

Sustainable dimension adaptation measure in green township assessment criteria

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Abstract. Urbanized areas are typically the most significant sources of environmental degradation, thus, an urban assessment criteria tools aiming at equally adapted sustainability dimensions need to be firmly embedded in benchmarking planning and design framework and upon occupancy. The need for integral systematic rating is recognized in order to evaluate the performance of sustainable neighborhood and to promote sustainable urban development. In this study, Green Building Index Township Assessment Criteria (GBI-TAC) will be measure on holistic sustainable dimension pillar (SDP) adaptation in order to assess and redefine the current sustainability assessment criteria for future sustainable neighborhood development (SND). The objective of the research is to find-out whether the current GBI-TAC and its variables fulfilled the holistic SDP adaptations towards sustainable neighborhood development in Malaysia. The stakeholder-inclusion approached is used in this research in order to gather professional's stakeholders' opinions regarding the SDP adaptations for sustainable neighborhood development. The data were analysed using IBM SPSS AMOS22 Structural Equation Modelling. The findings suggested an adaptation gap of SDP in current GBI-TAC even though all core-criteria supported SDP adaptation, hence lead to further review and refinement for future Neighborhood Assessment Criteria in Malaysia.

1. Introduction

The magnitude of sustainable development in the built environment sector, particularly in urban vicinities was established for quite a long time [1]. Urban development plays an important function in pursuing sustainability via socio-economic growth and technological innovation [2]. Sustainable development at urban level suggest a well-balanced and broader specific requirement of its inhabitant which include earnings equity, job opportunities, accommodation, basic amenities, public infrastructure, accessibility connectivity and also protection to the environment [3]. Sustainable environment can be achieved at different steps and level in the urban development from the inside out of the interiors and the buildings, neighborhood/township and cities. Neighborhood are the areas and systems of cities, made up by their own built environment, social context and financial dynamics [4]. Neighborhood are perimeter to a specifically-defined boundary, and a communal acquaintance exists between their occupants [5]. To enhance neighborhood/township sustainability, an understanding of its buildings, communal spaces, public infrastructure [6], the promotion of a managing principles [7], and collaboration amid its components is essential.

Sustainable evaluation criteria comprise of indicators acquired from literature review. Several analyses on evaluation indicators suggest the intent designations and characteristic [8][9], development means of a recent indicator categorizes [10][11][12][13][14], indicator significances threshold [13] and indicators framework [15]. Presently, due to the availability of many rating method approaches, it is rather challenging for stakeholders to actually assess which one has the most general application. Diverse sets of requirement, significances threshold, physical factors and locale guidelines renders distinction. Currently,



sustainable city development growth are mainly encouraged by governmental institution through relevant agendas, strategies, outlines, policies, plans, programs and incentives [16]. On the other hand, collaboration by third party establishment such as building industry related professional body and institutions efforts, the development of urban sustainability evaluation systems which are driven by market approach has achieved significance and has been progressively implemented by commissioners and developers of development projects.

The constraint for complete systematic evaluation systems is established in order to assess the implementation of sustainable conurbation and to encourage the overall sustainable urban growth. However, the current available sustainability assessment criteria systems is normally based on low carbon city framework (LCCF), the future of sustainable township development should be beyond the current LCCF; not only heavily weighted on reducing carbon related issues but towards a well-balanced sustainable pillars which addressed thoroughly economic pillar, environment pillar and social pillar. In this study the GBI-TAC is measured and then to address the missing gap of SDP adaptation in the current sustainability assessment criteria systems, it is a way forward and towards future sustainable urban development in Malaysia. Thus, the need for integral measure in SDP adaptation is important in measuring the certified sustainable neighborhood for continuing sustainable agenda aiming at professional stakeholders which act as sustainable input implementers in sustainable development. The Green Township Assessment Criteria targeted at developers may serve as sustainable label in obtaining green development status, but the real measure on SDP adaptations lies on professional stakeholders, key actors in implementing this guideline..

