Sustainable Dimension Pillars Adaptation in Green Township Assessment Criteria

Rostam Yaman, Jamalunlaili Abdullah & Farrah Zuhaira Ismail.
Faculty Architecture Planning & Surveying
Universiti Teknologi MARA
Malaysia

Noraini Ahmad
Department of Applied Arts
Kulliyah of Architecture & Environmental Design
International Islamic University Malaysia
Malaysia

Abstract— **Green township rating system in the ASEAN region and Malaysia are relatively new. For the case of Malaysia, there is lack of measure have been done to evaluate the Sustainable Dimension Pillar (SDP) adaptation in GBI Green Township Assessment Criteria (GBI-TAC). Thus, embark the research problem whether the GBI-TAC fulfilled the sustainability concept according to holistic SDP. The research aim and objectives is to measure and identify the SDP adaptation in GBI-TAC six core criteria. The research employ Stakeholders-Inclusion Approach in order to gather professionals' opinion towards SDP adaptation and analyzed using Confirmatory Factor Analysis. The outcomes suggested there is an adaptation gap of SDP and also ranked the variables in the current GBI-TAC. Hence lead to further review and refinement towards Sustainable Neighborhood (SND) Development in the ASEAN region generally and Malaysia specifically.**

Keywords— ***Sustainable Dimension Pillar; Township Assessment Criteria; Confirmatory Factor Analysis***

I. INTRODUCTION

The ever growth of population and longevity demanded a provision of an adequate and affordable spaces to live and make a living in the development strive of today, the urbanization and spatial concept of housing and working spaces requires a comprehensive new understanding of addressing those needs. It ranges from demanding subjects related to slums preventive measures, urban divide, economic and social development, and climate change [1]. From Urban Planners perspective, housing or spatial circumference and envelope is not simply as creating a roof to shade one's head, it is beyond that [2]. It addressed vital forms and functions in achieving holistic sustainable development or envisaged conception of sustainable green buildings. Sustainable development of housing and others types of spaces which encompassed an efficiency criteria's in energy, resources, social, cultural and economic yet to be an integrated policy in developing countries [3].

Generally, adhocly and instant urban planning and architectural development led to unsustainable developments. Inconsideration future projections of population density, infrastructure and amenities, uncontrolled urban sprawling and poor maintenance accumulate an amplified carbon footprint and growing negative impacts to the environments [4]. Rapidly low cost housing developments programs in remote locations resulting poor standard accommodations, parking and traffic congestions, and less considerations to end users lifestyle and livelihood strategies further adding the problems. Sustainable architecture development towards justifiable urban conurbations suggested key consideration together with conceptions to support the notions of living sustainably [5]. It's underpin a broad framework criteria for designing a sustainable dwelling spaces and rational operations.

This study will advocates to more holistic sustainable approach, not merely on the classical design thoughts of green building. A holistic sustainable development recognized beyond the multiple function of architectural space or housing, its renders both of physical and social systems, the physical forms of the buildings and the user experience. Spaces mold the behavioral and emotions of users [6], green buildings are to augment and harmonize the environment, social and economic dimensions of the sustainable building development. Hence, the holistic sustainable development parallel with solutions for the built environment – energy and resource efficiency, environmental, ecology and health reliability, resilience to natural risk [7].

Sustainable development via green building conceptions disentangle the tensions concerning climate change, urban growth, urban poverty, scheme for affordable housing and key solution reliable residential services, cleaner energy and mitigating from environmental conditions, thus, further elevated the possibility of enhanced social and economic growth [8]. Most of sustainable assessment criteria and rating system framework is developed by building related professional institutions such as the institute or association of planners, architect, engineers or designers [9]. However, there is lack of measure have been carried out to evaluate the balanced SDP adaptations on the pre-occupancy GBI-TAC. Hence, the research aim and objectives is to measure and identify the SDP adaptation in GBI-TAC six core assessment criteria.

