SPATIAL PATTERNS AND HUMAN BEHAVIOURS: A STUDY OF URBAN PUBLIC SPACES IN KANDY.

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Abstract

Rejection of architectural projects, urban designs and resettlements area major concern in Sri Lankan and worldwide architectural field. Throughout a vast architectural discourse, there are clear identifications that address the human experience in space as a way to success.

Experiencing the space is a vital need of human beings. It satisfies the objectives of a human's inherent emotional needs. Human behaviours and their expectation differ from place to place. To achieve a particular status of human behaviour within a place, the place should support that behavioural change.

The main objective is to study the phenomenon of spatial patterns and human behaviours in urban public spaces in Sri Lankan context. The study further focuses on waiting behavioural responsiveness towards geometric properties of public spaces using spatial theories of Jay Appleton, Norberg-Schulz and Christopher Alexander.

A well adopted, architectural and landscape context, Kandy city was selected for this study. Five different geometrical properties and four types of human behaviour patterns were selected for the study.

To study this complex landscape mosaic in Kandy, a mix method combined with observation checklist and questionnaire-based interviews were incorporated.

The primary research findings proved two out of four behavioural actions have a relationship with spatial patterns. The secondary research findings proved that three out of five geometric properties have a significant relationship with the waiting behaviour.

The research ascertained that existing spatial patterns and its geometric shape diversifies human behaviour. The major components of these behaviour–spatial pattern relationships are extracted and studied with the purpose of contributing to the current practice of user analysis method and design process.

Keywords: Human behaviours; Spatial patterns; Theory of centres; Geometric properties of public space; Kandy City.

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1. Introduction

In many problem based development projects there are certain, uncontrollable major issues that lead towards its failure. Even though in large scale regional and local planning projects, discussions on related matter are carried out, effective solutions are not provides by designers.

According to contemporary knowledge, the roots of this issue is adjoins with the architect's and user's perception towards the space. Once there is a conflict, there will be an issue. John Lang brief this as, "This disparity between success and failure illustrates the difficulty that architectures have had predicting the outcome of the designs – their impact on people – with any reasonable probability of accuracy."(Lang, Burnette, Moleski, & Vachon, 1974)

As designers, it is essential to understand user perception and behaviour patterns to work-out an effective design process. This study will provide answers as to why architectural projects urban designs and resettlements are falling? Author checks the hypotheses that "Spatial patterns are course changing in human behaviours".

2. Human behaviours

"The stimuli that impinge on an organism's sense organs and the observable responses or behaviour elicited as responses to stimuli" (Lang, Burnette, Moleski, & Vachon, 1974). They further explain three psychological processes causing to diversify human behaviours. They are perception, cognition and spatial behaviour.

> "Perception is the process of obtaining or receiving input, cognition is the through output function involving the processes of thinking, remembering, and feeling, and spatial behaviour denotes the output manifested in an organism's action and responses." (Lang, Burnette, Moleski, & Vachon, 1974)

Convergent behaviour patterns can be observed in spaces without possibilities to accomplish one's needs. Vice versa divergent and null behaviour patterns can be identified in spaces with possibilities. In this study, existing spatial patterns with both convergent and divergent behaviours are considered as accepted spaces. This has been further elaborated below.

> "Behaviour can be considered to be a goal-directed attempt by an organism to satisfy needs that are perceived and cognitively organized. The purposiveness of behaviour has long been accepted by most psychologists as its significant determinant, affecting not only a person's activities but also his perceptions and mental processes. A person will select whatever information is appropriate to his need and will remain relatively unaware of irrelevant feature of the external world. He will then organize this information to achieve his goal."(Lang, Burnette, Moleski, & Vachon, 1974)

Table 6: Spatial interpretation of diversify behavior actions.

