TOWARDS A SOCIAL LOGIC OF COCHIN, INDIA:

Understanding the influence of culture on the spatial organisation of cities

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Abstract

Existing studies using the Space Syntax methodology have compared cities, from different regions of the world, based on their configurational properties and have shown that while organic cities across the world follow various generic characteristics there are variations within them due to cultural differences. This paper sets out to explain the structural organisation of space and the distribution of commercial and residential land uses within Cochin, a South Indian city, using the configurational approach, and to be able to place Cochin within the comparison between cities across different cultures.

Cochin was ruled by the Portuguese, Dutch and British between the 16th and middle of the 20th century. The city itself comprises of almost three distinct areas in the form of a peninsular, a man-made island and a part of the mainland. The original historic settlement on the peninsular expanded onto an adjacent man-made island and the mainland. Development of these various parts has been influenced by colonial rulers to different degrees. The present day city centre is now situated on the mainland and over the last few decades since independence the city has spread further into the mainland away from the historic parts of the city. This has provided the opportunity to compare the spatial organisation of streets in various areas which have been influenced by the different colonial rulers to different degrees revealing the influence culture has had on the organisation of streets.

Analysing the organisation of the streets in combination with a land use map of the city, the study, identifies patterns in the distribution of commercial and residential land uses. The paper compares different parts of the city that have been varyingly influenced by the colonial rulers revealing distinct structural patterns in the spatial organisation of streets. This comparison becomes a means of identifying the distinct characteristics of the indigenous pattern of settlement formation found in areas that have developed more recently and much after the departure of the colonial rulers. The study also makes a syntactic comparison of Cochin with other cities in the world thus being able to place it within the existing general syntactic characteristion of cities from different regions of the world.

Through the analysis of the city as a whole; a comparison of the spatial structure in distinct geographic parts of the city; a comparison of the spatial structure of various residential areas across the city; and then the comparison of the city as a whole with other cities in the world, the study has been able to understand and describe much regarding the spatial character of Cochin and in that process reiterates that while on one side cities across the world follow a common genotype cultural variations can produce phenotypic variations.

Keywords: Spatial Structure, Culture, Land use, Edge centres, Through movement

Theme: Urban Space and Social, Economic and Cultural Phenomena

INTRODUCTION

Cochin, a port city located at 10*N and 76*5' E, along the south western coast of India has grown in 500 years from a small sea harbour at Mattancherry to a city with around 2.1 million during which it has been governed by the Portuguese, Dutch and British for different periods. The city has spread eastwards from the water front at Mattancherry to include the rest of Cochin Peninsular, British made Wellington Island, other islands west of the mainland and a large part of mainland Ernakulam, collectively referred to as Greater Cochin.

The aim of the study is to understand what the social logic of space of that of Cochin is. By analysing the structural patterns within the city's network of streets as a whole and in parts it tries to characterise the spatial distribution of commercial and residential land use across Cochin. Studies indicate how the various colonial rulers had a significant influence on expansion and development of the city and its various institutions, of which the British were most significant being involved in, among others, creating Wellington Island, the move to the mainland from Mattancherry, and establishing many public institutions along the mainland waterfront (Ravindran, 1989). Parts of this study are built upon the premise that settlement patterns in areas towards the east where the city has more recently expanded to, much after the various colonial rulers have left, would reflect an indigenous pattern of settlement. By comparing different areas, within the city, that have been influenced by the presence of colonial rulers in varying degrees, the study aims to highlight the effect of culture on the organisation of space within the city and thus to provide an understanding of the indigenous pattern of settlements in Cochin.

CONTEXT AND METHODOLOGY OF THE STUDY

Existing Space Syntax based studies (Hillier, 2001; Karimi, 1997, Raman, 2003) have identified how cities across the world have many similarities in the way they are configured but that there are variations from these commonalities with the variation in culture of the people that give the city shape and occupy it. These studies have identified how cultural variation is more evident in the way residential areas are structured. In studying Cochin, this research intends to draw it in comparison with cities from other cultures to be able to identify what are the cultural implications on the city of Cochin's spatial organisation. For this purposes, it analyses in particular various residential areas.