2. Research background

2.1 Sustainable Neighborhood Assessment Criteria

Sustainable township/neighborhood assessment criteria is an instrument that assesses the sustainable functions of designated neighborhood versus sets of benchmarking criteria [17]. There are two categories of urban sustainability evaluation approaches;

- The embedded decision making instrument into township scale development such as EcoDistricts, EcoDistricts Performance and Assessment Toolkit, Ecocity, HQE2R, One Planet Living, SCR, SPeAR, Cascadia Scorecard; and,
- The present third-party developed sustainable evaluation approaches and systems such as BREEAM Communities, LEED-ND, CASBEE, ECC, Qatar Sustainability Assessment System, (QSAS) Neighborhoods, Green Star Communities, Green Neighborhood Index (GNI), Green Mark for Districts, and GBI Township.

These sustainable township/neighborhood assessment criteria are typically developed by a building's related professional institute (normally not a government agency) or an independent third party institution. The common aims of third-party sustainable township/neighborhood assessment criteria are driven by: (1) an objective and environmentally-aware system in cooperation with market participants, without limiting the freedom of built environment design, (2) the mitigation of the impacts of development on the environment, (3) creation of a sustainable, (4) responsible local community etc. [18][19][20].

2.2. GBI Township Assessment Criteria In Malaysia

GBI Township Assessment Criteria were established by Malaysia Institute of Architects (PAM) and Association of Consulting Engineers Malaysia (ACEM) intended for Malaysia's primary sustainable urban rating instrument which progressively will be updated and reviewed towards sustainable future. This joint initiative between Malaysia Institute of Architects (PAM) and Association of Consulting Engineers Malaysia (ACEM) in green building indexing aims to support the construction development industry with regard to its sustainable development progression. GBI Township Assessment Criteria environmental rating approach is established to:

- Distinguish sustainable township criteria by instituting a generic nomenclatures and standard evaluations;
- Promote integration, holistic design; acknowledge and remunerate environmental leadership effort;
- regenerate built environment by reducing the environmental vulnerability of the development; and
- Ensure that the development of new township continues to play a key role in the near future while rejuvenating existing township development.

Sustainable township rating criteria are perceived as a guidelines in assisting urban planners, architects, engineers, builders, building owners, government agencies, housing developers and finally the end users in understanding the effect of each design project option and problem-solution with regard to being a more sustainable- responsive. The Malaysian indexing in green building was established to deliver a generic and verifiable means in sustainable benchmarking within the building industry of local context. GBI-TAC and its designed framework sets sustainability to additional level and lay out a vision for coherent approach in built environment paradigm. Its provide direction that will support all involved stakeholders in delivering sustainable urban developments.

2.3. Study Statements

Over the years, the Malaysian construction and development sector has emerged and thrived in the direction of a more progressive sustainable urban agenda. The subject of sustainable neighborhood/township benchmarking approach in the field of urban development in Malaysia is relatively new. Although GBI-TAC has been developed and implemented but there is no measure being conducted in assessing the SDP adaptations in its variables? There has been lack of study done to measure the greenness of the tools. Even though there are studies conducted on the dimension of environment, few are about what the social and economic values of environment, and/or its application in the sustainable urban development context. Do sustainable neighborhood or township evaluation criteria and frameworks in common signify sustainable holistically? [21]. Proficiency and comprehension on urban sustainability benchmarking criteria among the Malaysian sustainable urban development actors are vastly still low. Studies have indicated one of the main obstacles that hinder sustainable township/neighborhood development in ASEAN nations is the deficiency of knowledge in sustainable concerns subjects in relation to the involved building profession [22].

