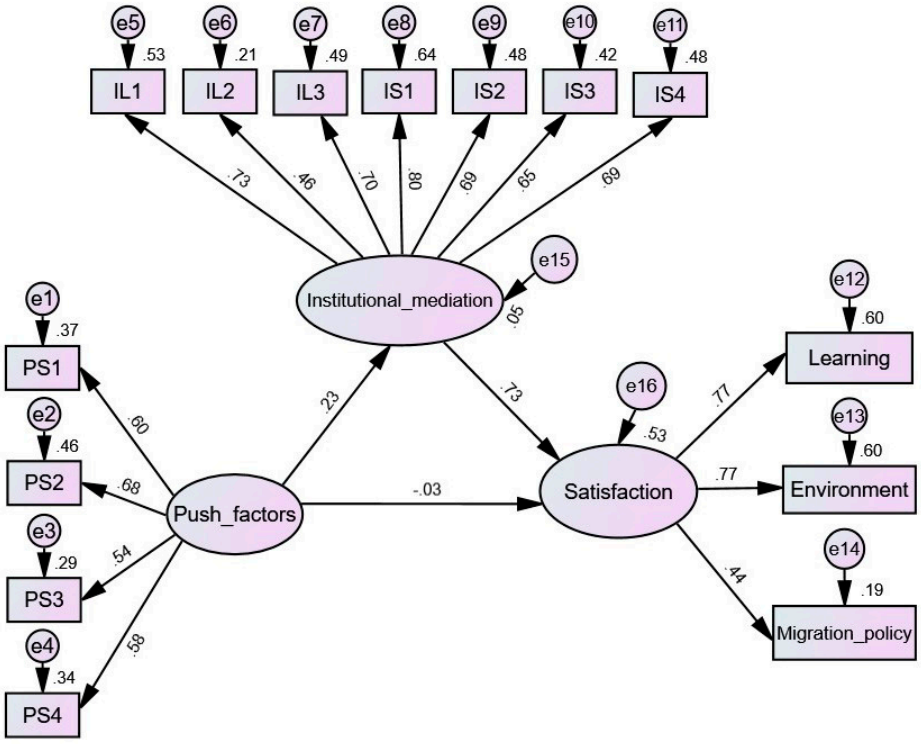

Figure 2. The results of SEM.

4.4. Testing of Effect of Mediation

The correlation coefficients of the latent variables are listed in Table 7. They reflect that the r between the push factors and satisfaction was 0.105; the r between the push factors and institutional mediation was 0.184, and the r between institutional mediation and satisfaction was 0.596. The results revealed that the predictor, mediation, and criteria were significant at the 0.05 or 0.01 level.

Table 7. Correlation coefficients of latent variables in the proposed model.

Latent Variables	Correlation	Push Factors	Satisfaction
Push factors	Pearson correlation	1	
	Sig. (2-tailed)		
Satisfaction	Pearson correlation	0.105 *	
	Sig. (2-tailed)	0.020	
Institutional mediation	Pearson correlation	0.184 **	0.596 **
	Sig. (2-tailed)	0.000	0.000

Note: * $p < 0.05$; ** $p < 0.01$.

In the results of testing the effect of mediation, we found that the statistical power depended on both the coefficient r_{11} (Push factors → Institutional mediation) and β_1 (Institutional mediation → Satisfaction), which are significant. This fits Sobel's suggestion that calculating the coefficient (r_{11}) and β_1 can determine the mediation effect (r_{11}*β_1) [61]. The result of the bootstrap method with 2000 samples showed that the effect of mediation (r_{11}*β_1) was 0.170, and it was significant at the 0.05 level. The direct effects of institutional mediation and push factors on satisfaction were 0.732 ($p < 0.05$) and −0.030 ($p > 0.05$), respectively. The details of the *p*-values and 95% conference intervals of percentile confidence (PC) and bias-corrected (BC) intervals are listed in Table 8. Based on the criteria of bootstrapping test, the results revealed that the indirect effect was significant. In addition, the values of the 95% confidence intervals with PC and BC did not include 0. The findings suggest that the mediation effect of institutional mediation works in this model.