II. RESEARCH BACKGROUND

Malaysia is a faction of the UN Framework on Climate Change and has endorsed the Kyoto Protocol on September 4th. 2004 [10]. Hence, Malaysia has moved towards a developed nations by the year 2020 and demands to deliver the obligations

of becoming a developed nations not limited to economic and technological positions but also towards sustainable development. The campaign towards green was announced in 2010 Budget which comprehended: the fund of not less than 1.5 billion Malaysian Ringgit (MYR) to be disburse as soft loans, tax exemption to building proprietors who acquire the new GBI certification, purchasers of buildings with GBI certification will also exempted from stamp duty which valid between Oct. 2009 until Dec 31st. 2014 [11]. From Malaysian development and economic context, the Return of Investment (ROI) factors in investment such as capital appreciation, higher rental income and cost saving based on projected demand in the future. Grounded upon the findings of the study, investment in green office building will open a new dimension in building development and real estate industry in Malaysia. The relevancy of this study is very much on the main stakeholders in green building industries, which are the developer who initiated the development and governments who encourage sustainable developments [12].

The role of Public Works Department (PWD) under Ministry of Works Malaysia progressive steps in formulating; adapting and applying sustainable project management towards achieving Malaysia government aspirations of green nations by 2020. It focused on energy efficiency and savings to reduce carbon emissions. PWD's has taken step forward by taking a collective approach with other related government agencies and professional bodies [13]. PWD's suggests the Green Building Design (GBD) and Universal Design (UD) as an aim in achieving sustainability in the field of built environment. The introduction of Green Building Index in Malaysia served as reinforcement method in strengthening the Green Building Design agenda even though it was not compulsory to comply. However, the government discourse in assimilating GBI framework criteria through Persons With Disabilities Act 2008 (Public Work Department Act) in promoting universal design, which is one of the criteria's in GBI is a step forward in legalizing the effort. Both of the GBI and PWD Act is a catalyst and support for Sustainable Development in environmental protection and social equity and equality [14].

III. Research Methodology

The Stakeholders-Inclusion Approach were employed in this study and focused on professional's surveys to evaluate the adaptation of ADP in GBI-TAC. The professional's survey is to find out further gap in SDP adaptation. These professional are key players in implementing GBI-TAC whether directly or indirectly involved in urban SND in Malaysia. The professionals in this research are individual or organization's involved in urban development project ranging from government sector, professional institution, developers, contractors, financers and academicians. The Professional's Surveys was conducted via online questionnaires surveys using Google Documents software package. The online surveys was emailed to the list respondents for feedback. A total 100 online surveys were disseminated to the listed respondents with a target of 50 returned response. The returned response were analyzed using SPSS AMOS 22 Confirmatory Factor Analysis (CFA) software package. The main objective of this phase is gather data for SDP adaptations balanced in all GBI-TAC criteria and its scoring weight. These basically will give a feedback on SDP balanced based on professional's opinion of core-criteria in GBI-TAC.

A. Profile of the Respondents

This study has gathered 61 valid professional respondents' opinions from various professional stakeholders who are involved in SND projects. The justification for such composition is that consultants is the key actor in implementing and the decision making for sustainable development project, developer is the commissioner, while contactor is the executor and academician is the observers and critics (Table 1).

Table 1: Number of Respondents by Designation

Designations	***N***	**Percentage (%)**
Architect	12	19.67%
Urban Planner	6	9.83%
Designer	8	13.11%
Landscape Architect	4	6.55%
Quantity Surveyors	4	6.55%
Engineers	5	8.19%
Total Consultant	**39**	**63.93%**
Dev. Executive	2	3.27%
Valuer/ E. Agent	5	8.19%
Total Developer	**7**	**11.47%**
Project Director	1	1.63%
C. Manager	7	8.19%
Total Contractor	**8**	**13.11%**
Researcher	1	1.63%
Conservator	1	1.63%
Academician	5	8.19%
Total Others	**7**	**11.47%**
Total	**61**	**100.00%**

B. A Theoretical Framework

The framework comprises of one latent exogenous construct SDP Adapt (SDP Adaptation), and six dependent variable of Climate, Energy & Water (CEW), Environment & Ecology (CEE), Community Planning & Design (CPD), Transportation & Connectivity (TRC), Building & Resources (BDR) and Business & Innovation (BSI) (Figure2).