Existing studies (Parayil, 2000; Franke & Chasin, 2000; Veron, 2000) refer to the state of Kerala, of which Cochin is the commercial capital, as a model for development for its achieving high standards in terms of social indices associated with health, education, status of women and poverty on par with developed nations, even in the absence of equivalent economic growth. Hence, being able to characterise the organisation of space in its cities could be relevant in understanding and reproducing this model. Currently various government bodies have undertaken studies (Ibrahim, 1978; RITES, 2001; Cochin Corporation 2002; NATPAC, 2008) that have analysed traffic in the Grater Cochin area to inform development proposals. In the light of such intentions to transform or improve existing conditions this study will provide a deeper understanding of city's street network.

The study is built upon the Space Syntax approach and in addition to the spatial analysis using the software, Depthmap, uses a land use map for the year 2006 prepared by the Town Planning Department, Kerala- India. The area taken into consideration includes Wellington Island, the area that falls within the Corporation of Cochin boundary on the Cochin Peninsula, and that part of the mainland that falls between the Coastline on the west, the railway line on the north, the



Seaport – Airport Road on the east and the south (Figure.1).

Figure 1 Map showing the area included for this study (Source: www.map.google.co.uk)

TOWARDS A SOCIAL LOGIC OF THE CITY

Urban-Rural Continuum and the Rural Bias:

In most other parts of India there is a strong dichotomy between villages and towns or cities however Kerala's physical growth is referred to as a 'corridor type development' and is known for an urban-rural continuum (Poulose, 1988; Corporation of Cochin, 2002) where urbanisation occurs almost continuously along communication routes. Almost all villages and towns in Kerala are provided with roads, communication facilities, electricity, water, education, health and recreation facilities like cinema theatres hence there are lesser incentives to migrate to towns and cities as there would be where there is a stronger contrast from the urban to the rural.

The City Development Plan (Corporation of Cochin, 2002) refers to the characteristic urban-rural continuum as a process by which contiguous urban expansion occurs along the arterial corridors with pockets of undeveloped areas in between. This can be clearly observed, from the land use map, to be the case even within the city of Cochin with more or less continuous and concentrated commercial development along the main arterial roads that feed into the city from other surrounding areas, such as the Old National Highway 47 Road and the Trippunithara Road (see fig.1). Not only was commercial activity concentrated but until the last two decades it was restricted to just these arterial roads and the downtown region where a network of streets join the above mentioned two arterial roads. In addition to the land use map if we observed the public bus route maps we will find most of the public buses, which carry 73% of the passenger traffic in Cochin, ply predominantly along the arterial roads- the National Highway and Trippunithara Road (Corporation of Cochin, 2006). This would reflect that commercial development even within the city occurs and tends to get restricted along the

arterial roads maintaining the continuum and therefore the regional phenomenon can be said to reflect at city scale as well.

Studies (GCDA, 2001; Corporation of Cochin, 2006) highlight the people's preference to live in residential plots with isolated buildings and to thus (Poulose, 1988) possess yard space. Thus, the combination of good communication and transport facilities with urban centres, equitable distribution of development and basic facilities across urban-rural areas, higher land prices in cities, and the preference for uncongested isolated residential buildings within individual compounds seem to be the key considerations that explain the 'rural bias' or the accelerated growth of the periphery regions of the city and class 3 cities (population between 20,000 and 49,999). These observations reflect the low proportion, of 4-8% of cities population, of the migration component in population increase by natural growth in cities in Kerala (GCDA, 2001).

Distribution of non residential commercial land uses:

The downtown area which occurs primarily east of the railway line and between the arterial roads is primarily constituted by 6 long north south aligned streets and linked by smaller east-west aligned streets which are all predominantly faced with commercial activity (Figure 2). While there is a cluster of bocks with close to 100% commercial land use around where the historic Broadway market was, other blocks in the downtown often have public/semi public land use and some residential land use as well. Historic markets at Broadway and at Mattancherry (on the peninsular) situated at these locations when transport occurred primarily over water, turned from major retail centres into wholesale markets when modes of transport changed. East of the railway line commercial development is restricted to the arterial roads or roads which were previously arterial roads and to select other streets but in the latter case with lesser intensity and less continuity. Beyond the concentrated water front commercial development at Mattancherry, commercial land use are found aligned along select longer roads aligned along the cardinal directions within the Peninsular.







