Design toolkits for campus open spaces from post-occupancy evaluations of federal universities in South-west Nigeria

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Abstract

Purpose – Participatory design strategy through post-occupancy evaluation of built assets is a feedback mechanism into the design process. This paper draws upon a wider empirical study that aims at evaluating the University Campus Open Spaces (UCOS) of six federal universities in South-west Nigeria. The purpose of this paper is to generate evidence-based design toolkits for UCOS towards spanning of disconnects between designers and users thereby revisiting and revitalizing their design criteria.
Design/methodology/approach – A sample ($n = 3{,}016$) of users was drawn in a cross-sectional survey through stratified random method. The research instrument was a structured questionnaire in multiple choice and Likert-type scales. The data obtained were subjected to statistical techniques.
Findings – Results show that males use the UCOS for active and passive recreation than females. The UCOS are male dominated because the females have higher concerns for lack of safety and inclement weather. Both genders have equal preference for sitting. "Group academic" activities are at peak in the "afternoon", while "being alone" takes place in the "evening" and "personal academic" in the "morning". Safety is primary to zoological and botanical gardens. Social interaction spaces enhance successful recreation parks. Coherence and legibility are the highest cognitive satisfaction factors for pedestrian sidewalks.
Practical implications – The research generated design requirements for UCOS, and it is important for informing better design solutions in the future.
Originality/value – The results are synthesized into three-in-two new frameworks to guide future design actions for innovative strategies between design and use/operational phases.

Keywords University, Campus, Landscapes, Built assets, Design frameworks, Open spaces, Post-occupancy evaluation
Paper type Research paper

Introduction

Design toolkits are intellectual and conceptual frameworks for designing spaces that are human centred (Hanington and Martin, 2012). They are evidence-based set of tools for identifying design requirements and users' needs for successful architectural deliveries (Forsyth *et al.*, 2017). Design toolkits are not only essential for delivering sustainable university campuses constituted by buildings with open spaces between them; they are *sine qua non* for revamping university campus-built assets (Aydin and Ter, 2008). Campus-built assets include land and water areas that are not covered by buildings. These areas are termed University Campus Open Spaces (UCOS) in this paper. UCOS include roads, plazas, parking lots, recreation parks, natural green areas and vacant lands. The plants, structural materials and art works on UCOS are referred to as landscape elements. Assessment of UCOS can be carried out through post-occupancy evaluations (POE). POE can aid the development of toolkits as a feedback and feedforward input into the design process (Preiser, 2001).

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It is a logical procedure for the assessment of built assets from the perception of users (Syafriny and Sangkertadi, 2010).

Furthermore, POE can help designers to design better UCOS in the future by assessing the performance of existing UCOS in their operational/use phase. Designs are usually carried out by relying on quantitative technical measures and simulation instead of users' perception. Worst still, designers are generally not fully acquainted with the performance of the spaces during their use phases in different settings (Yang, 2007). This leads to repetition of design mistakes and the spaces are used in manners that are only partly envisaged (Cubukcu and Isitan, 2011), causing a disconnection between designers and users.

Therefore, this study's concern about users' perception is guided by some questions:

RQ1. How does users' status influence the use of UCOS in South-west Nigeria?

RQ2. How do use and status influence perceptions of qualities?

RQ3. What factors underpin users' satisfaction? What aspects of user satisfaction can inform design of UCOS?

To answer these questions, the research aims to evaluate the UCOS of the six federal universities in South-west Nigeria with a view to evolving design frameworks. Specifically, it identifies the status of the users and assesses their perceptions of qualities. It also analyses the relationship between status of users and their perceptions of qualities. Other objectives are determination of the factors influencing users' satisfaction and development of design frameworks for UCOS. These offer tangible proof to direct future design decisions (Cubukcu and Isitan, 2011). Therefore, the study presents benefit of the integration of design and operational phases of future built assets for the study area and beyond. It was carried out on the campuses of six federal universities in the six States of South-west Nigeria. The States are Lagos, Ogun, Ondo, Oyo, Ekiti and Osun. The study is framed within the context of this location and situated within a wider literature background on the design of UCOS.

Literature review

University Campus Open Spaces design requirements

The goal of designs should be targeted towards the need of users and not the job satisfaction of designers for their distinctiveness (Saksa, 2011). The urban nature of university campuses suggests that this goal can only be achieved through participatory modelling (Lefebvre, 1996).

There are two categories of participatory modelling: pre-construction and post-construction. Pre-construction participation is generally called participatory design. It has to do with direct contribution of end users throughout the design process (Schuler and Namioka, 1993). However, it can only be used where the end users are specific during the design phase (Naderi and Shin, 2008). The participation of users after the design phase generally falls under post-construction participatory modelling. This modelling is characteristically called POE.

Post-occupancy evaluation (POE)

POE participatory modelling involves all prime stakeholders in the delivery process of a built asset. It has been discovered to be an unsurpassed procedure in landscape decision-making processes and has adequate results (Sandker *et al.*, 2010). Preiser (2002) names three types of POE to include indicative, integrative and diagnostics. Indicative POE provides the clue of strengths and weaknesses. Investigative POE is an in-depth process that gives a rigorous consideration to the causes and effects in performance. Diagnostic POE relates physical and environmental measures with measures of personal responses of occupants to create new

knowledge about aspects of performance (Preiser, 2002). Accordingly, the approach of the present study suggests diagnosis.

