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Determining the Prevailing Effects among Public Space Utilization Factors in Science Cities: A Study in Cyberjaya, Malaysia

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Abstract: The aim of this study is to develop an understanding on the contributing influences that occur among qualities of public space, public space aesthetics, the comfort derived in public space and public space accessibility in science cities. This study seeks to investigate the extent at which public space attributes impact on one another. The emphasis accruing to open greenery including public spaces in the physical development of science cities necessitates the selection of Cyberjaya Malaysia as the study area. Survey questionnaires were used to investigate potential respondent's perceptions on public space utilization and the feedback was validated with SEM (structural equation modelling). The findings indicated that the accessibility attributes significantly influenced other public space utilization attributes while good quality of public space influenced the comfort derived from it. Attractiveness of public space was found not capable to predict the comfort and good quality of public space.

Key words: Public space, science city, physical development, utilization, relationship.

1. Introduction

The significance of public space dated back to the ancient Greek and Rome periods [1]. Its relationship with people has attracted high interest especially in the 1990s [2, 3] while the rapid urbanization experience in urban cities offered new research insights in public development among the built environmentalist. Public spaces are those spaces that are publicly accessible such as parks, squares, streets and communal spaces [4-6]. Great cities are known for their successful public spaces [7, 8]. Public spaces in the context of this study are those open public spaces that are publicly accessible without undue restriction.

The contribution of public space has broadly been acknowledged in city planning [9-11] and human development [12]. For instance, the authority of England Planning Policy Guidance 17 stipulated that all local authorities must carry out the audit of existing public spaces taking into consideration its utilization potential [6]. Likewise, Western Australia has taken a step to approve 10% of the new housing development area of land for public spaces [13].

Importantly, the enrichment of public space in cities' physical environment is remarkable in science city as manifested in Silicon Valley, United State of America, Tsukuba Japan, and Cyberjaya Malaysia [14]. These authors equally asserted that most of the buildings in Tsukuba Japan has its physical environment incorporated with about 40% of green spaces that encompassed pedestrian and streets while Cyberjaya Malaysia is having over 30% of its physical environment occupied by open greener and public spaces. The Federal Town Planning Department Malaysia [15] has posited that relationship of man and the environment can be recognised from the Landscape Master Plan for Cyberjaya and its structured greenery and public spaces [16]. It is a science city that upholds its concept in attaining knowledge-based development goal. However, Ergazakis [17] and Carrillo [18] both

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defined science city as a technological city that is geared towards achieving knowledge-based development. Carrillo [18] stressed that science city often encompasses the intermix of industrial and academic research experts. Public spaces in Cyberjaya comprise of the following three categories: (1) the mini public space such as communal spaces, neighbourhood courtyards, pedestrian way and space between buildings; (2) the medium public spaces such as public square, urban courtyards and centres; (3) the extended public spaces such as public parks and recreational centres.

Therefore, celebrating the roles of public spaces without studying the in-depth interface of its utilization influencing attributes may retard its maximisation for human and environmental development. It is vital to understand the existing influencing relationship of public space utilization factors that determine user's satisfaction. This study focuses on public space in Cyberjaya. As a technological city, it is endowed in abundance public spaces with high knowledgeable residents as its users. It has been forestalled that public space utilisation predicts its satisfaction [11]. It reflects public space usage and patronage satisfaction. The satisfaction derived in utilization of public space rally around its attributes of comfort, quality, aesthetics and accessibility of public space. Accessibility has been emphasised as important in determining public space utilization [1] while Whyte and Talen [19] consider accessibility as primary among factors that determine public space utilisation. The measuring attributes of public space are hinged on the usage satisfactory level of the users. Researchers posit that accessibility to public space [13, 20, 21], attractiveness potential of public space [13], quality of public space [20, 22], and comfort derived from public space [23] significantly influence its utilisation.

This study considers comfort, attractiveness, good quality and accessibility as measuring constructs for public space utilisation. As such, the influencing relationships among the four constructs are investigated to determine the prevailing possessions within the constructs as a clue to clear cut understanding of developing an effective public space.