Figure 2 Land use map of Northern parts of Cochin Peninsula (Left); Land use of the whole peninsula (Inset); and Land use of parts of the mainland (Right).

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Other than the clustering of public and semi-public land uses north and south of the Broadway Market, which are mostly buildings established during the time of the English; and north-west of the Cochin Peninsula, which were mostly buildings erected by the Portuguese, Dutch and English; public and semi public establishments seem to be dispersed throughout the city (Abraham, 2009).

Most industrial developments are located as clusters of different sized units at different points in the city. Wellington Island is occupied almost completely by the port and defence establishments. Port and sea related industrial establishments take up large parcels of land along the coast on the islands, peninsular and on the mainland. Other than these clusters, small single independent units can be found dispersed within the city but are rarely found in the downtown area.

Visual observation of the land use map indicates that land use does not seem to correspond to blocks as a whole or to the intrinsic characteristics of blocks but on the other hand it rather appears that land use corresponds more consistently with streets as expected from the theory of movement economies (Hillier,1996a).

Spatial logic of Cochin:

Axial line representation of the integration values in Cochin, appears to be at once a single system and also a collation of three systems. This is so because of the way mainland Ernakulam is topographically and therefore almost topologically cut off by water bodies from Wellington Island and the Peninsula of Cochin, where each is linked to the other by just two bridges; and also because of the way each of the above mentioned parts of Cochin have distinct configurational patterns as can be seen in their corresponding segment maps.

Areas with higher values of integration (radius n) take the shape of an axis alongside a ring that is more square-like than round. It could also be considered as a ring with spokes that meet at its corners, excluding the north western corner which may have been highlighted had the islands north west of Cochin been included in this analysis. The axis is the National Highway 47 Bypass Road (Fig. 3) that connects Cochin to northern and southern neighbouring cities. The spokes represent the roads that connect Cochin with its outskirts or with other cities. However, one particular spoke, which is the Pipe Line Road, that leads from the north east corner of the system right up to what appears to be the geometric centre of the inner ring, is an insignificant rarely used, poorly surfaced road with restricted access that has come about after pipelines were laid underground. Two roads, along cardinal directions are highlighted with high integration values within the ring and intersect at a point a little west of the geometric centre of the ring.



Figure 3 (L to R) Integration at Radius N and 1000 Segment Map of Cochin.

Spaces along the eastern side of the ring, which represent the Bypass Road, are noted to have the highest integration values within the whole system. This makes streets immediately linked to the Bypass Road also of high integration values and intensification of street connections along the Bypass Road tends to imply that the area around the Bypass Road constitute the city's 'live' centre (Hillier, 1999).

Streets representing the north and south side of the inner ring have gradually decreasing values of integration moving westwards, while with increasing depth north and south of these streets integration values decrease less gradually and pockets of segregation can be observed. Even though the western side of the ring has the least integration value at radius 'n' compared to the other three sides, the integration values of streets in that area remain relatively high across a bit larger spread of grid intensification and the decrease in integration values is not as abrupt as is with around the other three sides.

Looking at the global integration values, we find Cochin's deformed ring and spokes do not seem to reflect the same characteristics of most deformed grid wheels as explained within the Space Syntax approach. The deformed grid wheel as per Hillier's theories in most cases reflect the foreground network of the city with spokes of high integration values that tend to converge from the edges of the city towards the 'live city centre' where the commercial retail activity can be considered to be most robust and concentrated. The 'live centre' of the city is usually characterised by an increased intensification of the grid and occurs in the area with highest integration values.

We find that the spokes from the edges of the city stop short of converging within an area and meet instead at a ring of roads that link them. The geometric centre of this ring and large parts towards the centre of this ring comprises unused barren low lands, therefore even devoid of streets and in no way are they containing the expected commercial activity. We find that the most integrated line within the configuration is the Bypass Road and from our observation of the land use map it is known that the downtown region of the city and the region with most

intense commercial land use is towards the western most parts of the mainland and not on the eastern side of the ring. Integration values of these commercial areas on the west are the least between the four sides of the ring and the westernmost north-south aligned streets within the downtown area failed to even get highlighted with integration at radius 'n' values. Also even when excluding streets west of the Bypass Road from the analysis we find that it is the most integrated street within the system hence negates the possibility of it being most integrated simply because of its geometric more central position.