POE has been engaged as a tool to assess specific physical design configurations. These configurations may be influential factors in supporting the use of campus spaces (Spooner, 2008). POE can help in the determination of activities, expectations, dissatisfactions and general experience of users in public open spaces (Malkoc and Ozkan, 2010). The experience of users can inform the formulation of design frameworks.

Design frameworks and satisfaction factors for open spaces

A number of frameworks that account for satisfaction (cognitive, social, spatial and affective) and use (purpose, period, mode and hindrance) factors abound in the literature. Few of these frameworks are most relevant to UCOS. These frameworks are identified in this section while readers can get their details in the literature. All the factors are explored in this study unlike the existing frameworks. This is required because Fornara and Troffa (2009) argue that "place experience is a complex pattern which involves affective, cognitive, social and behavioural aspects that interact with the physical features of the places" (p. 2).

Cognitive factors are environmental qualities that influence human perception and preferences (Kaplan and Kaplan, 1982; Tang *et al.*, 2015). The factors are coherence, legibility, complexity and mystery. Coherence means "environments easy to organize or structure". Legibility implies "environments suggesting they could be explored extensively without getting lost". Complexity has to do with "environments with enough in the present scene to keep one occupied". Mystery implies "environments suggesting that, if they are explored further, new information could be acquired" (Kaplan, 1992, p. 587). These factors are the four components of Kaplan and Kaplan (1982) information processing framework of space preference. However, this framework lacks other factors.

Social and use factors are components of socio-ecological framework by Sreetheran and Van Den Bosch (2014). Social factors of environmental satisfaction are socially constructed notions of place attributes that foster social interaction. They include conviviality, visual privacy and others (Thwaites and Simkins, 2006). In this socio-ecological framework, use factors include personal attributes of the user (age, gender, etc) and time (period) of use. However, it does not consider other factors. The other factors are conceptualized in this study as purpose, mode and hindrance to using spaces (Doughty and Lagerqvist, 2016).

Spatial factors are partly components of framework of urban park management (Chan *et al.*, 2015). The framework is limited to parks and gardens. The Place Diagram (Project for Public Spaces, 2000) is another framework. It is limited to socio-spatial considerations including accessibility and others. Affective factors are the components in the Russell and Lanius (1984) model of affective quality of places. The model proposes that emotional reactions to environments can be described by their relative position on unpleasant–pleasant and arousing–not arousing continua. These include beautifulness and others. However, the model lacks consideration for status of users.

Furthermore, the framework for built environment (Sandalack and Uribe, 2010) is another framework. It is a spatial framework and sets out the general character of the built environment. However, it lacks definition of users and their requirements. Also, urban design framework of Carmona *et al.* (2010) provides only spatial dimensions and underpinning concepts for the design process. The strength of socio-spatial framework for healthy campus open space design developed by Lau *et al.* (2014) shown in Figure 1 lies in its theoretical underpinning (Ulrich, 1984). It has a major flaw in its designer-oriented approach that excludes users' voice. Also, the authors acknowledge the inherent weakness of the framework by concluding that the next stage of research have to further

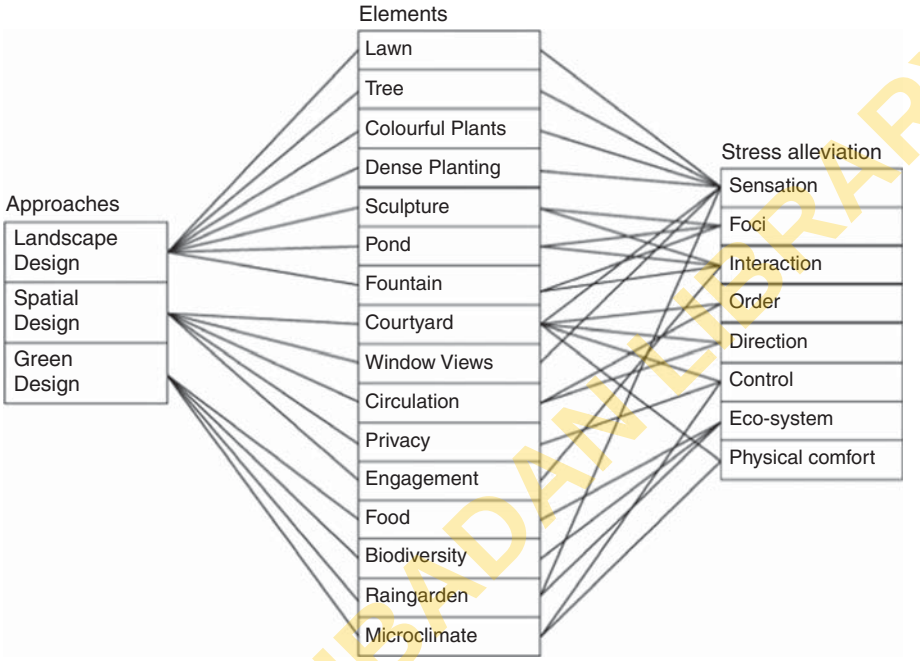


Figure 1.
Framework for healthy campus open space design

Source: Lau *et al*. (2014, p. 465)

quantitatively examine the collection of design strategies to achieve optimal use of space and create a vigorous, lively and sustainable learning, teaching and research milieu (Lau *et al.*, 2014). Despite the identified weaknesses of this framework, it provides the best approach to understanding the nature of UCOS landscape design since it was developed from a study on campus landscapes. In view of the diverse limitations of these existing frameworks, the study aims at evolving a related set of frameworks as design toolkits.