Past studies conducted on sustainable building rating system potential in Malaysia also show that key stakeholders in Malaysia's construction and development sector have insufficient understanding on sustainability development evaluation, benchmarking & indexing approach [23]. Due to this, many green certified urban development project in Malaysia claim sustainability merely for label advertisement, marketing tools and higher premiums instead of fully addressing the sustainable pillars. Certified GBI township projects normally a high-end urban development projects, study has indicated that sustainable certification do improve leasing and selling rate of developed properties, but this outcome is further substantial for end-users who are more innately concerned with sustainability, or pushing their 'green' appearance [21]. Even though the noble foundation for sustainable township/neighborhood is to promote and applied sustainable development, but there is no study was undertaken to address and gauge this issues. Thus, embark the problem of the research: whether the existing GBI Township Assessment Criteria fulfilled the SDP adaptation level according to holistic dimensions Pillars of Sustainability.

3. Research methodology

3.1. Stakeholders-Inclusion Approach

This research applies the Stakeholders-Inclusion Approach to deliver opinions concerning SDP dimensions of existing green township assessment. Therefore, Stakeholders-Inclusion Approach is appropriate and adopted for this research. For Stakeholders-Inclusion Approach opinion on SDP Adaptation, it constitutes a team of policy-makers and urban development professionals in accordance of their intellectual merit, rank in the order for decision-making and their competency or experience in sustainable urban development field. The conventional surveys methods experience richness in issues, meanwhile in Stakeholders-Inclusion Approach expert's surveys will basically supply richer feedback data, that is due to numerous iterations and responses, where the experts participating in Stakeholders-Inclusion Approach are positive towards additional enquiries for further elaborations [24]. The term 'stakeholders' in this study are basically an individuals or representatives from sustainable building industry related institutions or professionals such as urban planners, architects, engineers, designers, builders, manufacturers and academicians. These stakeholders are key players in implementing GBI Township Assessment Criteria whether directly or indirectly involved in sustainable urban neighborhood development in Malaysia. The respondents of Stakeholders Surveys is listed mainly from list of participants of sustainable workshops and continuing professional development programs conducted by Malaysian Green Building Confederation and other professional building related profession in Malaysia.

The Stakeholders 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 Stakeholder Surveys was disseminated to the listed respondents with a target of 50 returned response. The returned response in this phase is analyzed using IBM-SPSS AMOS 22 statistical software package.

3.2. Research Process

The research is about conducting comprehensive studies on current GBI township assessment criteria versus sustainability pillar dimension (SPD) aspects within urban development project. This study will look on adaptation of a well-balanced sustainability pillar dimension (SPD) which addresses economic, environment, and social impacts/aspect and loading factors. The research process includes content analysis, professional's stakeholder survey, SDP adaptation measure using Structural Equation Modeling analysis and finally derived to findings and discussions of the study (Figure 1).

4. Results & discussions

4.1. Full Structural Model of SEM

A full structural model is the element of the general path model that commends the relationship between a proposed set of unobserved latent variables [25][26]. In distinction with the measurement model (CFA), the full structural model (SEM) concerned of how the specific constructs (SDP Adapt factors) affect the latent construct (SDP Adapt) grounded on the underlying study theory.

The analyses of SDP adaptations in pre-occupancy sustainable township/neighborhood assessment criteria (GBI-TAC) are based on professional stakeholder's opinion in the Klang Valley/Greater KL. Since sustainable township/neighborhood is relatively new in Malaysia, most of the development and pool of professionals who implemented this sustainable guidelines are concentrated in this center region. Furthermore, the only available case studies of certified sustainable neighborhood development which was certified using GBI-TAC and occupied for more than one year is in the Klang Valley/Greater KL. Given there are six constructs to be analyzed, the analysis of structural equation models are particularly suited for this intention as it is to compare and distinct the outcomes in capturing the actual endogenous variables that affect the exogenous dependent variable. The SEM path model is applied to Stakeholders-Inclusion Approach – Professional Stakeholder Surveys set data. The fit indexes results reported in this SEM analysis are *P*-value, RMSEA, GFI, AGFI, TLI, NFI and ChiSq/df (Table 3).