Therefore in conclusion, at this juncture, there seems to be two possibilities with regard to the applicability of the concept of the 'deformed ring wheel' to Cochin. One, is that these observations may imply that the logic of space is different from that of other cities which comply with the concept of the 'deformed grid wheel', and the other possibility is that rather than being a misrepresentation of the reality, the analysis may be considered to be a prediction of the future reorientation of development in the city under the effect of the transformation that has occurred.

However, it must be noted that the Bypass Road came into full function only in the second half of the 1990's and the land use map that is being studied represents developments that have occurred only within a decade or less of the transformation. Also, within the years ever since this recording of these land uses, various shopping complexes, supermarkets, malls, and high end car showrooms have opened up or are under construction along the Bypass Road. If it is the case, that the results rendered by the analysis for integration at radius 1000, predict the relocation of the city centre or downtown towards the Bypass Road then this on the other hand will only reaffirm the concept of the 'deformed grid wheel', which suggests that the city centre is most likely to occur where the streets from the city's edges converge to, rather than negating its applicability for Cochin. This is so because previously when the National Highway linking Cochin to other cities north and south of it passed right through the city along the northern and western side of the ring and then through the peninsula down south, the downtown city centre took form where it is today along the old National Highway, and now that it has realigned bypassing the city and passing along the Bypass Road the centre is taking form along the Bypass Road. Hence in the realignment of inter-city highway along where the Bypass Road is, due its higher values of global integration and choice it has become a stronger seed enough to outweigh that at the present downtown.

However it may be noted that though the deformed ring wheel usually appears for integration values at radius 'n' in this case it identifies the axis and spokes and relates best to reality with integration values at radii 750 and 1000 (fig. 3).

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Figure 4 (L to R) Choice at Radius 7500 and 3000 segment map of Cochin showing the 3x3 grid

The Deformed Orthogonal Grid:

While existing literature recognises that Cochin's streets are generally aligned orthogonally there is little information regarding the origins of a grid or the exact delineation of a specific grid layout. However, choice values at radius 7500 (Fig.4) reveal a deformed 3x3 grid iron layout with deformations occurring at the northern corners due to canals and railway lines cutting across as well as minor deformations occurring within other grid lines as well. Most of the grid squares in the central and eastern grid columns appear to range approximately between ground dimensions 1800 to 2000 metres except the column on the west which is approximately 1500 metres wide.

An interesting aspect of this grid is its relationship with various specific prominent historic buildings. The southernmost grid line links historic landmark buildings such as the Ernakulam Siva Temple, District Law court, Maharajahs College and Durbar Hall (Maharajas Court) to the Trippunithara Palace (then residence of the royal family) when extended. Also all three of the southernmost horizontal streets intersect with the third vertical line (from the left) beside temples.

The alignment of key historic buildings with the streets of a 3x3 grid seems to hint towards a planning decision, at some point of time, to lay streets in this particular manner. In the light of no mention of any specific reason as to why Cochin has been laid out as it is this observation could be considered significant yet will need further investigation.

Local Centres – Edge Centres:

Choice values at radius 3000 (Fig. 4) highlight, rather than a 3x3 grid, the further break-up of the upper middle grid and therefore appears to portray a grid with increasing block sizes when moving southwards. At this radius there appears to be consistency in the size of some blocks that are highlighted and are adjacent to each other. However, more significantly, it highlights in most cases distinctly yet in some cases not as boldly, almost all of the relatively longer streets in Cochin which have continuous commercial land use along the whole length of the street,

excluding some streets in the downtown area. At shorter radii of 2000-2500 (fig. 5), shorter streets with and without continuous commercial developments are also highlighted, while at increasing radii from 5000 to 10000 (fig. 5) the commercial streets become less highlighted until being unidentifiable. Considering we know from land use maps that continuous commercial activity are restricted to streets in the downtown region, arterial roads and only a few other streets; these choice values indicate that such continuous retail activity along the length of streets, though maybe of different intensities, is characteristic with streets that provide some degree of potential shortest through movement for journeys greater than 3000 metres and less than 7500 metres.