This review suggests that none of the existing frameworks in the literature includes all the factors that are crucial to understanding the performance of UCOS. Since the frameworks are also developed from different contextual settings, they are not compatible to be fed simultaneously into the design process of UCOS. This gap in the literature informs the pursuit of the present study. Each of the existing frameworks accounts for one or more of use, cognitive, social, spatial and affective satisfaction factors. These are their strengths. However, the existing frameworks are not fully user centric. Also, none of the frameworks account for all use and satisfaction factors holistically and simultaneously within the context of users' design requirements for all types of UCOS. The strengths have been integrated into the current study by including all the use and satisfaction factors in a single study in the same context of users' design requirements. It combines all the factors concurrently by aggregating the peculiar strengths of the existing frameworks thereby overcoming their weaknesses and situating them in a single research design.

Research design

The study population and geographical spread are wide. In view of this, the sample drawn is extremely large and covers campuses of six universities. For such large population, and because of the need for generalization, Nardi (2018) recommends survey design being

"less costly to reach larger samples" (p. 20). Monette *et al.* (2013) propose applied research design when there are specificity and practicality of research concerns as in this case. Chilisa and Kawulich (2012) also suggest the necessity of applied research design when the required data variables and parameters of study are based on critical realist ontology.

Data were collected on the research populations. These comprise of all the open spaces and users on the university campuses. The different groups of users involved in the survey are students, academic and non-academic members of staff. The students have high populations compared with staff members. They are mostly young and active people, both undergraduates and postgraduates, male and female. The staffs are less in population compared with the students. They are mostly middle aged and include both male and female. The coverage area within each campus was restricted to academic and administrative zones. They are the areas that are common to all the categories of users compared with residential areas. The sample size of users that was drawn from the population was determined according to Krejcie and Morgan (1970) table. The required total sample of users was 2,245.

The instrument for collecting quantitative data from the sampled users is structured questionnaire. It contained 80 close-ended questions. The questions were based on the investigation variables and parameters. This was to enable uniformity and analysis as recommended by Sreejesh *et al.* (2014). The variables and parameters were sourced from the existing frameworks in the literature. They were organized into three sections. Section 1 contains seven general information as status of users about gender (two categories), discipline (five categories), car ownership (two categories) and impairment status of users (five categories). All these are nominal scale variables. Others are age (four categories), educational status (five categories) and level, for students (six categories) and are ordinal scale variables.

Section 2 contains measurement of perceptions of qualities of 12 types of UCOS. These include zoological and botanical gardens and others. The perceptions of qualities were measured separately for each type of UCOS. The measurements were based on ordinal scale devised as 1 = poor, 2 = scanty, 3 = averagely set, 4 = well set, and 5 = excellent.

Section 3 contains the satisfaction factors in five groups. The first group is uses of the UCOS. In this group, purpose (seven categories), period (six categories), mode (five categories), and hindrances (five categories) were measured on nominal scales. The second group is four cognitive factors including coherence and others. The third group is seven social factors including conviviality and others. The fourth group is seven spatial factors including accessibility and others. The fifth group is 13 affective factors including restfulness and others. Each member of second to fifth groups was measured as ordinal scale variables. The scale was calibrated as 1 = very unsatisfactory, 2 = unsatisfactory, 3 = undecided, 4 = satisfactory and 5 = very satisfactory.

UCOS were categorized according to Stanley *et al.* (2012) in the instrument design. This categorization was partly adopted by Lau *et al.* (2014) and improved by Shakibi (2015) by adding sub-categories. Simple stratified random sampling (SSRS) technique was employed for the users. This was because each university campus readily forms stratum (Levy and Lemeshow, 2008). According to Chaudhuri and Stenger (2005), this randomization is required for generalization of results based on probability sampling theory.

Randomization was also carried out during pilot survey towards the standardization and validation of the instrument. In total, 245 (i.e. 10 per cent of sample size as recommended by Simon, 2011) copies of the instrument were administered based on SSRS technique. The instrument was statistically verified for criterion validity and internal consistency (Groves, 1987). All the items on the same scale in the instrument were correlated ($p < 0.05$) and Cronbach's α value of 0.928 the least for items on the same scale (Cohen and Swerdlik, 2010).

Copies of the standardized instrument (3,016 in number) were administered to obtain the main data. The data obtained were subjected to descriptive and inferential statistical techniques with Statistical Package for the Social Sciences 20.0 version Software. The descriptive techniques include frequencies and percentages because the variables are discrete (nominal and ordinal). Also, because of the categorical/discrete data involved, non-parametric inferential analyses were carried out. χ^2 statistic tests were carried out to test the relationships between statuses of users, use' factors and perception of quality (PoQ) of 12 types of UCOS. The goal was to test a null hypothesis that PoQ is not contingent upon use' factors. According to Kothari (2004), a null hypothesis is a statistical proposition on the relationship between two variables that can be put to a test "to determine its validity" (p. 184). The data involved in the χ^2 tests are status of users, period, purpose, mode and hindrance. Others are PoQ of zoological and botanical gardens, playgrounds and others. Where significant relationships were established in the χ^2 tests, Cramer's *V* Correlation tests were carried out as *post hoc* to determine the strength of such relationships with effect sizes. This involves the relevant data in the χ^2 tests and include gender, mode, hindrance, impairment and discipline.