Behavioural Action	Spatial Interpretation	Need	Convergent Behaviour	Divergent Behaviour	Null Behaviour

Walking	Move from a point to another.	Shortest and quickest way to do it.	Walk in a lines. Without changing the lane.	Move differently, likewise running, creping or other divers action.	Zigzag walking. With changes of lane.
Seating	Stop in a point. With seating action.	Relax the body and mind for a while or talk with someone.	Seating facing an open space or scenery on a formal seating.	Seating facing an open space or a scenery on an informal seating	Seating without facing an open space or scenery on a formal or informal high.
Standing	Stop in a point. With standing action	Relax the body and mind for a while or talk with someone.	Stand with the help of vertical element. Under shade.	Stand with the help of vertical element. Not under shade.	Stand without the help of vertical element. Under shade or non-shade.
Level Change	Move from lower elevation to a higher or vice versa.	Shortest and quickest way to do it.	Cross a stair perpendicularly	Cross a stair diagonally.	Achieve the level change with maximum physical strength. Like jump over.

The table above further explains the four types of behaviours which were identified during the polite study, according to the pre-introduced behavioural process. Instead of conducting observations on 'three psychological processes' mentioned above, observations on 'behavioural actions' were carried out in this study.

3. Spatial patterns

Spatial pattern is a popular term used under geography, ecology and landscape ecology subject areas. It basically means the organization and placement of people and objects on earth. The term 'spatial pattern' explains or describes the arrangement of a place, a scene, or an object. In this research, the term 'spatial pattern' has been used with the same meaning but in a smaller scale. In other words, it has the same idea of 'spatial structure'.

Thus, thisresearch focuses only on the spatial structure of the public space (i.e. physical arrangement, size, the interaction of forms, shapes) not onit's aspects (i.e. 'Access', 'Sociability', 'User activities' and 'Comfort'). In other words, it addresses the geometric properties in a public space.

Fig 47. Spatial Patterns highlighted using geometric shapes.

Sorce: author

3.1 Alexander's spatial theory of 'Wholeness' and 'Centres'

The general idea of wholeness is a big picture creates by various coherent entities. Alexander brief it as, "The wholeness in any part of space is the structure defined by all the various coherent entities that exist in that part of space, and the way these entities are nested in overlap each other." (Alexander, The Nature of Order:The Phenomenon of Life, 2002)

"Centres" are those particular identified sets, or systems, which are distinct, noticeable parts within the larger whole. This perceptible distinctness quality differentiates 'centres' from the rest making them cohere. The arrangement of these coherent parts articulates other coherent parts to emerge. Meaning, centre is a kind of an entity, which can be defined only in terms of other centres.

3.2 Geometric properties of urban public space.

Jay Appleton (1975) identified two properties which can effect on human behaviours. This is known as prospect-refuge theory. This theory basically addresses the degree of enclosure-ness and relationship to human behaviours.

> "Appleton suggests that individuals are motivated to perceive their surroundings in such a way that environmental information is acquired and stored in a form in which it can be efficiently and quickly retrieved when needed to ensure survival" (Mumcu, Duzenli, & Ozbilen, 2010)

In early 80's Norberg-Schulz define the daily environment with eight geometric properties. "In current literature, we may distinguish between two uses: space as three dimensional geometry, and space as perceptual field"(Norberg-Schulz , 1980). Christopher Alexander (2002) developed an idea of spatial structure by identifying fifteen geometric properties and his theory of 'centres'.

Following table (table 2) classified the all geometric properties defined by Jay Appleton, Norberg-Schulz and Christopher Alexander. It further identified geometric properties which have similar characters or definition.

Table 7: Geometric Properties of urban public space

Jay Appleton (1975) Task	Norberg-Sculz (1980) Need	Christopher Alexander (2002) Techniques
Refuge factor	Boundaries	Levels of Scale
Prospect factor	Degree of extent	Strong Centres
	Degree of enclosure	Boundaries
	Centre	Repetition
	Figure-ground	Positive Space
	Rhythm	Good Shape
	Proximity	Local Symmetries
	Scale	Deep Interlock and Ambiguity
		Contrast
		Gradients
		Roughness
		Echoes
		The Void
		Simplicity and Inner Calm
		Not-Separateness

All those properties are generally suitable to conduct this study. However, due to time limitations five properties were selected. These selections were made based on certain special considerations.