Figure 5 (Clockwise from top left) Choice at Radius 750, 1000, 2000, 10000 segment map of Cochin

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A segment map of choice at radius 750 (fig. 5) highlights the internal organisation within some blocks highlighted at radius 3000 in addition to those streets highlighted at radius 3000. It reveals structures that try to link the centre of the block (the block highlighted at radius 3000) to its edges, in other words a sort of small scale deformed ring wheel. Internal routes with lesser angular complexity and which provide through movement within the blocks (the blocks at radius 3000) were highlighted. Hence, we find a deformed grid iron structure at a larger scale and deformed wheel internal structures at a smaller radius. In some parts only certain segments or rings of space are highlighted. Land use maps show commercial activity at or within the proximity of the internal centres of the blocks however in most cases there are very few retail units. Much more intense retail activity is found in the streets that were highlighted by choice values at radius 3000 which also appear in analysis at radius 1000 (fig. 5). This implies that it is the combination of high local and global choice values along the edges of the blocks that attract retail and commercial activity towards them rather than the internal centres. In conclusion it can be said that local centres in Cochin occur at the edges of blocks rather than within them.

The Urban Block

While certain structural patterns are revealed only through a syntactic analysis, certain others are clearly distinguishable from comparing the configuration of streets on the mainland, the peninsular and on Wellington Island. While on the mainland the longer streets are mostly aligned in the north south direction, on the peninsular the longer streets are mostly aligned in the east-west direction.

Streets west of the railway line on the mainland form continuous rings or blocks and there are very few dead ends (Fig. 6). There is a consistent formation of orthogonally aligned blocks throughout the downtown area with blocks approximating rectangles. Yet, in the absence of an overlying equally spaced grid, blocks in the downtown show great variation in size.



Figure 6 Choice at Radius 500 segment map of Cochin showing varying shapes and sizes of blocks on the mainland with the railway highlighted in white(Top); and similarly for the peninsular and Wellington Island (Bottom)

East of the railway line, there is an increase in the number of dead ends hence many streets do not contribute to shaping blocks. Individual streets tend to be aligned parallel to the grid lines of the 3x3 grid however fail to form regularised grids or blocks, creating blocks are of various shapes and sizes. However, on the peninsular there is a more consistent formation of rectangular blocks of more or less similar sizes throughout the region; and on Wellington Island which was a planned settlement blocks are almost of perfect rectangles. On the whole, other

than in planned parts of Wellington Island there aren't any patchworks of equal size blocks.

Analysing the various spatial characteristics of the city reveals various differences between the spatial layout on the mainland, Wellington Island and the peninsular. It can be inferred that the well connected and well knit nature of the grid on the mainland downtown area is dissimilar to that found on the peninsula or Wellington Island. The grid intensification on the mainland appears to be a reflection of it being the city centre of Cochin having occurred over time as a natural process by which intensification occurs so as to provide better connectivity and accessibility to already well integrated areas, as these are crucial spatial requirements for a 'live city centre' (Hillier, 1999). The well connect nature of streets on the Peninsular and Wellington Island found both in residential and commercial areas appears to be a characteristic cultural feature of the settlement and the colonial authority who were involved in establishing it.

Comparison of residential areas:

To be able to get a better understanding of the way residential areas are configured here in Cochin six residential areas, referred to in this study as Area A,B,C,D,E & F (Fig.7), are briefly compared here. The first five areas have been chosen at increasing distance from the sea coast. Considering studies and maps (Corporation of Cochin, 2002) indicate that the city has been growing eastwards and hence there would be lesser colonial influence on the spatial patterns in areas furthest away from the coast and peninsular, Area E which is located outside the 3x3 grid may be assumed to have the most indigenous layout while Area F located in the peninsular would be that most influenced by colonial settlers.