Spearman's rank correlations were carried out to determine the relationships between satisfaction factors and PoQ. This is because the data involved are measured in ordinal scale. The data include satisfaction with cognitive, social and spatial factors and PoQ of 12 types of UCOS earlier mentioned. Ordinal regression analyses were carried out to estimate the impacts of satisfaction factors influencing perceptions of qualities. It involves the data for the Spearman's rank correlations. The data for these two analyses are measured in ordinal scale as required by Kothari (2004). Corder and Foreman (2014) recommend Kruskal–Wallis *H*-test to establish if there is any significant difference among variables that are based on location as nominal data. Therefore, the data involved in this test are campuses of six universities as a variable and PoQ of 12 types of UCOS in the campuses. Kruskal–Wallis *H post hoc* tests involving these data were carried out where significant differences were discovered. This was to identify where the differences lie through the value of the test statistic for each university. The results of the analyses are presented in the next section.

Results, findings and discussion

Response pattern

A total of 3,016 copies of questionnaires were administered to all the categories of respondents during the main data collection. Out of this number, 2,347 (77.82 per cent) were returned. A total of 1,759 (74.95 per cent) out of the figure returned were found suitable for analysis through data cleaning process recommended by Bohannon *et al.* (2007). This figure (1,759) represents 78.35 per cent of the calculated minimum sample size of 2,245 (100 per cent). This is within the "very good rate" of 70–85 per cent in landscape assessment face-to-face questionnaire survey research according to Milburn *et al.* (2003). This suggests that a robust response rate was achieved and results of the analyses are reliable based on the users' concerns.

Statuses of users of the campus open spaces

Statuses of the users are shown in Table I. There are more males than females. Majority are undergraduate students while few attended only Primary Schools. Most of them are in their active age bracket of 19–45years while the least are above 65 years of age. Majority does not own cars and do not have physical challenge. Those who are enrolled in the Basic/Applied/Agric Sciences are more, and those in Arts and Commercial are the least. The users represent all categories and are well acquainted with the UCOS. Therefore, their value judgements can be upheld as outcomes of experiences in the uses of the spaces.

Status variable	Categories	Frequency	Percentage
Gender	Male	1,095	62.3
	Female	664	37.7
	Total	1,759	100
Age	Below 18 years	121	6.9
	18–45 years	1,610	91.5
	46–65 years	18	1.0
	Above 65 years	10	0.6
	Total	1,759	100
Educational status	Primary School	5	0.3
	Secondary School	7	0.4
	Undergraduate	1,539	87.5
	BSc/HND/NCE	112	6.4
	PGD/MSc/Ph	96	5.5
	Total	1,759	100
Discipline	Basic/Applied Sciences	721	41.0
	Engineering and Technology	381	21.7
	Social Sciences and Humanities	288	16.4
	Arts and Commercial	169	9.6
	Environmental Sciences	198	11.3
	Total	1,759	100
Class level (Student)	100 L	333	19.0
	200 L	432	24.6
	300 L	434	24.7
	400 L	250	14.2
	500 L	175	10.0
	Postgraduate	133	7.6
	Total	1,759	100
Physical challenge	None	1,755	99.8
	Blindness	3	0.2
	Walking stick assisted	1	0.1
	Crutches assisted	–	–
	Wheel chair assisted	–	–
	Total	1,759	100
Car ownership	No	1,667	94.8
	Yes	90	5.1
	Total	1,759	100

Table I. Status of users of University Campus Open Spaces in South-west Nigeria

Uses of the campus open spaces

Results of the analyses are outcomes of experiences of users. In the results, "group academic" purpose has the highest use being 496 (31.5 per cent). This is followed by "personal meditation", 411 (26.1per cent), among others. "Passive recreation", 10 (0.6 per cent) is the least. "Afternoon (12:00 noon–4:00 p.m.)" users are the highest being 505 (32.3 per cent) and "night (8:00 p.m.–6:00 a.m.)" use, 39 (2.5 per cent) is the lowest. Majority, 541 (34.1 per cent), of the users sits in open spaces. The least, 151 (9.5 per cent), stands among other results. "Unfavourable weather", 586 (41.2 per cent), constitutes major hindrance to use of the UCOS while "lack of safety", 137 (9.6 per cent) is the least. The uses are also affected by status of users. "Passive recreation" takes place throughout all periods.

Relationships between status of users and uses of the UCOS

According to Allen (2017), apparently small values of strengths of association (effect sizes) have high implications when the sample size is large. The sample size in this study is large, being 1795. The degrees of freedom (df) are also high, varying between 5 and 30.

McGrath and Meyer (2006) propose that, for a df of 5, 0.01–0.04 is a small effect size, 0.05–0.13 is a medium effect size and 0.14–0.22 is a large effect size when the sample is large. The p-value shows how likely the association found by the effect size in the samples exists in the study (parent) population. p-value is significant at 95 per cent (0.05/0.005) or 99 per cent (0.01/0.001) confidence level. This implies that the chance that the association is due to sampling error is only 5 or 1 per cent, respectively. p-value greater than 0.05 shows that the result obtained on that parameter/variable from the sample is not true of the study population and should, therefore, be discarded as recommended by Benjamin *et al.* (2018).