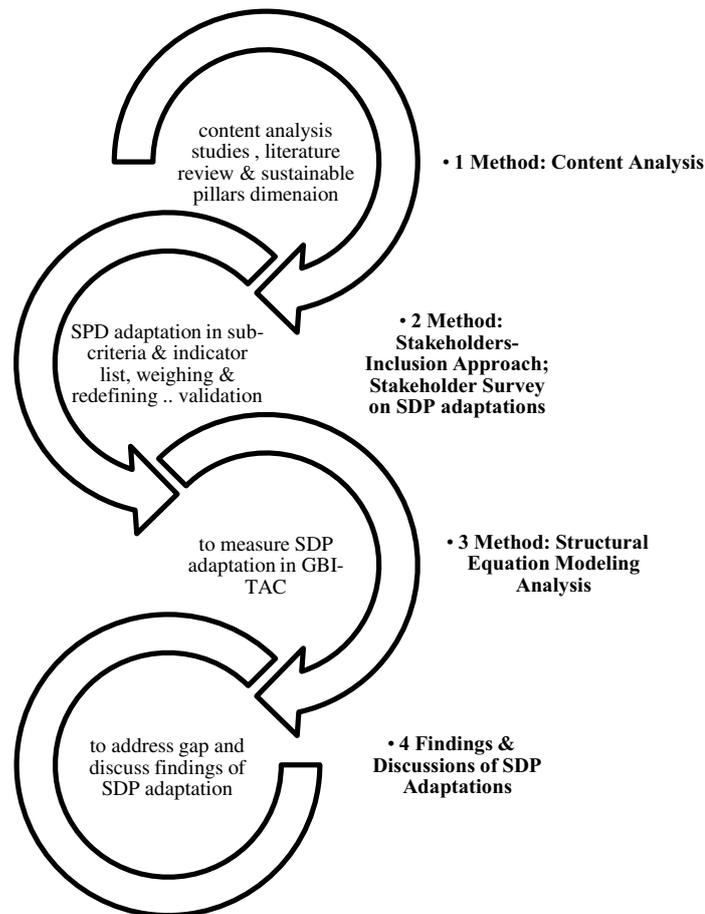


Figure 1. Final deliverables of mix method research process

The analysis emphasizes on measuring the different dimension of SDP Adaptations and variation across the assessment core-criteria of GBI-TAC. In this context, for each sustainable dimension, there is a necessity for researcher to assess the complex relationships within the SDP Adaptations and to compare the value of constructs across the assessment core-criteria in terms of correlations. Figure 3 represents the full Structural Equation Model (SEM) for SDP Adaptation in pre-occupancy assessment criteria of GBI-TAC.

4.2 SEM Analysis Result of SDP Adaptation

The generated outcome result of full structured model yielded the P -value = .000, RMSEA = 0.042, TLI = .977 and ChiSq/df = 1.148 which highly fulfilled the threshold outcores. The other reported indexes values is GFI = .882, AGFI = .740 and NFI = .845 are tolerable for an acceptable path model even though the index values are lower than constraint level of 0.9 (GFI, AGFI and NFI) respectively and ≤ 5.0 (ChiSq/df). The full structured model describes that the data are appropriate where all the given paths coefficient (P -value) of the underlying structure were statistically highly significant at 0.001 (***) value and statistically significant at ≤ 0.05 value. Therefore, the parameter estimates of the hypothesized full structure model were free of any offending value. However, for $\text{Q4.3ENP} \leftarrow \text{TRC}$ that indicated only significant correlation between construct. The positive coefficient sign with P -value (0.042) in $\text{Q4.3ENP} \leftarrow \text{TRC}$ path is statistically significantly related. Therefore, all hypothesized paths of the full structured model show significant correlation implying that all hypotheses are supported. The positive co-efficient

sign of *P*-value at (***) or ≤ 0.05 is due to the sufficient sample size of Stakeholders-Inclusion Approach – Professional Stakeholders Surveys which covers the main center region of Klang Valley/Greater KL as a study area. A structured model profiling such as sample size affects the parameter accuracy of estimates and model fit indexes. The structure model with larger sample size can generate lower values of RMSEA index. Table 1 renders the parameter estimates of the full structural model of SDP Adaptations.