We find that in area A, B & C (Fig. 8a) the internal deformed ring wheel pattern that was visible at choice radius 750 & 1000 is more distinct than in other areas, and in area D there appears to be two local centres identified with one likening spokes radiating from a centre and the other being a series of almost linearly (relative to the rest of the neighbourhood) continuing segments (Fig. 8b). In the case of E we find that the choice values at this radius identify ring like structures within the residential areas and in the case of F there appears to be the slight indication of a central segment with spokes towards the edges. On observing the land use map and the analysis for integration and choice values at radius 750, we find that the location of local `commercial activity in most of the areas is reflected more distinctly with values of choice rather than values of integration.



Figure 7 Segment Map of Cochin for values of Choice at radius 3000 showing the 6 residential areas that were studied in detail

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Figure 8a Areas A, B & C (Top to bottom) with Integration at radius 750, land use and choice at radius 750



Figure 8b Areas D, E & F (Top to bottom) with Integration at radius 750, land use and choice at radius 750

As found in previous studies (Hillier,1999) in the six areas studied there is an increase in block sizes, reduction in intensity of the street network, and streets are less connected when moving away from the city centre. While from Area A to E the shape of blocks becomes more irregular and there are more streets that don't contribute to block formation, at F on the peninsular the shape of blocks are more regular.

At A and B which is closest to the downtown and where there is a clearly identifiable internal deformed ring wheel, we find many dead end streets. In C which is at the edge of the city centre area and hence in less proximity to commercial activity internal streets have lower choice values than found in area A and B. This suggests that internal streets are less prone to through movement. Here we find there are fewer streets and dead ends but the angular changes in direction involved from travelling from one edge to the other edge are greater. In area D internal streets have greater values for choice hence potential through movement than C but lesser than A and B. Here the internal streets are more sinuous and require greater angular direction changes, if travelling from edge to the opposite, than A and B. With area E we find many dead ends and even tree like structures while with area F not only are there very few dead ends but direction changes are at times minimal as well.

In conclusion, there appears to be a system within indigenous residential areas to reduce potential through movement along residential streets by balancing between organising themselves in a more sinuous manner with greater direction changes and creating dead ends.

Syntactic Comparison of its part and as a whole:

A comparison of the syntactic values (see Table 1 above) of Cochin as a whole, the part of the system on the mainland, Wellington Island, Cochin Peninsula and other European, British, American, Arab and an Indian city, Ahmedabad clearly reflects the difference between the Peninsula, Wellington Island and the Mainland and as a whole between it and other cities. We find that the mean connectivity, mean local integration and global integration are much lesser than those found in the west and even lesser than that in Arab cities. However, like the Arab cities studied Cochin can be considered to be less linear than cities in the West. The values of connectivity and integration for the Peninsula and Wellington Island are higher than that of the Mainland however are not as high as the average for the European or American cities. This seems to reaffirm how all organic cities tend to follow a generic pattern and that there are phenotypic variations for cities from particular regions (Karimi, 1997).

	No. Of Cases	Mean Connectivity	Mean Local Integration R3	Mean Global Integration Rn	Synergy Rn-R3	Intelligibility Rn-Con
USA	12	5.835	2.956	1.610	0.559	0.224
Europe	15	4.609	2.254	0.918	0.266	0.137
U.K	13	3.713	2.148	0.720	0.232	0.124
Arab	18	2.975	1.619	0.650	0.160	0.231
Ahmedabad	1	2.970	1.747	0.801	0.193	0.115
Cochin (Whole)	1	2.770	1.341	0.434	0.104	0.023
Cochin Mainland	1	2.714	1.317	0.513	0.213	0.049
Cochin Peninsula	1	2.882	1.397	0.426	0.359	0.129
Wellington Island	1	3.310	1.506	0.540	0.294	0.147

Table 1 Com	parison of s	vntactic measures	(Karimi.	1997	: Raman	2003)
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It clearly shows that Cochin's mean syntactic properties are closer to Arab cities than European, British or American. It reveals that Cochin may possibly have the least mean connectivity of the cities studied using the Space Syntax methodology and included in the above studies, and therefore could be considered as a new benchmark. As all the above mean values of Cochin fall closest to those of Ahmedabad and that too lesser than it, it contributes towards reaching a characterisation for Indian cities.