In view of these statistical decision rules, results show that there is significant difference in the purpose of using the UCOS between males and females ($df = 6$, $\chi^2 = 18.051$, $p = 0.006 < 0.05$). The effect size of this difference is also high at Cramer's $V = 0.107$. The modes of pedestrian use of the spaces are significantly different between the genders ($df = 5$, $\chi^2 = 29.001$, $p = 0.000 < 0.05$) with high effect size (Cramer's $V = 0.135$). The mode of pedestrian use ($df = 10$, $\chi^2 = 101.509$, Cramer's $V = 0.179$. $p = 0.000 < 0.05$) and hindrances to use ($df = 8$, $\chi^2 = 34.591$, Cramer's $V = 0.110$. $p = 0.000 < 0.05$) are significantly different among the age groups.

Relationships between purpose and period of use

Spearman ρ correlation was carried out on the four uses' factors to understand the pattern of their relationships. "Common purpose of use" and "common period of use" are highly correlated with a coefficient of 0.936 at 95 per cent confidence level ($p = 0.000 < 0.05$). This implies that particular activities go on in each of the UCOS at peculiar times. The bar chart generated in the analysis and shown in Figure 2 explains the pattern of these relationships. It shows that "group academic" is at its peak in the "afternoon" and "group religious"

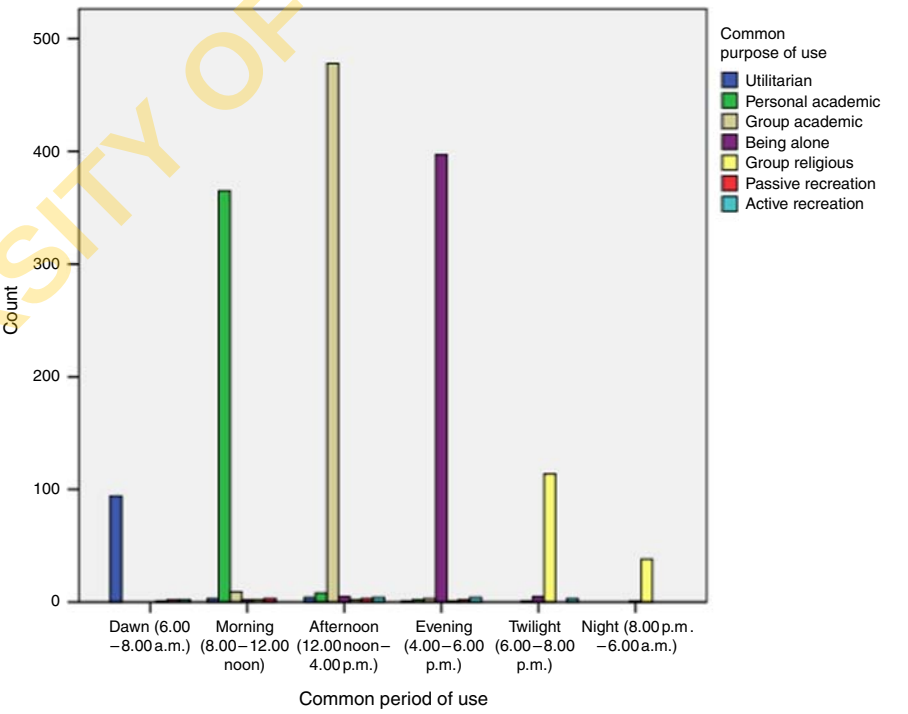


Figure 2.
Relationship between common uses and periods of use of the University Campus Open Spaces in South-west Nigeria

activities take place in the "twilight" and "night". The chart also shows that "being alone" is at its peak in the "evening" and "personal academic" in the "morning". Others are "utilitarian" in the "dawn" and "active" and "passive recreation" take place in the UCOS throughout all periods but not as pronounced like other uses.

Testing of hypothesis that perceptions of qualities are not contingent upon use' factors

χ^2 tests were carried out to investigate the null hypothesis that perceptions of qualities are not contingent upon use' factors. According to the results, hindrances to use affect the PoQ of zoological gardens ($df = 16$, $\chi^2 = 47.852$, $p = 0.000 < 0.05$). However, period ($p = 0.421 > 0.05$), purpose ($p = 0.192 > 0.05$) and mode ($p = 0.181 > 0.05$) of use do not. This result is similar to that of botanical gardens where only hindrances to use ($df = 16$, $\chi^2 = 50.839$, $p = 0.000 < 0.05$) relates with PoQ.

Furthermore, only mode of pedestrian use ($p = 0.082 > 0.05$) does not have significant impact on the PoQ of plazas/squares. Period ($df = 16$, $\chi^2 = 38.585$, $p = 0.008 < 0.05$), purpose ($df = 24$, $\chi^2 = 45.756$, $p = 0.005 < 0.05$) and hindrances ($df = 16$, $\chi^2 = 42.907$, $p = 0.000 < 0.05$) significantly affect the PoQ of plazas/squares. The general accessibility characteristic of these UCOS may suggest that perceptions of their qualities are reliant on these latter factors. For courtyards, only hindrances to use ($df = 16$, $\chi^2 = 28.050$, $p = 0.031 < 0.05$) significantly affect the PoQ. Period ($p = 0.966 > 0.05$), purpose ($p = 0.860 > 0.05$) and mode ($p = 0.748 > 0.05$) do not. Both mode of use ($df = 20$, $\chi^2 = 37.513$, $p = 0.010 < 0.05$) and hindrances ($df = 16$, $\chi^2 = 41.581$, $p = 0.000 < 0.05$) have significant impact on the PoQ of pedestrian sidewalks. For pedestrian linear corridor, only purpose has significant impact on PoQ ($df = 24$, $\chi^2 = 47.207$, $p = 0.003 < 0.05$). The PoQ of vacant lots is significantly affected by purpose ($df = 24$, $\chi^2 = 49.977$, $p = 0.001 < 0.05$), mode ($df = 20$, $\chi^2 = 34.085$, $p = 0.026 < 0.05$) and hindrance ($df = 16$, $\chi^2 = 28.585$, $p = 0.027 < 0.05$) concurrently.