2. Site Background

Cyberjaya is judged as a modern science city that constitutes the multimedia super corridor center in Malaysia. The conception of Cyberjaya city is commenced out of a study by management consultancy McKinsey for the multimedia super corridor and commissioned by the Federal Government of Malaysia in 1995 [15]. The city is located in Sepang, Selangor and about 50 km south of Kuala Lumpur city in Malaysia. Cyberjaya occupied an area of about 28.94 square kilometers with population of about 45,000 that comprises of 19,000 workforces, 16,000 students and 10,000 residences [16].

3. Definition of Measuring Constructs and Hypotheses

3.1 Accessibility

Lau and Chiu defined accessibility as the freedom of man to meet the basic needs for the actualisation of desirable quality of living. Accessibility of public space is an important factor in the design and planning of public spaces. The spatial pattern of public space and its accessibility influence the people's choice [24, 25] while proximity and dispersion in public space can be measured by its degree of accessibility [19, 26]. Accessibility entails its proximity and the likely social barrier in visiting a public space. Thus, location of public space is an important factor in its planning. On the visual and physical dimensions, the connectivity of public space to the built environment can be used to determine its accessibility. Pasaugullari and Doratli [22], and Erkip [27] asserted that utilisation of public space will not be visible if its location is far from the users. The comfort, attractiveness and quality of public space can only be observed and acknowledged when it is accessed. Therefore, the following hypotheses are formulated (Figs. 1 and 2):

H1a: Accessibility to public space positively influences its degree of attractiveness.

H1b: There exists an interrelationship between accessibility to public space and public space attractiveness.

H2a: Accessibility to public space positively influences the comfort derived from it.

H2b: There exists an interrelationship between accessibility to public space and comfort derived from public space.

3.2 Quality of Public Space

Quality of public space surrounds the degree of the facilities and amenities provided coupled with the standard of upkeep. Maintenance of public space facilities and amenities influence its quality [28]. The size and nature of activities occupied in public space are related to its user judgement of quality [39, 30]. Similarly, the security and safety available in public space influence the quality attached to it. Good quality public spaces enhance the quality of living in the urban environment [31]. Good quality facilities and amenities attract users and invariably facilitate its accessibility. Thus, it was hypothesized (see Figs. 1 and 2) that:

H3a: Accessibility to public space positively influences its quality.

H3b: There exists an interrelationship between accessibility to public space and public space quality.

3.3 Comfort in Public Space

Comfort has been suggested to be part of the prerequisite for a successful public space [5]. The comfort derived from public space can be considered as an integrative dimension of natural experience in an urban setting that assured intimacy and sense of protection. Greenery and features like water body and urban amenities have become an interesting theme in today's public space research. Amenities such as streets, posts and lighting; landscape such as greenery, water body and sculptures; facilities as in safety aids and convenience form the basis to predetermine the user's comfort in public spaces [32, 33]. High standard public space facilities and amenities contributed to comfort derived in public space [28]. Hence, comfort is derived from well instituted public space physical features [4]. Such features lie in degree of good quality, maintenance and attractiveness of public space. Therefore, it was hypothesized (see Figs. 1 and 2) that:

H4a: Comfort derived from public space positively influences its attractiveness.

H4b: There exists an interrelationship between comfort derived from public space and public space attractiveness.

H5a: Comfort derived from public space positively determines its quality.

H5b: There exists an interrelationship between comfort derived from public space and public space quality.

3.4 Public Space Attractiveness

Public space attractiveness is reflected in its physical environment which denotes its aesthetics. Attractiveness is the perception of the physical judgment of things by individual as being aesthetically pleasing. In this context, it encompasses every aspect of public space that has the potential of attracting the attention of people. Public space attractive feature includes its landscape and fittings [20, 34, 35]. A good physical setting of public space constitutes its aesthetics and attractiveness [13]. Proper maintenance of public space facilities and amenities for better outlook determines its beauty and attractiveness. As such, public space attractiveness reflects it quality. Hence the following hypotheses were proposed (see Figs. 1 and 2):

H6a: Public space attractiveness positively influences its quality.