Table 8. Summarizing the estimated standardized effect of indirect, direct, and total effect with PC and BC.

Effects	Estimated	PC/BC *p*-Value	95% Confidence Interval	
			PC	BC
Indirect effect Push factors → Institutional mediation → Satisfaction	0.170	0.006/0.009	0.057–0.277	0.049–0.271
Direct effect Institutional mediation → Satisfaction	0.732	0.001/0.001	0.624–0.827	0.623–0.826
Push factors → Satisfaction	−0.030	0.659/0.681	−0.172–0.128	−0.170–0.130
Total effect	0.14	0.138/0.154	−0.058–0.334	−0.061–0.332

The histogram shows the distribution of the B quantities with 2000 samples $C_{GLS}(\hat{\alpha}_b, \mathbb{a}_b)$, $b = 1 \ldots, B$ (see Figure 3). It implies that the model and its construct are reliable, and when the targeted samples were extended to 2000, it was still robust.

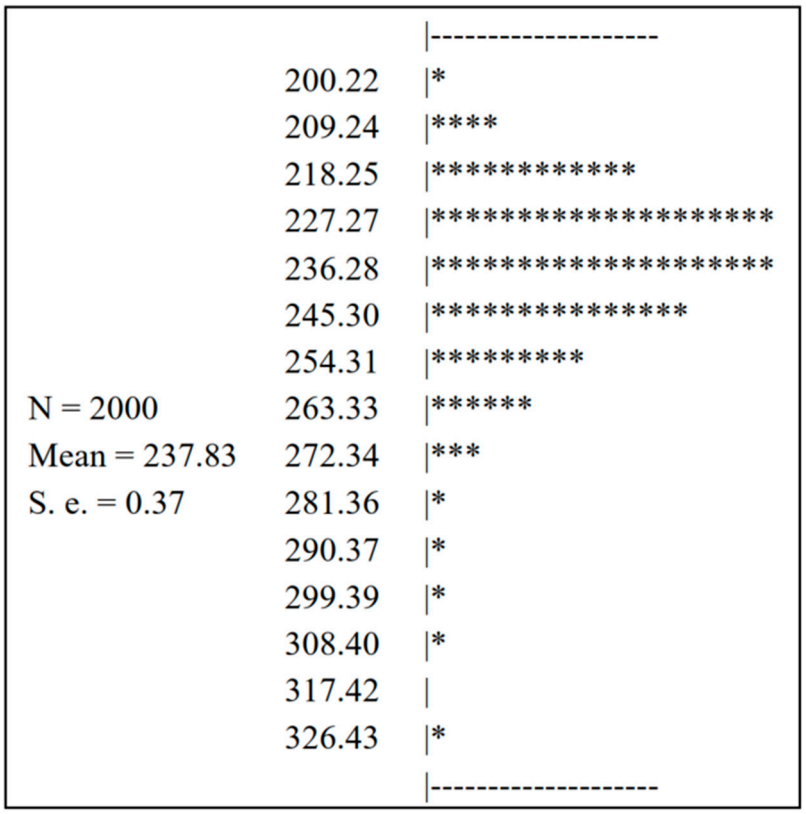

Figure 3. Generalized least square discrepancy (implied vs. population).

5. Discussion

Previous studies argued attracting and retaining more international students could provide advantages in the future, for example, increasing the revenue of higher education institutes, upgrading innovative systems, and promoting economic performance [1,2]. Basically, we agree with this argument when considering the pressure of declining enrollment in higher education and national economics. Among the study fields in higher education, we found that STEM has become crucial for achieving this purpose. We selected STEM programs as research targets, assuming that STEM fields are attractive. If we can recruit more international students, for instance, it may release the threat of declining enrollment in the higher education system [15,16]. Moreover, this study emphasized the issues of international students in STEM, for example, lockdown impacting international students during the COVID-19 pandemic [7,9]. During the post-pandemic era, global mobility could be a new challenge for international students planning their study journey.