1. The geometric property or its concept should have an evolution in literature.
2. The geometric property or its concept should be available in the study context (consider in pilot observation of the site).

According to those considerations, 'degree of enclosure-ness', 'level of scale', 'boundaries', 'rhythm' were selected. For clearness and convenience of the study 'Degree of enclosure-ness' geometric property was divided into two components. Namely, 'degree of openness' and 'degree of closeness'.

Table 8: Selected geometric properties

Geometric property	Description
Degree of openness	Surrounding is clear. There are more visual physical accesses. Human feel openness.
Degree of closeness	Surrounding is not clear. There are less visual physical accesses. Human can feel closeness.
Level of scale	Smooth, proportional change of scale of centre in space. The strong centres is made stronger partly by smaller stronger shapes contain by it.
Boundaries	A boundary separates a centre from other centres. And boundary focuses attention on the centre .A boundary is itself made of centres.
Rhythm	Space extends with a varying degree of continuity in different centres. Which the centres are strengthened when they repeat, by the inspection of other centres between the repeating once.

Sorce: (Alexander, The Nature of Order:The Phenomenon of Life, 2002), (Norberg-Schulz , 1980), (Appleton, 1975)

Table 9: Research prototype.

Literature survey	Find and defined the key terms.	• Evolution of relevant literature.
Select case study	Deferent urban spatial patterns exist adjoin.	• Comparison of cases logically.
Pilot study	Test questionnaire and observation guidelines.	• Sample questionnaire • Sample guidelines
Detail survey	Collect raw data.	• Observation • Questionnaire • Photographic survey
Analysis	Eliminate result for testing hypotheses.	• Excel spreadsheet • Charts • Chi-square test

4.1 Study area

For the purpose of conducting this study in an architectural context, city of Kandy was taken into consideration. There are well-adopted spatial patterns, many historical layers and a complex landscape mosaic in Kandy. The unique topography of this context enables studying human behaviour with change in levels. Kandy city dwellers (user) are more specific and attached to the context unlike in another city. According to Kapila de Silva in his article "Rethinking the spirit of place: Conceptual convolution and preservation pragmatics". He mentions as below;

> "For residents of Kandy, the city evokes a very strong sense of the sprite of place, defined collectively by some city features and symbolic meanings associated with the city. The Sprite of Kandy in fact is a juxtaposition of several core-dimensions, which include the senses of sacrality, historic solemnity, scenic serenity, and well- being, all complimentary to each other." (Silva, 2008, pp. 5-6)

Given below are five urban public spaces identified during the pilot visit.

A - Lake round near boat house.
B - Dalada street in front of KCC and KFC building (30m length).
C - Castle lane (40m length).
D - Dalada street, the walkway at Queen's building.
F - Dalada street near to clock tower. In front of Gorge de Silva park.

These spaces were selected considering certain factors, which are mentioned below.

i) Places should exist adjoin to each other,
   a. For a more generalized answer.
ii) Ease of study.
iii) Those sites should defer in spatial patterns (have to have an identifiable deferent characters).
   a. Based on the need of study the human behaviours within different spatial patterns.

Frome those identified five spaces, three urban public spaces were selected for the study to achieve a quality output through a limited period of time. (Figure 2). These sites were selected by a critical evaluation of their spatial patterns.