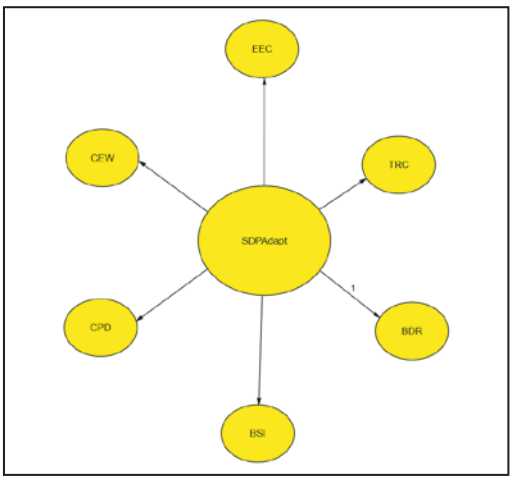

Fig. 1. The Theoritical Framework of Study

All endogenous variables is assessed by means of an interval scale which vary between from 1 (Very Low Adaptation) to 5 (Very High Adaptation) with the given SDP adaptation statement of GBI-TAC. Hence, the measurement of model for every exogenous construct is rather simplified. For this model of SDP Adaptation, the study could assess the CFA measurement within one model for all constructs to achieve the respective thresholds for validity and reliability [15.16, 17 & 18]. Thus, this model of SDP Adaptation study decided to conduct all-in a single CFA procedure for all exogenous construct. As stated by Awang [15], Awang et al. [16] and Kashif et al. [17 & 18], prior to model the CFA, the study prerequisites to verify that all constructs in the theoretical model are discriminant of each other or it's are not highly correlated particularly amongst the exogenous constructs. If there are two or more exogenous constructs are highly correlated (above 0.85), then it will resultant of a significant problem called Multicollinearity.

Table 2: The three categories of model fit and their level of acceptance.

Name of category	Name of index	Level of acceptance
Absolute Fit Index	RMSEA	RMSEA < 0.08
	GFI	GFI > 0.90
Incremental Fit Index	AGFI	AGFI > 0.90
	CFI	CFI > 0.90
	TLI	TLI > 0.90
	NFI	NFI > 0.90
Parsimonious Fit Index	Chisq/df	Chi-Square/ df < 3.0

IV. Findings & Discussions

A. Reliability Analysis

The Stakeholders-Inclusion Approach model of SDP Adaptation construct consists of six exogenous constructs named as CEW, CEE, CPD, TRC, BDR and BSI (Figure 3). Each exogenous constructs is measured using three (3) endogenous variables of SDP adaptation in the questionnaire which were Environment Dimension (EnP), Social Dimension (SoP) and Economic Dimension (EcP) (Figure 3).

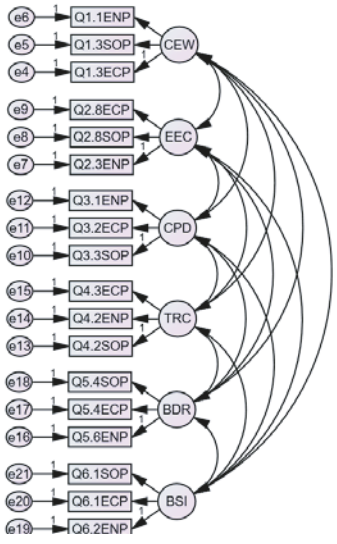

Figure1: The exogenous constructs and endogenous variables of SDP adaptation.