Intrinsic factors influencing users' satisfaction

Cognitive factors. A Spearman's rank-order correlation was run to determine the relationship between 1759 users' satisfaction with four cognitive factors and perceptions of qualities. The strengths of correlations are measured as Spearman's ρ (r_s). The decision rules on the interpretation of ρ- and p-values are the same as earlier explained for Cramer's V.

All the results obtained indicate high correlations. The minimum ρ is 0.174 and the maximum being 0.400, majority at 0.250 upwards. Very few ρ values are at this lower band and all are significant at 99 per cent ($p < 0.000$) confidence level. For instance, the correlation results for sports pitch (complexity: $r_s = 0.355$, $p = 0.000$; coherence: $r_s = 0.333$, $p = 0.000$; legibility: $r_s = 0.324$, $p = 0.000$; and mystery: $r_s = 0.308$, $p = 0.000$, in descending order) and playgrounds (complexity: $r_s = 0.325$, $p = 0.000$; mystery: $r_s = 0.323$, $p = 0.000$; coherence: $r_s = 0.300$, $p = 0.000$; and legibility: $r_s = 0.294$, $p = 0.000$, in descending order) demonstrate the diversity of the different requirements for various field sports events and varieties of playgrounds for different games. On the whole, higher satisfaction with the cognitive factors informs higher PoQ.

Social factors. Spearman's rank-order correlation results for zoological gardens show that safety ($r_s = 0.330$, $p = 0.000$) has the highest correlation coefficient. This is followed by social interaction spaces ($r_s = 0.312$, $p = 0.000$), the least being open space for personal meditation ($r_s = 0.252$, $p = 0.000$). Among other results, recreation parks present a departure with social interaction spaces ($r_s = 0.306$, $p = 0.000$) being the highest. This is followed by open space for personal meditation ($r_s = 0.289$, $p = 0.000$) and safety ($r_s = 0.236$, $p = 0.000$) being the least. Sports pitch and playgrounds have similar results with recreation parks. Their social interaction spaces are equally significant to the satisfaction of users. Conviviality ($r_s = 0.309$, $p = 0.000$) is the second significant satisfaction factor for sports pitch and playgrounds.

Spatial factors. Six spatial satisfaction factors were investigated through Spearman's correlation. Among other results, convenience ($r_s = 0.314, p = 0.000$) has the highest coefficient and continuity ($r_s = 0.265$, $p = 0.000$) the least for zoological gardens. Invariably, zoological gardens should be designed for convenience to enhance the movement of users from one section to another. However, they are not expected to be at continuity with other UCOS at the main activity areas. Rather, they should be secluded since the proximity correlation coefficient is also low ($r_s = 0.266$, $p = 0.000$) compared with others. Among other results, correlation of spatial satisfaction factors with squares/plazas (accessibility: $r_s = 0.288$, $p = 0.000$; proximity: $r_s = 0.217$, $p = 0.000$; among others) suggests that squares/plazas require all the spatial factors but with gradient of importance for the best PoQ.

Affective factors. The correlation coefficients' results of affective satisfaction factors for zoological gardens suggest that fascinating-ability ($r_s = 0.346$, $p = 0.000$) is the most important. This is followed by pleasantness ($r_s = 0.323, p = 0.000$) while recuperative-ability ($r_s = 0.252$, $p = 0.000$) is the least. Results for botanical gardens is similar to this but beautifulness ($r_s = 0.294$, $p = 0.000$) is second to fascinating-ability as satisfaction requirement. The affective satisfaction factors that have the highest correlation coefficient for each UCOS are as follow: conservation areas, beautifulness ($r_s = 0.291$, $p = 0.000$); fascinating-ability for recreation parks ($r_s = 0.319$, $p = 0.000$), sports pitch ($r_s = 0.340$, $p = 0.000$) and playgrounds ($r_s = 0.336$, $p = 0.000$).

Influence of satisfaction factors on perceptions of quality

Ordinal regression analysis was carried out to estimate the impacts of satisfaction factors influencing perceptions of qualities. The results in the model for each UCOS indicate that as the ratings of the satisfaction factors increase, the PoQ increases. Each overall model is significant at 99 per cent confidence level as shown in Table II.

Comparison of responses among the six federal universities

Kruskal–Wallis *H* and *post hoc* tests were carried out to identify the pattern of the statistically significant differences in the responses among the six universities. A pairwise customized analysis result shows that all the UCOS are perceived to be of different qualities in most cases, except few. For instance, result shows that there was a statistically significant difference in the PoQ of zoological and botanical gardens among the universities with $\chi^2(\text{df}, 5) = 531.927, p = 0.000 < 0.05$ and $\chi^2(\text{df}, 5) = 332.577, p = 0.000 < 0.05$, respectively. *Post hoc* tests reveal that the university located in Oyo State has the best perceived zoological and botanical gardens with test statistics of 1,207.46 and 1,105.19, respectively. The two gardens are perceived to be of least qualities in the university located in Ekiti State with test statistics of 309.97 and 361.86, respectively. This confirms observations that the university located in Oyo State has the first zoological and botanical gardens in the study area.