H6b: There exists an interrelationship between public space attractiveness and public space quality.

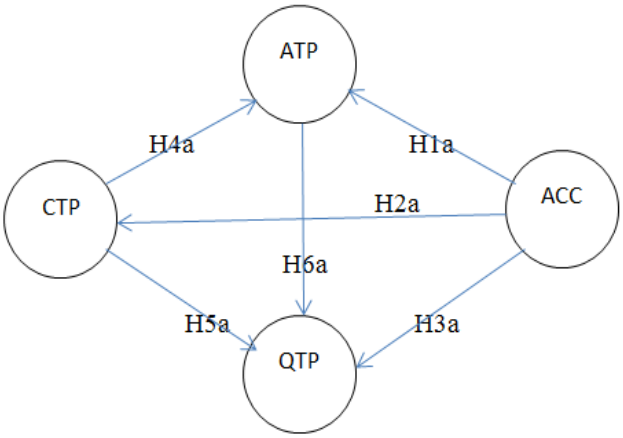

Fig. 1 Research theoretical model.
Comfort = CTP, Quality = QLP, Accessibility = ACC, Attractiveness = ATP.

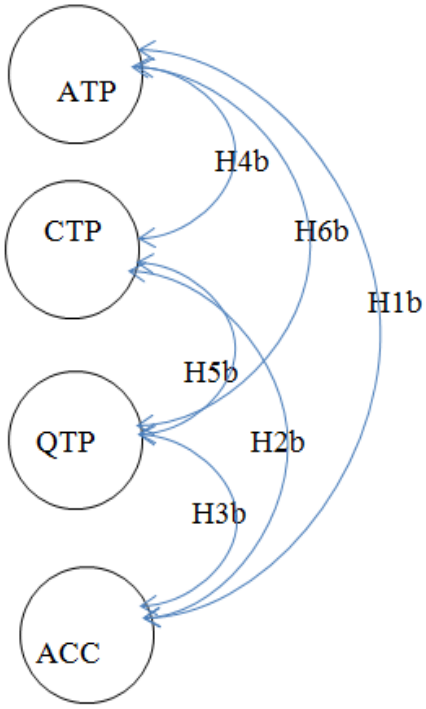

Fig. 2 Research theoretical model.
Comfort = CTP, Quality = QLP, Accessibility = ACC, Attractiveness = ATP.

4. Methodology and Measures

A total of 450 sets of questionnaires were randomly distributed to be administered on residents in Cyberjaya Malaysia. However, 211 questionnaires were successfully completed, which translates to 46.9% of the response rate. The usable questionnaires returned represented a response of 46.9% of the respondent rate. In this study, all constructs were measured with multiple items. Thus, the indicators that were used to operationalize the constructs were mainly adopted from literature as they affect public space utilisation and are carefully modified for use. The indicators for each construct were measured using a five-point Likert-scale that ranges from 5 for strongly agree to 1 for strongly disagree. The influencing potentials of public space utilisation constructs in the science city were depicted in the research model (Figs. 1 and 2). Hence, the approach measurement for this research model is explained as follows. Accessibility to public space was measured by using three items. Two items were adopted from Erkip [27]: traveling time and proximity, while one other item was modified from Whyte [36] that emphasized on public space which is easy of connection to users' surrounding. This factor was related to the degree of possible barrier to access public space. Four-item scale was used to measure public space attractiveness which comprises landscape, maintenance, aesthetics and form. Landscape item was adopted from Gobster [23] and Giles-Corti et al. [13]. Maintenance and aesthetics were adopted from Pasaugullari and Doratli [22] and public space form was modified from Wu and Plantinga [8]. Three items used to measure comfort were safety, physical features and size. Safety was adopted from Erkip [27] while two items, public space physical features and size, were modified from Ward-Thompson [29] and Low et al. [30] as the authors suggested that public space comfort judgment is visible using its physical features and size. Public space quality was measured using three items derived from Pasaugullari and Doratli [22] which focused on the perception of quality judgment of public space on its facilities, amenities and human activities. In summary, a total of 13 items were used for this model.