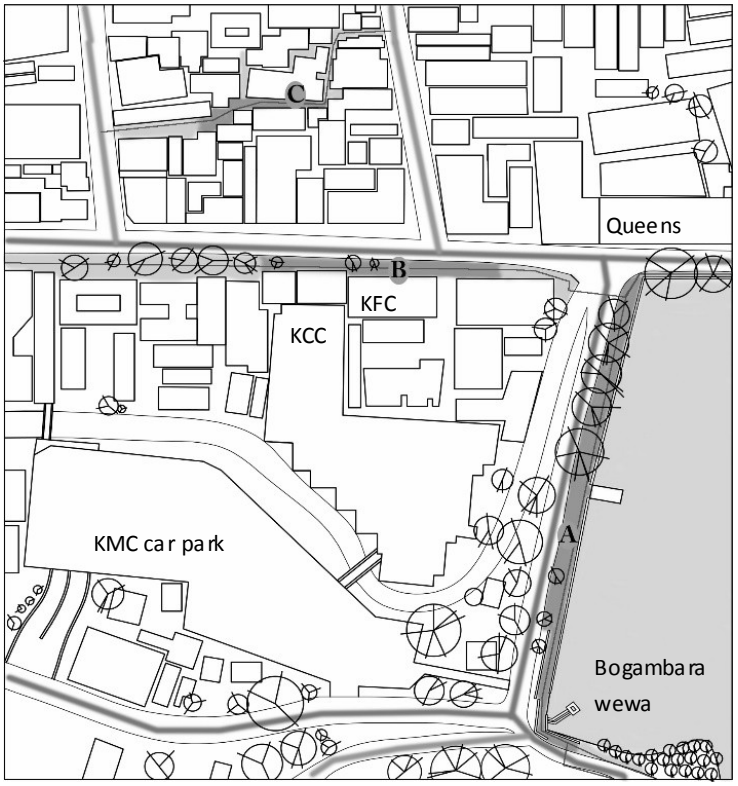
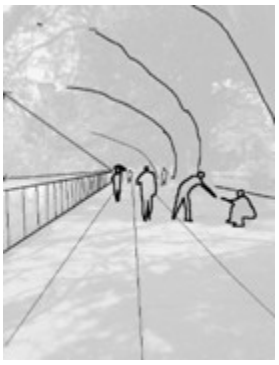


Fig 48: The selected sites.
Source: Compiled by author

Table 10: Selecting three sites out of five

Place	Pattern	Suitability	Description

A - Lake round near boat house. 		Better	Spatial patterns are special to this space. Geometric properties are very clear to identify. Degree of enclosure-ness is maximum rather than other spaces.
B-Dalada Street in front of KCC and KFC building. 		Better	Spatial patterns are special to this space. Geometric properties are very clear to identify. Degree of enclosure-ness is in medium level relative to other spaces.
C - Castle lane 		Better	Spatial patterns are special to this space. But Geometric properties are not very clear to identify. Degree of enclosure-ness is in low level relative to other spaces.

D - Dalada Street, walkway at Queen's building. 		Good	Different spatial Patterns rather than other spaces and geometric properties are very clear but It seems to be a semi-public space rather than public space.
F - Dalada Street near to clock tower. In front of Gorge de Silva park. 		Weak	Spatial patterns are weakly express in this space. Geometric properties are not clear.

4.2 Data Collection and Field works

This research is used a qualitative and quantitative mix methods (transformative mix method).

Raw data was collected through fieldwork in two steps. The first step consisted of unobtrusive participant observation. The second consisted of questionnaire-based interviews.

- ❖ Observation checklist.

The human behaviour in these selected public spaces was observed according to a list of guidelines (table 1), which were based on theoretical aspect extracted by literature surveys, and empirical aspects gain from pilots study. Thereafter, an observation checklist was formed accordingly to carry out studies conveniently.

Steps in observation procedure.

i) Observations were carried out during daytime between 10.30 -15. 30 GMT.
ii) Maximum of one hour was spent in each site to collect and record quantitative data.
iii) 20 data were recorded from one site. (Total of 60 from 3 sites)
iv) A datum records,
   - A total number of crowd.
   - Number of Seating, walking, standing and level changing behaviour.
   - The divergent and the null behaviour of them.
v) A datum is considered as one minute. (All the counts of behavior was taken within minute)

❖ Questionnaire based interview.

Human perception on "waiting behaviour" in selected public places and its relationship to geometric properties of space was studied incorporating questionnaire-based interviews derived from the theoretical framework.