Design frameworks for University Campus Open Spaces

The findings of the study are synthesized into three-in-two design frameworks patterned after Lau *et al.* (2014). They are integrated into the frameworks in Figures 3 and 4 by linking the variables, parameters and factors in the study discovered to be related since the study is designed as a correlation research (Kothari, 2004).

Composite use-purpose-period framework. Figure 3 shows a composite use-purpose-period framework, developed from the findings of the study. According to these outcomes shown in Component "A", the use-user' status sub-framework indicates that gender of user determines the purpose and mode of use for which design provisions should be made. Also, age classification determines outdoor furniture requirements for different modes of use.

University Campus Open Space (UCOS)	Model	Model fitting information −2 log likelihood	χ^2	df	Sig.	Pseudo R^2 Cox and Snell	Nagelkerke	McFadden
Zoological gardens	Intercept only	3,968.631						
	Final	102.613	3,866.018	245	0.000	0.949	0.992	0.950
Botanical gardens	Intercept only	4,109.654						
	Final	183.170	3,926.483	245	0.000	0.945	0.990	0.936
Conservation areas	Intercept only	3,934.261						
	Final	12.610	3,921.652	245	0.000	0.954	0.996	0.975
Recreation parks	Intercept only	2,897.989						
	Final	0.000	3,897.989	245	0.000	0.953	0.997	0.977
Sports pitch	Intercept only	3,520.057						
	Final	2,036.866	1,483.191	245	0.000	0.677	0.723	0.410
Playgrounds	Intercept only	3,824.094						
	Final	350.200	3,473.894	245	0.000	0.932	0.979	0.884
Squares/plazas	Intercept only	3,916.660						
	Final	0.000	3,916.660	245	0.000	0.953	0.997	0.979
Courtyards	Intercept only	3,575.498						
	Final	0.000	3,575.498	245	0.000	0.947	0.996	0.976
Parking	Intercept only	3,556.070						
	Final	1,689.758	1,866.312	245	0.000	0.758	0.808	0.511
Pedestrian sidewalks	Intercept only	3,734.092						
	Final	298.406	3,435.686	245	0.000	0.930	0.981	0.898
Pedestrian linear corridors	Intercept only	3,676.050						
	Final	0.000	3,676.050	245	0.000	0.950	0.996	0.975
Vacant lots/informal meeting places	Intercept only	3,897.797						
	Final	0.000	3,897.797	245	0.000	0.951	0.997	0.978

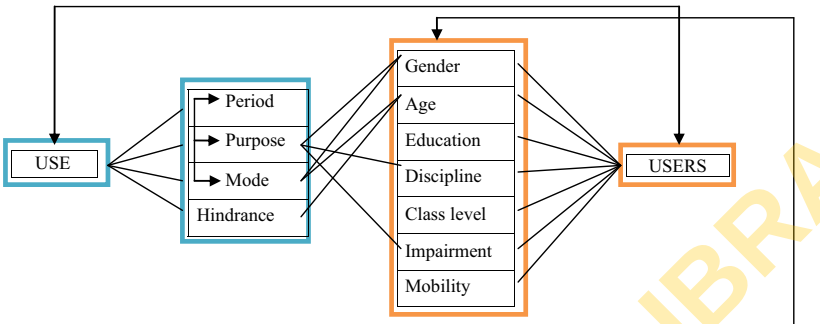
Note: Link function: Logit

Table II. Ordinal regressions of perception of quality of open spaces (dependent/outcome) and factors determining the satisfaction of the users (independent/predictors) in Federal Universities in South-west Nigeria

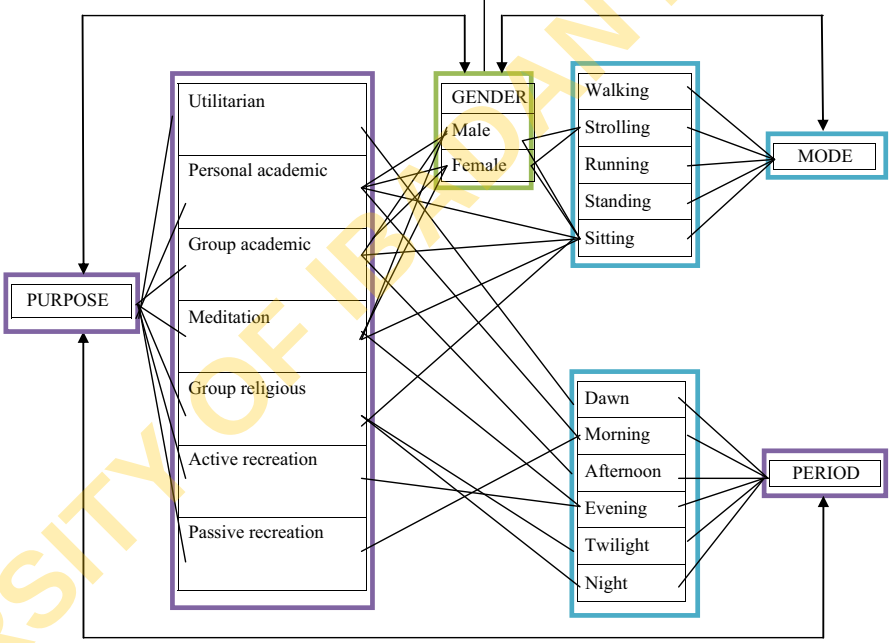
Component "B" shows the proposed purpose-period-mode sub-framework. According to the outcomes of the study, the framework indicates that personal academic, group academic, meditation/being alone and group religious use require sitting facilities for both males and females for different activities. Specifically, it stresses the requirement for group religious activities at twilight and night.