Table 1 Respondents profile (n = 211).

Measure	Items	Frequency	Percent (%)
Gender	Male	132	62.6
	Female	79	37.4
Residents status	Yes	154	73
	No	57	27
Duration of residents	0-3 years	66	31.3
	4-6 years	36	17.1
	7-9 years	88	41.7
	10 years and above	21	10.0
Educational status	High school or equivalent	4	1.9
	Undergraduate	29	13.7
	Graduate	136	64.5
	Postgraduate degree	42	19.9
Evidence of public space usage	Yes	199	94.3
	No	12	5.7
Types of public space visited	Neighbourhoods courtyard/communal spaces	119	56.4
	Public square/urban clusters	43	20.4
	Public parks	27	12.8
	Others (bus/stop, canopy, etc.)	22	10.4

The demographical factors of age, sex, education, gender, working status, duration of residents, evidence of public space usage and types of public space visited were used to investigate their impact on the subject matter as illustrated in Table 1. Seventy three percent (73%) of the responds are residents in science city and they show good interest as they account for 94.3% of total respondents. The majority of public space users in Cyberjaya exhibited high level of literacy as 64.5% were holders of university degree or equivalent while 19.9% were postgraduate degree holders as reflected in Table 1.

5. Data Analysis and Results

SEM (structural equation modelling) was applied to analyse the collected data to validate the research model based on its potential to test casual interfaces between latent variables of multiple indicators [37]. The measuring indicators were examined using confirmatory factor analysis and test for validation [37, 38] in line with the two-stage process for using SEM. Internal consistence reliability which is a treatment for uni-dimensionality was accessed by Cronbach's Alpha. Alpha values results ranged from 0.849 to 0.900 and above the acceptable threshold of 0.70 suggested by Nunnally and Bernstein [39]. The level of multiple attempts to measure the same concept in agreement (convergent validity) was assessed based on the factor loading, composite reliabilities and variances extracted.

Table 2 presents factor loadings of indicators in the measurement model. Factor loadings for all the constructs exceeded 0.5 as the loadings range from 0.791 to 0.897 at significant level of p = 0.002. The measurement for the proposed model demonstrated an adequate convergent, reliability and discriminant validity. The two models (Figs. 3 and 4) exhibited the same measurements. As presented in Table 4, the observed normed χ^2/df for the measurement model was 1.622 (χ^2 = 95.701; df = 59) which indicates a strong fit value [40].

The GFI (goodness fit of index) was 0.937 and the CFI (comparative index fit) was 0.977 while the adjusted CFI was 0.904 all of which exceeded the recommended value of $\geq$ 0.9 for strong fit [40]. The RMSEA (root mean square error of approximation) was 0.054 which also indicates strong fit. Therefore, the combination of the analysis output implies that the measurement model exhibited a very good level of

model fit. Hence, the measuring model is fit to explain this research hypothesis. Table 3 demonstrates outstanding effects of accessibility on other public space utilization factors.

Having presented the measuring model fit, the result of the goodness fit as reflected in Table 4 suggests strong acceptable degree of model fit and provides support to the validity and structural model. The practically significant path was depicted by bold lines while the insignificant path is depicted by thin lines (see Figs. 3 and 4). Paths coefficient of ≥ 0.2 was considered practically significant [40-42]. In Fig. 2, the H1 result indicates that accessibility to public space (ACC) was found to positively influence public space attractiveness

Table 2 Confirmatory analysis model result.