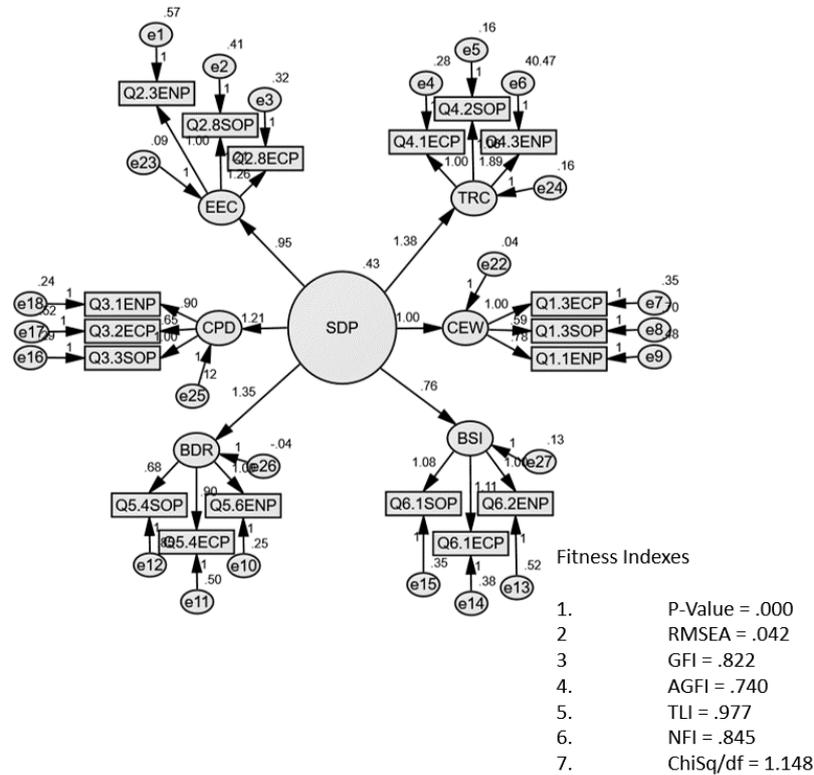


Figure 2. The standardized coefficients of Full Structural Model for SDP Adaptations

Table 1. Parameter Estimates of the Full Structural Model of SDP Adaptations in GBI-TAC

Construct & Variables	(a)Unstd	(b)Std	S.E.	C.R.	<i>P</i>
TRC <--- SDP	1.458	.931	.239	6.109	***
EEC <--- SDP	1.003	.938	.209	4.809	***
CEW <--- SDP	1.000	.863			
CPD <--- SDP	1.225	.905	.213	5.759	***
BDR <--- SDP	1.365	1.019	.214	6.376	***
BSI <--- SDP	.798	.860	.185	4.317	***
Q2.3ENP <--- EEC	1.000	.664			
Q2.8SOP <--- EEC	1.271	.810	.225	5.648	***
Q2.8ECP <--- EEC	1.328	.874	.215	6.176	***
Q4.1ECP <--- TRC	1.000	.886			
Q4.2SOP <--- TRC	1.054	.932	.095	11.044	***
Q4.3ENP <--- TRC	1.756	.263	.864	2.031	.042
Q1.3ECP <--- CEW	1.000	.799			
Q1.3SOP <--- CEW	.560	.441	.172	3.258	.001
Q1.1ENP <--- CEW	.745	.624	.161	4.627	***
Q5.6ENP <--- BDR	1.000	.851			