- Structure of questionnaire

The questionnaire contained twelve close-end questions in two sections. The First section was on city dwellers perception on "waiting" in the particular space. The second section was on city dwellers perception on "geometric properties of the public space". It was compiled in both 'Sinhala' and 'English' for participant's choice. The participants were guided to answer according to a rating system.

- Sampling

A total of sixty volunteers were interview (Twenty from each public space). This sample, which was selected according to the "SRS" (simple random sample) method, includes individuals from all age groups, religious groups, and gender. The advantage of this method was that it enabled to simplify a conclusion, which represents a larger population.

Table 11: Distribution of the demographical characters related to the participants.

Demographical data	Number of persons	Percentage (%), Y=100
Gender		
Male	29	48.3
Female	31	51.7
Age (Years)		
15-30	20	33.3
30-50	22	36.7
Above 50	18	30.0

4.3 Data analysing tools

In this research data analysis was done in two steps. The first step uses basic methods of data analysis such as 'frequency distribution' and 'descriptive statistics' using Microsoft Excel software. The second step uses an advanced data analysis method to confirm the previous

interpretation. This method known as chi-square test was performed using SPSS (Statistical Package for the Social Science) software.

4.4 Limitations

This study was done according to a theoretical framework established through the study literature reviews. After careful consideration, the most effective parameters were selected and the study was limited to five theoretical parameters and a theoretical framework was established.

The method of study contains some limitations. The first factor being that the study was limited to the daytime. The day-night variation of human behaviour has not been considered in the scope of this study.

Initially it was observed if there was any relationship between the human behaviours and the spatial patterns of the place. Thus, as only a relationship was found in 'waiting behaviour' of people (including both sitting and standing) and the geometric properties of the public place, the study was limited to these areas only.

The changes in behaviour according to age factor were limited to three broad age categories and were focused on a more generalized research outcome.

Finally, this study does not consider demographic factors which affect people's behaviour, perception and their answers to the questionnaire such as cultural background, ethnicity, their housing environment and income level.

5. The findings

Based on the results of the research, of the four behavioural actions, two show a direct relationship with the spatial patterns of the surroundings. The results are as shown in the table below.

Table 12: Results for relationship of human behavioural action and spatial patterns.

Human Behaviour	Personal value (P-value)	Relationship
Seating	0.001 (< 0.05)	Yes
Walking	0.082 (> 0.05)	No
Standing	0.010 (< 0.05)	Yes
Level changing	0.055 (> 0.05)	No

According to the results behaviour actions which have shown Pearson value less than to 0.05, there is a relationship with existing spatial patterns.

Thus, as per the findings from urban public spaces A, B and C in Kandy city, it is clear that there is a relationship between the standing and seating behaviours of people and the spatial patterns of the surrounding. Therefore spatial patterns become a key consideration in designing public spaces which either facilitate or deter human behaviour.