Measure	Measure items	Standardized estimate	*t*-value	Cronbach's alpha
Accessibility				
Travelling time	Acc1			0.849
Proximity	Acc2	0.811	11.859	
Barriers	Acc3	0.824	12.014	
Attractiveness				
Maintenance	Atp1	0.813		0.894
Landscape	Atp2	0.788	12.513	
Aesthetics	Atp3	0.855	13.863	
Forms	Atp4	0.841	13.594	
Quality				
Facilities	Qtp1	0.815		0.854
Amenities	Qtp2	0.816	12.042	
Human Activities	Qtp3	0.809	11.969	
Comfort				
Safety	Ctp1	0.897		0.900
Physical features	Ctp2	0.841	15.757	
Size	Ctp3	0.858	16.238	

Comfort = CTP, Quality = QLP, Accessibility = ACC, Attractiveness = ATP.

Table 3 Significant effects of accessibility on other measured constructs.

Construct	ACC		
	Direct effect	Indirect effect	Total effect
CPT	0.64	-	0.64
QTP	0.38	0.14	0.52
ATP	0.28	-0.03	0.25

$p \leq 0.002$.

Table 4 Overall model fit indices.

Measures	Fit index	Scores	Recommended value	Literature
Absolute fit measures	χ^2/df	1.622	$\leq 2^{xx}, \leq 3^{x}, \leq 5^{x}$	Browne & Cudeck [43] Chau& Hu [44]
	GFI	0.937	$\geq 0.9^{xx}, \geq 0.80^{x}$	
	RMSEA	0.054	$\leq 0.05^{xx}, \leq 0.08^{x}$	
Incremental fit measure	NFI	0.970	$\geq 0.90^{xx}$	Browne & Cudeck [43]
	AGFI	0.904	$\geq 0.90^{xx}, \geq 0.80^{x}$	
	CFI	0.977	$\geq 0.90^{xx}$	
Parsimonious fit measure	PCFI	0.739	Higher score prefer	Chow & Chan [45]
	PNFI	0.713		

Acceptability: Acceptable: ^{xx}, marginal: ^{x}.

$p \leq 0.002$ level.

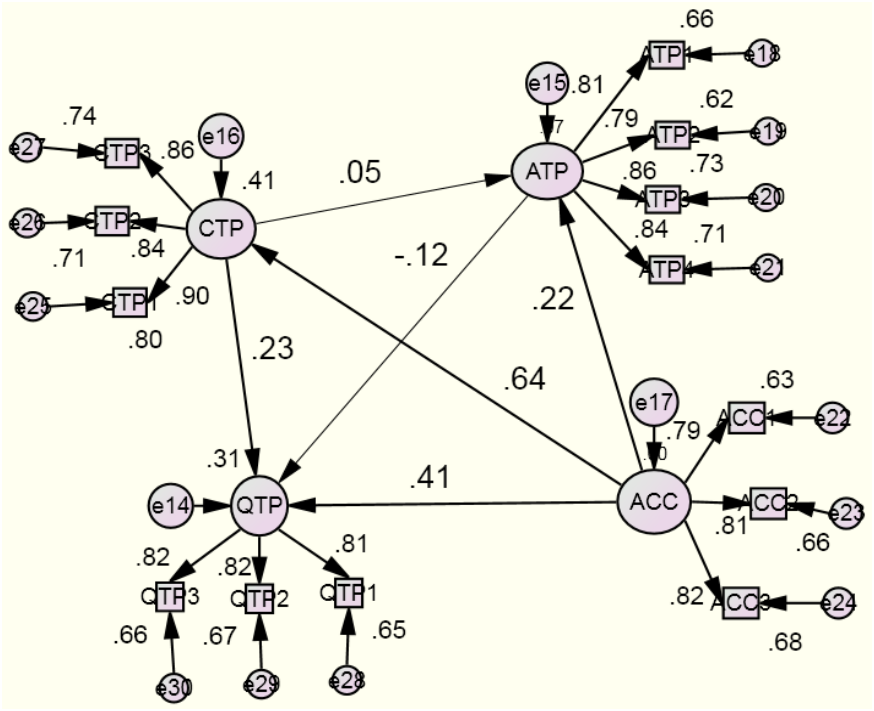

Fig. 3 Results of AMOS regression analysis.
Comfort = CTP, Quality = QLP, Accessibility = ACC, Attractiveness = ATP.