Construct & Variables	(a)Unstd	(b)Std	S.E.	C.R.	P
Q5.4ECP <--- BDR	.942	.755	.130	7.244	***
Q5.4SOP <--- BDR	.720	.558	.148	4.874	***
Q6.2ENP <--- BSI	1.000	.637			
Q6.1ECP <--- BSI	1.149	.739	.238	4.832	***
Q6.1SOP <--- BSI	1.099	.726	.233	4.710	***
Q3.3SOP <--- CPD	1.000	.845			
Q3.2ECP <--- CPD	.657	.618	.123	5.358	***
Q3.1ENP <--- CPD	.866	.822	.112	7.758	***

Source: This Research

Note:

- (a) Estimated unstandardized regression coefficients
- (b) Standard error of estimated unstandardized coefficient.
- (c) Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. The symbol *** indicates that the null hypothesis is rejected at the .001 level of significance.

4.3 Climate, Energy & Water (CEW)

The standardized (b) loading estimates of the endogenous construct (observed) yielded for Climate, Energy & Water (CEW) are as presented in Table 1. Economic Dimension (ECP) yields the highest significant value at .799 indicating that SDP Adaptations in this dimension is of importance or highly adapted. This is followed by Environment Dimension (ENP) with significant value at .624 and Social Dimension (SOP) with significant value at .441. CEW pre-occupancy assessment sub-criteria of GBI-TAC concerns heat island design principles, efficient streetscape & greenspace lighting, on site energy generation, renewable energy, reduction in waste water and reduced water use. Even though the CEW assessment sub-criteria seems to incline to Environment Dimension, however, the loading estimates from Stakeholders-Inclusion Approach – Professional Stakeholder Surveys full structured SEM modeling indicating Economic Dimension is highly adapted or most significant in SDP Adaptations.

4.4 Environment & Ecology (CEE)

Overall, the outcomes imply that EEC is within the loading values level that suggest considerable SDP Adaptations in pre-occupancy GBI-TAC. Two out of three observable endogenous constructs yielded above significant loading value of regression weight. The full structured model standardized loading estimates for Economic Dimension (Q2.8ECP) is highly significant at .874 value, followed by Social Dimension (Q2.8SOP) which is also highly significant at .810 value and lastly the Environment Dimension (Q2.3ENP) which is less significant at .664 value. The SDP Adaptations in EEC sub-criteria of GBI-TAC concerns with the preservation of biodiversity reserve, land reuse strategy, ecology availability, flood management & avoidance, wetland & water body conservation, agricultural land preserve, hill slope development principles, sustainable storm water design & management, proximity to existing infrastructure services, services infrastructure provision and light pollution control. The less significant outcome in Environment Dimension is due to lacking implementation of sustainable management and provision efforts of Environment & Ecology assessment sub-criteria in most of township/neighborhood development projects in Klang Valley/Greater KL.

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. The less significant values yielded reveal that the Environment Dimension for pre-occupancy EEC assessment core-criteria of GBI-TAC sustainable projects implementation need improvement to further support the sustainable township/neighborhood development growth parallel with the nation's sustainable development agendas.

4.5. Community Planning & Design (CPD)

For CPD Construct, two out of three standardized loading estimates is above 0.7 significant level as suggested by Hair (2010) [27]. The Social Dimension (Q3.3SOP) obtained high significant value at .845 and Environment Dimension (Q3.1ENP) also yielded high significant value at .822. Only Economic Dimension (Q3.2ECP) generated less significant value but closed to acceptance level at 0.7 where the standardized loading estimates values is at .657. This outcomes suggest high SDP Adaptations in Social Dimension and Environment Dimension in pre-occupancy assessment criteria of GBI-TAC while least adaptation and consideration for Economic Dimension. Averagely, CPD Construct yielded at .774 value for standardized loading estimates which signifies significant.