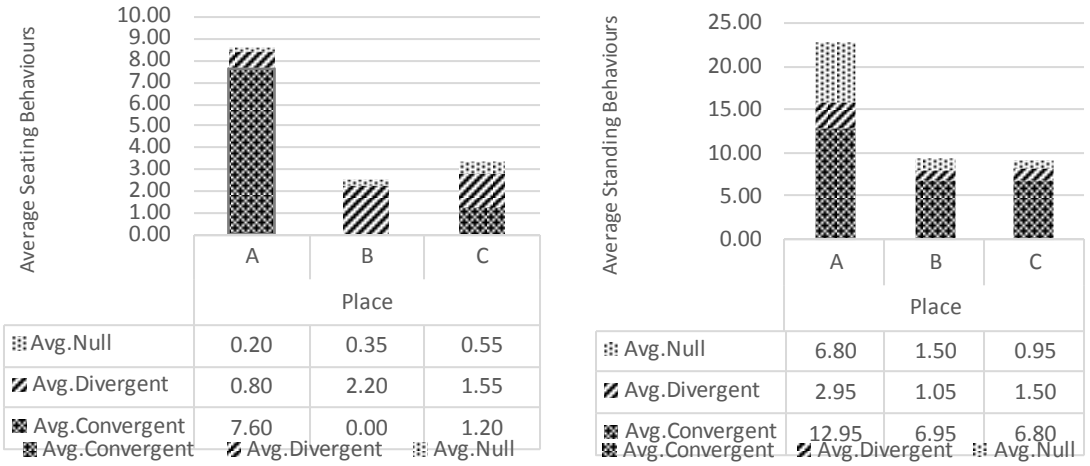


Fig 49: Seating and standing behaviour in three urban spaces
Sorce: compiled by author according to observations

In the above graph, only those walking perpendicular to the direction of the stairs and those following the uniformity of changing levels were considered. Others were considered as null or divergent behaviours and thus could have been a key aspect in concluding that the geometric shape does not have a significant impact on these two behavioural patterns.

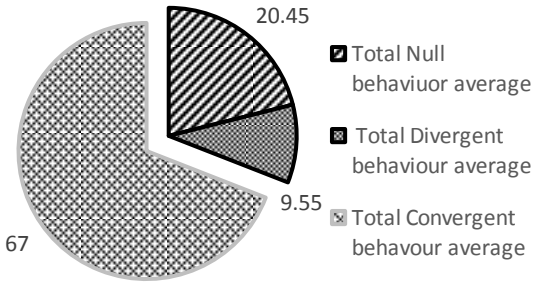


Fig 50: Total percentage of considering four behavioural action in three urban spaces
Sorce: compiled by author according to observations

Furthermore, above analysis show a high percentage of divergent and null behaviours in Kandy city when compared to the total convergent behaviour.

There are both fixed concrete spaces which have specific functions and define user behaviour as well as convertible spaces within the selected urban public spaces of Kandy. These are both acceptable to the user and thus become a key consideration in the user analysis of the public spaces of Kandy city and can be applied to the local context.

As per the research, three out of five geometric properties had a significant relationship with the waiting behaviour of people. Thus, it can be seen that human spatial behaviour responds to the geometric properties of the public space.

According to the results of below table geometric properties which have shown personal value less than to 0.05, there is a relationship with ‘waiting behaviour’.

Table 13: Results for relationship of geometric properties in public space to waiting behaviour.

Geometric Properties	Personal value (P-value)	Relationship
Degree of openness	0.044 (< 0.05)	Yes
Degree of closeness	0.169 (> 0.05)	No
Level of Scale	0.004 (< 0.05)	Yes
Boundary	0.172 (> 0.05)	No
Rhythm	0.014 (< 0.05)	Yes

As per the research results, in the selected urban public spaces of A, B and C in Kandy City, there is a distinct relationship between the 'Degree of openness', 'Level of scale' and 'Rhythm' of the geometric properties with the 'waiting behaviour' of the people. These findings thus provide guidelines to designing urban public spaces which facilitate 'waiting behaviours' in the city of Kandy.

Thus, the following three factors need to be included when designing urban public spaces for the city of Kandy which facilitate 'waiting behaviour' in persons.

- Openness.
- Smooth and sequential change of scale in geometric shapes.
- Good rhythm thought whole space.

Finally, the results are not convincing enough to prove any relationship between human inherent properties and 'waiting behaviour'.