(ATP) with 0.22 path coefficient. H2 indicated that accessibility to public space (ACC) positively influences comfort derived in public space (CTP) having 0.64 path coefficient that signified strong influence (Fig. 3).

The H3 implies that accessibility to public space (ACC) has positive influence on the quality of public space (QTP) with 0.41 path loading while H4 reflects that comfort derived in public space (CTP) cannot positively influence public space attractiveness (ATP) as it exhibited lower path coefficient of 0.05 (Fig. 3). The results of H5 showed that comfort derived in public space (CTP) can determine public space quality (QTP) having path loading of 0.23. Finally, public space attractiveness (ATP) was found not to positively influence public space quality (QTP) as it demonstrated negative contribution having -0.12 (Fig. 3). In Fig. 4, the model analysis result reflect that accessibility (ACC) and comfort derived in public space (CTP) enjoyed strong relationship with other public space attributes having demonstrated a practically significant correlation path coefficient of approximately ≥ 0.2 with other

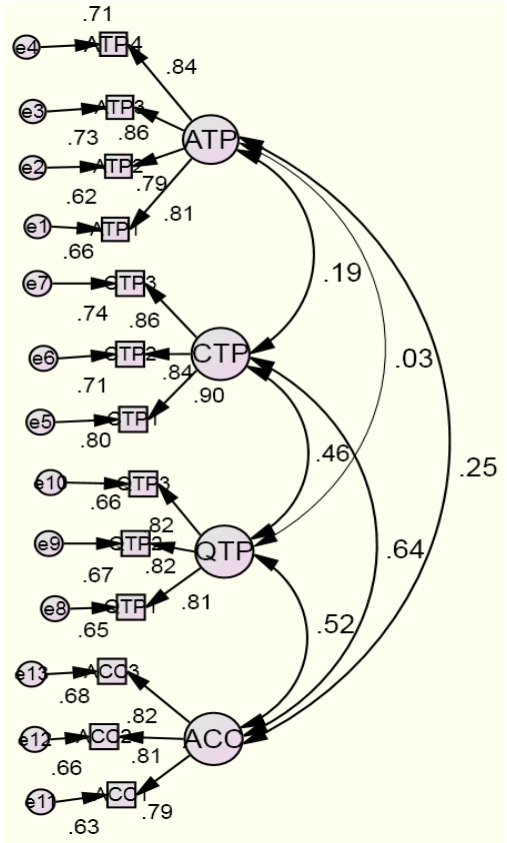

Fig. 4 Results of AMOS correlation analysis.
Comfort = CTP, Quality = QLP, Accessibility = ACC, Attractiveness = ATP.

attributes. Public space attractiveness (ATP) and quality of public space (QTP) exhibited weak correlation path coefficient relationship of 0.03 that is below the marginal and acceptable significant level [41, 42].

6. Discussion and Implications

This study proposed theoretical research model for empirical studies to link public space utilization attributes. The aim is to develop an understanding on the influence of accessibility, quality, attractiveness and comfort derived in public space on each other in their contribution to its utilization.

Reviewing the weights across all dimensions (Tables 5 and 6), the findings revealed that accessibility to public space has positive influence in determining the attractiveness of public space. It equally has influencing potentials on the quality of public space and the comforts derived in it. Therefore, this research outputs strongly support previous literature [13] that suggested accessibility as an attribute that contributed higher to public space utilization. In addition, Whyte [36] posits that accessibility remains primary in determining public space utilization and that it can help to predetermine the influencing level of other public space predicting attributes.