What works for attracting and retaining international students has also challenged the previous arguments. This study found that international students in STEM did not suffer serious negative push factors in their original countries. Table 3 revealed that push factors perceived by the international students in STEM are relatively low (2.58–3.64 on the five-point Likert scale). The push factors with those international students in STEM did not link to satisfaction directly in the testing of SEM. The findings are different from the argument of previous studies that push factors to exert negative influences on migrants [27,28,30,31,33]. Considering that STEM fields have strong attraction may confirm that international students engaged in STEM are a special case in the mobility flow of the world.

This study intended to move the theoretical arguments to evidence-based research practices. This study provided a framework to verify the relationships among negative push factors, institutional leadership and international strategies, and satisfaction in STEM. This study demonstrated that higher education institutes could exert strong institutional mediation on international students' satisfaction. Previous studies suggest that international students might suffer anxiety, confusion, depression, loneliness, and isolation [44–47]; this

study found that STEM programs with strong institutional mediation can build a friendly learning environment for international students. The findings suggest that most international students in STEM were satisfied with their learning situation, campus environment, and daily life.

If migration policy allowed the graduated international students to get permanent residency, it would encourage more international students to engage in related study programs. The government has considered loosening the requirement of permanent residency for graduates from STEM. This phenomenon in STEM was supported by Altbach and Knight's argument that internationalization of higher education encouraged international students, taking into account their international mobility [51]. While the migration policy is a policy intervention controlled by the government level, it may not be extended to other study fields.

Moreover, the results of bootstrapping in SEM have demonstrated that the effect of mediation existed in our proposed model. Considering the samples are limited, the bootstrap method could be an optimal solution to project the reliability of research to a relatively large group.

6. Conclusions

This study aimed to obtain effective institutional strategies for international students and their satisfaction with STEM programs. According to the research design and verification of the structural equation modeling, we explored the effect of institutional mediation between the push factors and satisfaction factors, which can provide useful information for attracting and retaining international students. The push factors may belong to the negative domain for most international students. How to remove the negative factors for international students has become an emerging issue on campus. The SEM results demonstrated negative push factors among international students, which, through effective institutional leadership and international strategies, impact their learning and environment satisfaction in STEM. The findings suggest that institutional mediation could be an influential factor that leads to international students' satisfaction. Appropriate institutional mediation, for example, institutional leadership and institutional strategies, can make a difference in the retention of international students. This linkage is important, but previous studies did not provide supportive evidence. This study proposed an innovative approach by which to detect international students' issues, not limited to STEM. Based on the findings, we may suggest that higher education institutes can reinforce their institutional mediation measures for international students, for example, reviewing their institutional leadership and international strategies as in our proposed framework.

Regarding the limitations and implications of this study, we had the following challenges: First, we provide an example with a rigid model to test the issue, but the perceptions of international students might vary in different spaces and special moments. For example, during the COVID-19 pandemic recovery, the findings may be different from other periods. Second, in conducting this type of study, the sampling technique might become challenging. It is not easy to fit the criteria of probability sampling for international student groups. Third, considering that studies focus on international students, we suggest that the testing model can be extended to wider higher education settings to explore similar issues. Fourth, since international students have become competitive resources in higher education, this design can be used to review the competition between programs in a system or in an institute for their sustainable development periodically. Finally, based on spatial theory, we are living in a global village. For sustainable development purposes, both internationalization at home and internationalization abroad should be integrated into higher education.

Related information for enhancing internationalization from further studies can promote sustainable higher education systems. For further studies, we encourage comparing international students' participation in other programs, as well as considering differences of gender and countries of origin, in order to develop effective strategies for attracting and retaining students.

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