This study employed internal consistency approach to assess the reliability using Cronbach's Alpha correlation-coefficient for evaluating internal consistency [19]. It is commonly agreed that a standard Cronbach's Alpha is 0.70 or higher, however in the exploratory research study Cronbach's Alpha value can be lower up to 0.60 [19].

Considering the importance of SDP and its adaptation in relationship with GBI-TAC, a single latent construct (SDP Adaptations) was generated with these six most influence criteria factors as its endogenous variables. SDP Adaptations construct acted as the dependent variable. Each exogenous construct comprises of question items to which the respondents would denote based on a 5-scale point that suggest the extent to their conformity or disconformity with each given assertion (Table 3).

Table 1: Measurement of the Variables of the Hypothesized Model.

Construct	Item	Survey Dimension	Mean	SD	Alpha
CEW (Climate, Energy & Water)	Q1.1ENP	Environment	3.868	0.884	0.610
	Q1.3SOP	Social	2.950	0.938	
	Q1.3ECP	Economic	3.623	0.915	
CEE (Environment & Ecology)	Q2.3ENP	Environment	3.803	1.029	0.792
	Q2.8SOP	Social	3.590	1.054	
	Q2.8ECP	Economic	3.688	1.041	
CPD (Community Planning & Design)	Q3.1ENP	Environment	3.967	0.930	0.808
	Q3.3SOP	Social	3.852	1.030	
	Q3.2ECP	Economic	3.688	0.922	
TRC (Transportation & Connectivity)	Q4.2ENP	Environment	3.442	1.057	0.884
	Q4.2SOP	Social	3.803	1.137	
	Q4.3ECP	Economic	3.655	1.093	
BDR (Building & Resources)	Q5.6ENP	Environment	3.819	1.008	0.788
	Q5.4SOP	Social	3.311	1.103	
	Q5.4ECP	Economic	3.754	1.059	
BSI (Business & Innovation)	Q6.2ENP	Environment	3.344	1.030	0.751
	Q6.1SOP	Social	3.459	0.905	
	Q6.1ECP	Economic	3.786	0.933	

B. Full Measurement of CFA

CFA is applied to assess all the construct via the overall measurement path model as shown in Figure 3 prior to full model measurement, the exogenous constructs (dependent variables) and their endogenous variables (independent variables) were selected corresponding to its underlying study theories. The factors denote exogenous constructs, and the supporting study questions denote their endogenous variables. Table 2 specifies the detail breakdown of CFA measurement of the listed constructs and variables. In executing the full CFA model measurement, firstly, the appropriateness of fit for every measure was assessed in order to equate how adequate the model describes the data rationally. In this study, Chi-square (χ^2), RMSEA (Root Mean Square Error of Approximation) TLI

(Tucker Lewis Index) and CFI (Comparative Fit Index) are applied to decide whether the model is acceptable. Measures of full CFA model fit indices employed in this Phase 2 study and its acceptance level are described in Table 6.

Secondly, the estimated path model outcomes are assessed to identify transgressing estimates. This is referring to the results signs and the statistical significance of overall study estimated parameters, which are the regression weights, the standardized regression weights and the probability value (*P*-value). For instance, the standardized regression weights are examined in order to value the relative significance of the measures. The suggested standardized loading factor estimates supposed to be at 0.5 value or above, and preferably at 0.7 value or higher value [19]. Figures of probability value (*P*-value) specifies statistical significance of the co-efficient grounded on the study hypotheses. Proviso that the *P*-value is at 0.05 or lesser, the study co-efficient are significant (Figure 4). .