Considering the comfort derived in public space, it was reflected that the attractiveness of public space cannot be predicted by its comfort as the path loading is below the practically significant status of loadings in relation to attractiveness (Figs. 3 and 4). However, this factor can be justified in the context of science city physical environment that footholds to beautification and aesthetic settings [14, 17]. On this basis, it can be opined that the attractiveness factor of public space in science city has been somehow overshadowed by the beatification outlook of entire science city. Therefore, emphases are not attached to public space aesthetic as the city beauty can be experienced at every area of its physical environment. The comfort derived in public space was found to be practically significant to the quality of public space. This finding is consistent with literature that associated quality of public space facilities and amenities to the expected user's comfort [32, 45]. Meanwhile, the result strongly reflects that the possibility of attractiveness of public space to predict its quality was not visible.

It was observed from the analysis research model that only accessibility of public space can predict its attractiveness (Fig. 3). This implies that accessibility is primary among other factors that determined public space utilisation. It can therefore be suggested that for effective public space accessibility, the attractiveness and good quality attributes of the public space should be considered to trigger users' comfort and embrace higher patronage.

Table 5 Summary regression result for the model constructs.

Path	Hypothesis	Hypothesized	Path coefficient	Results
ACC→ATP	H1	Accessibility to public space will positively influence its attractiveness.	0.22	Supported
ACC→CTP	H2	Accessibility to public space will positively influence comfort derived from it.	0.64	Supported
ACC→QTP	H3	Accessibility to public space will positively influence its quality.	0.38	Supported
CTP→ATP	H4	Comfort derived in public space will influence its attractiveness.	0.09	Not supported
CTP→QTP	H5	Comfort derived in public space will positively determine its quality.	0.22	Supported
ATP→QTP	H6	Public space attractiveness will positively influence its quality.	-0.16	Not supported

Comfort = CTP, Quality = QLP, Accessibility = ACC, Attractiveness = ATP.

Table 6 Summary correlation result for the model constructs.

Path	Hypothesis	Hypothesized	Path coefficient	Results
ACC↔ATP	H1b	Accessibility to public space has significant relationship with its attractiveness.	0.25	Supported
ACC↔CTP	H2b	Accessibility to public space has significant relationship with comfort derived from it.	0.64	Supported
ACC↔QTP	H3b	Accessibility to public space has significant relationship with its quality.	0.52	Supported
CTP↔ATP	H4b	Comfort derived in public space has significant relationship with its attractiveness.	0.19	Supported
CTP↔QTP	H5b	Comfort derived in public space has significant relationship with its quality.	0.46	Supported
ATP↔QTP	H6b	Public space attractiveness has significant relationship with its quality.	0.03	Not supported

Comfort = CTP, Quality = QLP, Accessibility = ACC, Attractiveness = ATP.

7. Conclusion and Limitations

Many and validated coherent data are not readily available for public space satisfaction and utilization determination. The finding of this study is one of the maiden attempts to present empirical evidence on the interface and contributing potentials within the public space utilization measuring attributes as a precursor towards effective public space development. The study offers an insight to significance of quality, comfort, attractiveness and accessibility to public space.

Hence, understanding public space utilization attributes is crucial to cities and urban designers in enabling them to provide an effective public space in science cities and urban centres. Therefore, this study has developed understanding of the interface, associations and influences and exhibited among the tested public space utilization attributes. It presented the degree of each attribute potential impacts on another in relation to its usages. This finding fashioned a significant professional clue on the degree of necessity and types of attributes required when proposing and designing public spaces in science cities. This was supported in the analysis result model that postulates the examined public space utilization attributes as contributing factor in determining its patronages. Users need to be attracted by the beauty, features and settings in public space to develop visiting interest. As such, higher efforts should tend towards developing aesthetical and nature appealing public spaces of high quality amenities and facilities that will outstand other physical environs in the city.

Accessibility was found to have overriding impact on public space utilization. Therefore, urban designers should direct much of their expertise on the location, proximity and access barrier to free public space as to affirm the factor of its publicness. The facilities and amenities provided in public space should be of good quality to strengthening user's accessibility degree and influence the comfort derived in public space. This research was carried out in technology-oriented city. The study finding may not reflect the situation of public space in conventional cities where much emphasis may not be attached to city physical environment unlike in science cities. Future studies should look into a comparative study of public space in the conventional cities and the science cities.

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