Spaces-satisfaction factors' framework. Figure 4 shows the spaces-satisfaction factors' framework. It contains 12 types of UCOS and 5 groups of satisfaction factors according to the research design. Since the research design is correlational, the UCOS that correlated with specific satisfaction factors in the outcomes are linked together. This concept is adapted from Lau *et al.* (2014). According to the outcomes of the study, the framework indicates that coherence is the most general cognitive design requirement for all the types of UCOS. Therefore, complex recreation parks can be coherent and enhance wayfinding behaviour, being legible.

Social interaction spaces are required in the design of recreation parks, sports pitch and others. Convenience of use is a major design requirement for zoological and botanical gardens, recreation parks and others. Safety concerns are crucial to the location and design of zoological and botanical gardens and conservation areas. Courtyards should be connected to indoor spaces and be made convivial by including facilities for snacks where users can also socialize. Pedestrian linear corridors require proximity, among other functional requirements. Recreation parks allow multiple uses/purposes while mode of use should be considered for conservation areas.



Component "A": Use-Users sub-framework for the design of UCOS



Component "B": Purpose-Period-Mode sub-framework for the design of UCOS

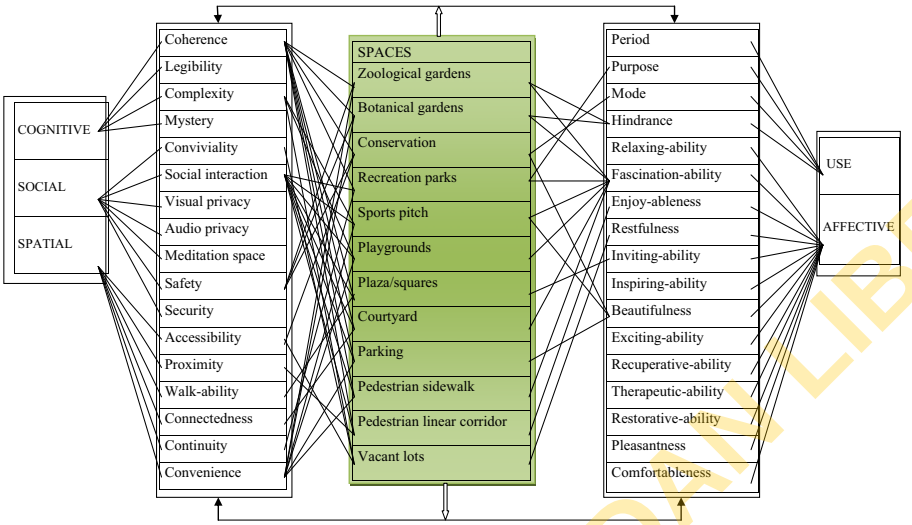
Source: Adedeji *et al.* (2017)

Figure 3.
Composite use-purpose-period framework for the design of University Campus Open Spaces

Unlike these proposed frameworks, the limitations of each of the existing frameworks show in incorporating different strands of use and satisfaction factors while lacking in others. These have been overcome in the proposed new frameworks by incorporating all the factors.

Recommendations and conclusions

The study discovers that males use the UCOS for active and passive recreation than females. The UCOS are male dominated because the females have higher concerns for lack of safety and inclement weather. Both genders have equal preference for sitting. "Group academic" is at its peak in the "afternoon" and "group religious" in the "night". The higher



Source: Adedeji *et al.* (2017)

Figure 4.
Spaces-satisfaction factors framework for the design of University Campus Open Spaces

the age and academic level of a user, the higher the required design provisions. Specific UCOS were perceived to be of better quality on each campus.

Safety is a primary satisfaction factor for zoological and botanical gardens. Social interaction spaces are central to successful recreation parks, sports pitch and playgrounds need to be convivial. Coherence and legibility are by far the highest cognitive satisfaction factors for pedestrian sidewalks than for any other UCOS.

Furthermore, UCOS should be designed for pleasurable strolling. Period of use is significant to designing for various uses at different hours. Social interaction spaces and convenience of use should be integrated into the design of recreation parks, sports pitch, playgrounds, plazas/squares and all other civic open spaces. Safety concerns should be built into the location and design of zoological and botanical gardens and conservation areas. Courtyards should be connected to indoor spaces and made convivial. Recreation parks should be designed to allow for multiple uses/purposes and mode of use should be considered for conservation areas as indicated in the proposed frameworks.

None of the existing frameworks holistically and simultaneously account for use, cognitive, social, spatial and affective satisfaction factors for all typologies of UCOS. The existing frameworks are also not fully user centric. These limitations have been overcome in the proposed frameworks. They account for all use and satisfaction factors holistically and simultaneously within the context of users' design requirements for all types of UCOS.

The findings of the study are synthesized into a new set of comprehensive frameworks for the design of UCOS. This is an original contribution to the body of knowledge that details the parameters for understanding and measuring the performance of UCOS. These findings can be applied in practice by engaging the frameworks for brief analysis towards programme development at the design stage. Thus, the frameworks are detailed design requirements and how they are interrelated. They are recommended as design toolkits as feedback and feedforward input into the design process for innovative strategies between design and use/operational phases. They promise to boost and optimize the life-cycle sustainability of campus-built assets. Directions for further works include studies on design considerations for maintenance and management involving design professionals and horticultural considerations on materials and installations.

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