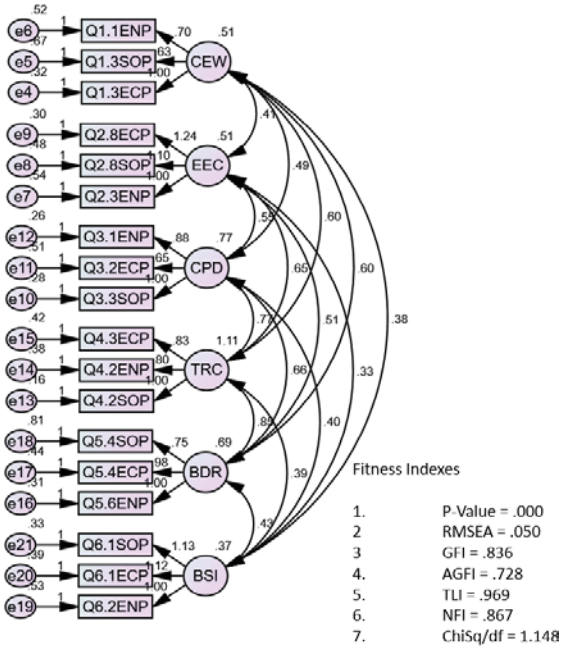

Figure 4: Study output resulted from the Confirmatory Factor Analysis (CFA) procedure.

Table 6: Parameter Estimates of Full Measurement Model.

Construct &Variables			(a)Unstd	(b)Std	S.E.	C.R.	*P*
Q1.3ECP	<---	CEW	1.000	.780			
Q1.3SOP	<---	CEW	.593	.459	.167	3.546	***
Q1.1ENP	<---	CEW	.727	.596	.158	4.597	***
Q2.3ENP	<---	EEC	1.000	.643			
Q2.8SOP	<---	EEC	1.291	.784	.237	5.454	***
Q2.8ECP	<---	EEC	1.427	.885	.230	6.195	***
Q3.3SOP	<---	CPD	1.000	.867			
Q3.2ECP	<---	CPD	.643	.625	.114	5.631	***
Q3.1ENP	<---	CPD	.849	.836	.101	8.379	***
Q4.2SOP	<---	TRC	1.000	.926			
Q4.2ENP	<---	TRC	.828	.832	.087	9.497	***
Q4.3ECP	<---	TRC	.855	.808	.092	9.283	***
Q5.6ENP	<---	BDR	1.000	.797			
Q5.4ECP	<---	BDR	.964	.733	.135	7.151	***
Q5.4SOP	<---	BDR	.774	.567	.155	4.988	***
Q6.2ENP	<---	BSI	1.000	.632			
Q6.1ECP	<---	BSI	1.168	.755	.228	5.113	***
Q6.1SOP	<---	BSI	1.140	.745	.228	5.007	***

C. The Overall Measurement of CFA

The overall measurement of parameter estimates are shown in Table 6. The CFA model generated the overall data (relative Chi-square = 1.148; RMSEA = 0.050; TLI = 0.969) which satisfied their critical outscores. The values of GFI (0.836), AGFI (0.728) and NFI (0.867) are acceptable for a satisfactory model although these are slightly less than the suggested condition level of 0.90 (Hair, 2010). Thus, the model justifies that the data were ideally well represented as most of the indices yield acceptable values of standardized loading estimates.

1) Climate, Energy & Water (CEW)

The *P*-values for all specific parameter estimates of CEW are statistically very significant value at 0.001 (***) level, signifying that the paths model created from the construct to all three variables are accepted. The standardized regression weights of the construct and variables are range in-between 0.459 to 0.750. The relationship between construct to Q1.3ECP (Economic Dimension) indicated an ideally significant value as indicated by Hair (2010), where the regression weights generated are above than 0.7. It is distinctly indicated that Economic Dimension is significant and highly adapted in the CEW core-criteria among the other two SDP adaptations of GBI-TAC. Nevertheless, the correlation concerning construct to Q1.3SOP (Social Dimension) and Q1.1ENP (Environment Dimension) denoted less significant but closed to the considerable level indicated by Hair (2010). These variables concerned CEW sub-criteria of GBI-TAC which includes heat island design principles, efficient streetscape & greenspace lighting, on site energy generation, renewable energy, reduction in waste water and reduced water use.