The 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 less significant regression weight value yielded for Economic Dimension shows that this dimension need improvement in SDP Adaptations to support sustainable growth and minimizing the CPD assessment core-criteria sustainable adaptation gap. This is due to lack of consideration in SDP Adaptations and implementation of Economic Dimension related factors in CPD pre-occupancy assessment sub-criteria which 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.

4.6. Transportation & Connectivity (TRC)

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. The standardized loading estimates for Environment Dimension is at .263 value, hence, insignificant or has the lowest consideration in SDP Adaptation. However, the standardized loading estimates yielded for Social Dimension and Economic Dimension is highly significant where the estimates value at .932 (Q4.2SOP) and .889 (Q4.1ECP) respectively. On average, TRC construct standardized loading estimates yielded .693 value which indicates just significant or slightly below 0.7 value suggested for acceptance level by Hair (2010)[27].

Pre-occupancy assessment sub-criteria of TRC construct concerns assessment sub-criteria that includes green transport masterplan, availability and frequency of public transport, facilities for public transportation, pedestrian networks, cycling networks and alternative transport options. The low standardized loading estimates for Environment Dimension is due to poor implementation of sustainable transportation masterplan and public transportation management and facilities. Another reason is due to minimum application of non-vehicular network systems and alternative options in the certified neighborhood development. Hence, the insignificant values yielded reveal that Environment Dimension is highly less adapted in SDP Adaptations of TRC construct. Its needs improvement in this dimension to better facilitate and support the sustainable growth of township/neighborhood development and its pre-occupancy assessment criteria and certification.

4.7. Building & Resources (BDR)

For BDR Construct standardized loading estimates, two sustainable dimension standardized loading estimates are above 0.7 significant level as suggested by Hair (2010). The Environment Dimension (Q5.6ENP) obtained high significant value at .851 and Economic Dimension (Q5.4ECP) also yielded high significant value at .755. Economic Dimension (Q5.4SOP) generated less significant value but closed to acceptance level at 0.7 where the standardized loading estimates values is at .558. This results imply 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. Averagely, BDR Construct yielded at .721 value for standardized loading estimates which denotes significant.

The variation of regression weight values within the defined sustainable dimension representing SDP adaptation priority concerns for BDR pre-occupancy assessment core-criteria. Environment Dimension and Economic Dimension shows the priority rank significant factor of the BDR assessment core-criteria in sustainable neighborhood development. The less significant regression weight value yielded for Social Dimension shows that this dimension least considered in SDP Adaptations in BDR pre-occupancy assessment criteria. This is due to less involvement or public participation through Social Dimension related factors in BDR pre-occupancy assessment sub-criteria which concerns low impact material (building & infrastructure), regional material, quality in construction, construction waste management, site sedimentation and pollution control, sustainable construction practice and GBI certified building. The low standardized loading estimates for Social Dimension is due to indirect relationship of social participation in the implementation of sustainable construction management and practice. Another reason is due to minimum application of low impact material and regional material during the development stage. Thus, the less significant values yielded reveal that Social Dimension is less adapted in SDP Adaptations of BDR construct.

4.8. Business & Innovation (BSI)

Lastly, is the Business & Innovation (BSI) generated outcomes. Economic Dimension (ECP) yields the highest significant value at .739 (Q6.1ECP) indicating that SDP Adaptations in this dimension is of importance or highly adapted. This is followed by Social Dimension (SOP) with significant value at .624 (Q6.1SOP) and Environment Dimension (ENP) with significant value at .637 (Q6.2ENP). BSI has the least pre-occupancy assessment sub-criteria of GBI-TAC. The assessment sub-criteria of BSI concerns on business, innovation and GBI Facilitator. BSI assessment sub-criteria inclined to Economic Dimension and Social Dimension, hence, the loading estimates from Stakeholders-Inclusion Approach – Professional Stakeholder Surveys full structured SEM modeling indicating these two Dimension is highly adapted or most significant in SDP Adaptations while less significant in Environment Dimension.