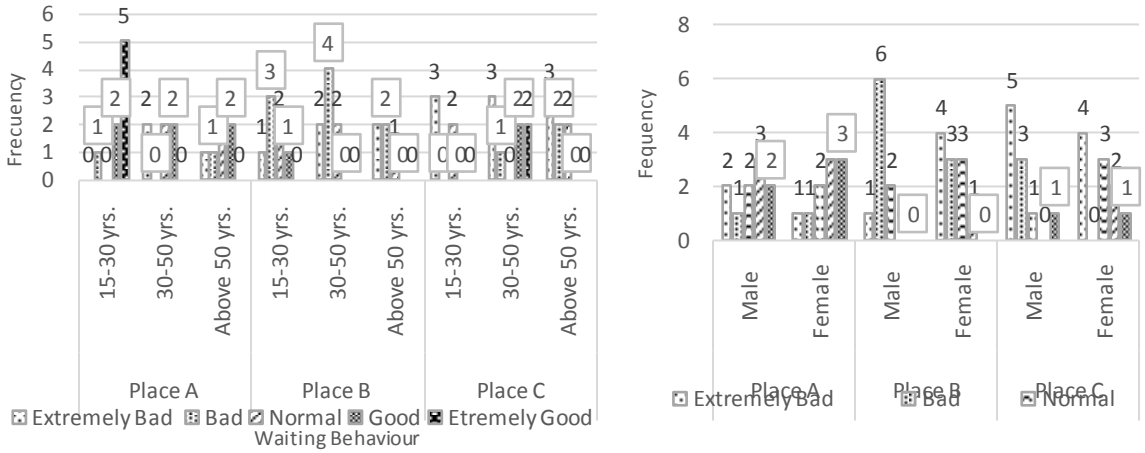


Fig 51: Preferences to waiting behaviour according to Age & Gender variation
Sorce: compiled by author accordig to questionnaire based data

The chi-square test also fails to show a relationship of those two factors. The age factor score 0.531 p-value and the gender factor score 0.354 p-value. Both factors are not under the range of 0.05. So there is no relationship.

6. Conclusion

Based on the hypothesis; “Spatial patterns cause changes in human behaviours”, this research stands to find the relationship between spatial patterns and human behaviours in urban public spaces.

Build environment is a vital need for human life. However, there are various problems in adapting human behaviours to the built environment. Landscape architecture is a field that helps to incorporate this need for a built environment while solving problems related to the adaptation of human behaviour to these same environments. There are relatively few studies conducted on ‘user behaviour and their surroundings’ through a landscape architectural point of view, and thus, contributions of this research will enhance and strengthen the current practice of user analysis in architectural and landscape architectural designs.

The primary research findings proved that sitting and standing behavioural actions have a direct relationship with the three selected study areas. Other behavioural patterns such as walking and moving from level to level, does not have a strong relationship with the spatial patterns of the place.

Thus, it can be concluded that human behaviour does not totally depend on the spatial patterns, rather there may be other factors which come into effect. However, spatial patterns do cause a significant change in human behaviours as shown above.

There are several geometric properties which affect this phenomenon of spatial patterns and human behaviours. The second part of the research was based on five different geometric properties of which, three; degree of openness, level of scale and rhythm proved to have a significant relationship with the ‘waiting behaviour’ of persons.

The analysis shows that there is no significant impact of human’s inherent properties such as age and gender to the main research findings.

Final conclusions of this research are,

1) Design for user behavior is an essential factor for successful design outcome.
2) Architect or the landscape architect can address the user behaviours by addressing spatial patterns (spatial structure).
3) Geometric properties in spatial structure can be used as a tool to design a particular behavioral pattern.

7. Recommendations

This study will act as a base point for future studies in Sri Lanka on ‘Spatial patterns causing changes in human behaviour’. This study also hopes to provide guidance and act as a starting point for future research topics.

It is also important to consider the behavioural changes between day and night can be an avenue to continue this research on in the future. This research can also be continued by taking into consideration the various availability of geometric shapes in different spaces. For a more practical outcome, this study needs to be conducted in other cities of Sri Lanka as well.

However, this research did not have conclusive results with regard to variations in human behaviour based on inherent human properties and thus a larger data sample is recommended for future studies. Having more specific age categories will also facilitate better results.

The questionnaire also diluted the core idea of the theoretical framework to a certain degree and thus did not fulfil the expected level of findings. Thus, a more phenomenological method would be more appropriate.

Finally, it is important to do more research relating to this research topic to achieve successful human responsive designs in architecture and landscape architecture.

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