2) Environment & Ecology (CEE)

CEE sub-criteria of GBI-TAC regards to augment biodiversity reserve, land reuse, ecology, flood management & avoidance, wetland & water body conservation, agricultural land preserve, hill slope development, sustainable storm water design & management, proximity to existing infrastructure services, services infrastructure provision and light pollution. The *P*-values of all specific individual parameter estimates for CEE Construct are statistically significant at 0.001 (***) value, representing that all three variables of the construct paths are accepted. The regression weights of the construct between the variables are range from 0.643 to 0.885 which is within the ideally significant level with two from three variables generated values higher than 0.7. Common understanding for CEE core-criteria for SDP adaptation is that Environment Dimension should has the highest adaptation, however, from the standardized loading estimates of CEE Construct, the Economic Dimension and Social Dimension portrays a substantial function in dealing with pre-occupancy assessment criteria (GBI-TAC). EEC --> Q2.8ECP and EEC--> Q2.8SOP signify the correlation between CEE Construct and the Economic and Social Dimension adaptation. The economic and

social factors plays a major role in enhancing sustainable neighborhood in respect to the surrounding environment and native ecological systems as these Economic and Social Dimension variables generated above fulfilled regression weight score. Thus, as accordance to measurement concerned, the correlations between CEE Construct and its variables are significant and accepted.

3) Community Planning & Design (CPD)

The *P*-values of all specific individual parameter estimates for CPD Construct are statistically significant at 0.001 (***) value. The hypothesized model paths shows significant correlation, thus hypotheses of variables are all supported. For all variables of CEE Construct, the relationship co-efficient are yielding from 0.625 to 0.867 in standardized regression weight, which on standard are ideally significant. Two from three variables generated the loading estimates above 0.7 value which are ideal regression weight (Hair, 2010). The two variables are Q3.3SOP (0.867) and Q3.1ENP (0.836) which related to Social Dimension and Environment Dimension in pre-occupancy CPD core-criteria of GBI-TAC. The only variables which is below 0.7 loading estimates is Q3.2ECP (0.625) which is Economic Dimension concerned. All these variables are to represent SDP adaptations in GBI-TAC which are planned and designed for the advantage of the reside community. CPD are initiated using an integrated approach of master planning and best practice in urban design values by emphasizing user-centered and greenspaces. The CPD pre-occupancy assessment criteria concerns greenspaces, compact development, amenities for communities, provision for universal accessibility, secure design, health in design, recycling facilities, community diversity, affordable housing, community thrust and governance.

4) Transportation & Connectivity (TRC)

The *P*-values for all specific individual parameter estimates intend for TRC Construct are statistically significant at 0.001 (***) value, suggesting that all model paths from the construct to all three variables are accepted. The standardized loading estimates of the construct yielding from 0.808 to 0.926 which are idyllically significant, whereby all three variables generating loading estimates beyond than accepted value of 0.7. The variables included with the construct consist of the SDP adaptations in TRC core-criteria of GBI-TAC. The Sustainable Township/Neighborhood are well-connected places that have a broad range of transportation options, excellent accessibility, connectivity and are well linked to surrounding districts. The TRC pre-occupancy assessment sub-criteria includes green transport masterplan, availability and frequency of public transport, facilities for public transportation, pedestrian networks, cycling networks and alternative transport options. The importance of TRC as one of the influential pre-occupancy assessment factors can be seen when all the generated loading estimates is above acceptance level and probability values is significant. The results thus supported all the hypotheses.