The less significant regression weight value yielded for Environment Dimension shows that this dimension need improvement in SDP Adaptations to support sustainable development growth and minimizing the BSI assessment core-criteria Environment Dimension adaptation gap. The lack of consideration in SDP Adaptations and implementation of Environment Dimension related factors in BSI pre-occupancy assessment sub-criteria should be improved in particular the innovation sub-criteria where there is an avenue for this dimension further enhancement.

4.9. Summary of Full Structural Equation Model

Following the full structural model discussed above, and the hypotheses formulated as the base of the model, the following table summarized the hypothesized model in terms of its P-value. All path coefficients of the causal structure were statistically significant when the P-value indicated less than 0.001 (***), showing that the hypotheses are all supported. Table 2 presents the hypotheses results formulated for Phase 2 full structural model.

Table 2. Summary of Hypotheses

Hypothesis	Hypothesis Path	P-value	Results
Hypothesis 1:	SDP Adapt --> CEW	***	Supported
Hypothesis 2:	SDP Adapt --> EEC	***	Supported
Hypothesis 3:	SDP Adapt --> CPD	***	Supported
Hypothesis 4:	SDP Adapt --> TRC	***	Supported
Hypothesis 5:	SDP Adapt --> BDR	***	Supported
Hypothesis 6:	SDP Adapt --> BSI	***	Supported

5. Conclusion

The Stakeholders-Inclusion Approach view on SDP Adaptations data were analyzed using IBM SPSS Amos 22. The generated outcome result of full structured model yielded value is as shown in Table 3 below. The full structured model of SEM analyses describes the data are appropriate where all the given paths co-efficient (*P*-value) of the underlying structure were statistically highly significant at 0.001 (***) value and statistically significant at ≤ 0.05 value. Thus, hypothesized paths of the full structured model for SDP Adaptations study show significant correlation implying that all hypotheses are supported.

Table 3. The SDP Adaptations model fit and their level of acceptance

Study Area	Name of index	Yielded Value	Level of acceptance
SDP-Adapt	RMSEA	0.042	RMSEA < 0.08
	GFI	0.882	GFI > 0.90
	AGFI	0.740	AGFI > 0.90
	CFI	0.982	CFI > 0.90
	TLI	0.977	TLI > 0.90
	NFI	0.845	NFI > 0.90
	ChiSq/df	1.148	Chi-Square/ df < 3.0

For Stakeholders-Inclusion Approach – Professional Stakeholder Surveys full structured SEM modelling, six constructs are tested. 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, the 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 from Phase 2 full structured SEM modelling indicating Economic Dimension and Social Dimension is highly adapted or most significant in SDP Adaptations while less significant in Environment Dimension.

Table 4. Summary of Hypotheses for SDP-Adapt. Study

Study Area	Hypothesis	Hypothesis Path	P-value	Results
SDP-Adapt	Hypothesis 1:	SDP Adapt --> CEW	***	Supported
	Hypothesis 2:	SDP Adapt --> EEC	***	Supported
	Hypothesis 3:	SDP Adapt --> CPD	***	Supported
	Hypothesis 4:	SDP Adapt --> TRC	***	Supported
	Hypothesis 5:	SDP Adapt --> BDR	***	Supported
	Hypothesis 6:	SDP Adapt --> BSI	***	Supported

Following the full structural model of SDP Adaptations study and as discussed in previous sub-sections, and the hypotheses formulated as the base of the model, the following table summarized the hypothesized models in terms of its P-value. Table 4 presents all path coefficients of the causal structure were statistically significant when the P-value indicated less than 0.001 (***), showing that all the hypotheses are all supported. However, to conclude, there should be an improvement in environmental dimension for CEW, CEE, TRC core criteria; economic dimension for CPD core criteria; and social dimension in BDR core criteria for further review and refinement of GBI-TAC in the near future.

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