5) Building & Resources (BDR)

The *P*-values of all specific individual parameter estimates for BDR Construct are statistically significant at 0.001 (***) value, implying that the model paths from construct to all three variables are significant. The standardized loading estimates of the three construct shown the value ranging from 0.567 and 0.797 which are significant even though one of the loading estimates are below 0.7 as suggest acceptance. The variables attached in the construct suggest professional stakeholders opinion on SDP adaptation on GBI-TAC which concerns low impact material (infrastructure), low impact material (building & structures), regional material, quality in construction, construction waste management, site sedimentation and pollution control, sustainable construction practice and GBI certified building. Based on standardized loading estimates, the highest significant level is Environment Dimension which mean high adaptation and followed by Economic Dimension and lastly Social Dimension. BDR core-criteria of Sustainable Township/Neighborhood imply a lower impact on resources – by applying the 'more from less' principle, emphasize the need to minimize the use of highly resource intensive materials by using a life cycle approach and it's also make effective use of local materials and resources for the construction of new communities.

6) Business & Innovation (BSI)

The *P*-values for all specific individual parameter estimates for BSI Construct are statistically significant at 0.001 (***) value, signifying that the model paths from construct to all three variables are accepted. The standardized loading estimates of the construct indicated the value ranging from 0.632 to 0.755 which are significant though one of the loading estimates are lower than 0.7. Two from three variables generated the loading estimates above 0.7 value which are ideal regression weight (Hair, 2010). The two variables are Q6.1SOP (0.745) and Q6.1ECP (0.755) which is Social Dimension and Economic Dimension respectively in pre-occupancy CPD core-criteria of GBI-TAC. The only variables which is below 0.7 loading estimates is Q6.2ENP (0.632) which is Environment Dimension concerned. The BSI core-criteria in GBI-TAC for Sustainable Township/Neighborhood are tailored to respond to local needs in creating business and employment whilst incorporating innovative solutions. It's also to provide employment opportunities for its residents to work closer to their homes, provide avenues for businesses to form and flourish, and demonstrate best practices through the implementation of innovative technologies and solutions at many different levels of the township.

V. Conclusions

The generated outcome result of full model yielded value were statistically highly significant at 0.001 (***) value and statistically significant at ≤ 0.05 value. Thus, the hypothesized paths of the full structured model for the study show significant correlation implying that all hypotheses are supported. The standardized (b) loading estimates for CEW suggested that Economic Dimension (ECP) yields the highest significant value, indicating that SDP Adaptations in this dimension is of

importance or highly adapted. The loading estimates from Phase 2 indicated that Economic Dimension is highly adapted or most significant in SDP Adaptations. The overall outcomes for EEC construct imply that it is within the loading values level that suggest considerable SDP Adaptations in pre-occupancy GBI-TAC. All specific path co-efficient of the causal CEE full structure model are statistically significant at 0.001 (***) values, the parameter estimates of the hypothesized full structured model are also exempted from offending statistical values including the SDP Adapt ---> CEE path, therefore this hypotheses is supported. For CPD Construct, **t**he regression weight values vary among the designated sustainable dimension indicating that SDP adaptation differ in relative advantage as for the case of CPD core-criteria, Social Dimension and Environment Dimension appears to be the significant factor that brings the CPD assessment core-criteria towards an enhanced sustainable neighborhood development. The standardized average outcomes indicated that TRC has the slightly lower loading factor and satisfactory level of acceptance within the overall pre-occupancy assessment evaluation core-criteria of GBI-TAC. For BDR Construct standardized loading estimates, the results imply that high SDP Adaptations in Environment Dimension and Economic Dimension in pre-occupancy assessment criteria of GBI-TAC while least adaptation and consideration for Social Dimension. Lastly, is the Business & Innovation (BSI) generated outcomes, the standardized loading estimates yielded for BSI indicated Economic Dimension and Social Dimension is highly adapted or most significant in SDP Adaptations while less significant in Environment Dimension. To conclude, there are SDP adaptation gaps in GBI-TAC. Hence, to achieve a balanced SDP adaptations towards a more holistic sustainable development, these gaps need to be addressed in the future GBI-TAC review and refinement.

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