The comparison of the values of the mainland, Wellington Island and Cochin Peninsula show that though they follow a general tendency there are individual variations, in particular with the case of Wellington Island which was planned by the British and has a mean connectivity close to that of the British cities. It is interesting to note that synergy of the individual parts are relatively high especially compared to the Arab cities, and that of the Peninsula is even higher than the European cities.

Reading the city:

'Intelligibility' is a second order measure, correlating connectivity and global integration, which considers the relationship between what can be seen locally and the city overall. Intelligibility of the mainland is particularly low at 0.049 which could be partly influenced by the number of canals, streams, rivers and water bodies inundating the region. The intelligibility is only lower at 0.023 when Cochin is analysed as a whole as only two bridges link the peninsular with the island and the island with the mainland. The notably high difference between the intelligibility values of the three parts could be a reflection of how the experience of navigating and reading the city is different in each part.

With regard to the mainland, choice values at radius 3000 were found to identify, as explained previously, a network of streets with continuous commercial activity. Considering that local centres with the most robust commercial activity were observed to be located along these streets as well would mean that most areas between these edge defining streets have much lesser pedestrian or vehicular movement, and movement within these areas are most likely to be just for local journeys. The land use map also reveals that east of the railway line residential land use occupies most of these areas that are tucked away from the busy street life characteristic of commercial areas.

In Cochin, most residential streets within these areas are shaped in a sinuous manner and therefore are unlikely to be used for through traffic since the actual impression when travelling on them is that it is not certain where it will end at. Many of these internal streets provide through access, but one would need to take quite a few turns before arriving at an edge street and therefore the tendency is for them to be avoided for this purpose. Venturing through residential areas or looking at the land use map one can identify that, many streets that are two turns away from the edge defining streets, house only residential buildings and then end in a dead end. In residential areas towards the east and away from the city centre tree like structures in the street network had been identified. Residential streets are mostly solely residential but for the occasional grocery shop or the house partially converted to a shop. This makes the land use also a means of reading space in the residential areas, because if while traversing through streets two or three turns away from the edge one comes across small shops attached to the front of houses or houses converted to shops one can get a sense that the street leads back to an edge defining street eventually.

Another reason why residential streets that do have potential for through movement are most often not used for through movement is because their widths are relatively narrow and at times it is even difficult for two cars to pass side by side at a time without slowing down enough. The

width of street thus becomes a way of controlling and creating the privacy that segregated dead end streets would otherwise provide. The fact that almost all houses have compound walls reduces the visibility even more while walking on the sinuous road so contributes to discourage strangers from through movement. Thus another means of intuitively reading the city is with the help of observing the width of streets. It is relatively rare to find streets especially east of the railway line that are intense with commercial activity and relatively narrow (compared to the arterial streets).

This intuitive reading of the city however does not apply to the streets in Cochin Peninsula and therefore makes it difficult to orientate for somebody who has lived only on the mainland, as the street network on the peninsula are much more interconnected and much less sinuous. Two or three turns into a residential area often lead to other perpendicular non residential streets rather than dead ends. The widths of streets are also greater in Cochin Peninsula and therefore they do not provide as a means of navigation about either.

Spatial culture of Cochin

The low mean connectivity compared to other cities found in table.1 is a reflection of the mechanism that seeks segregation from through movement potential. As to why there is a tendency towards segregation may possibly have to do with the culture of the people who may be seeking privacy and familiarity compared to anonymity, that a more linear street based system would provide. Further research is required to be able to substantiate this observation. In simplest terms, the phenomenon could be attributed as a mechanism to avoid access of residential areas to strangers as has been inferred in other studies (Raman, 2007; Karimi, 1997).

In an effort at 'description retrieval' of the 'random generative process' (Hillier & Hanson, 1984) behind Cochin city, the study suggests that in residential areas, the rule behind placing the diad (of an open space attached to a contained space) may be that it should be placed in such way that the open space is most preferentially accessible from the rest of the city only from one direction. This would imply that a tree like structure would be ideal for residential areas.

This then would also explain why the residential areas are structured so that the commercial local centres are towards the edges. In such a situation residents do not have strangers walking into the central parts of their residential areas and commercial establishments can take advantage of the larger scale through movement taking place along the edges.

While the aspect of the commercial activity locating along the edges of a residential area may appear to have some similarity with the 'edge oriented commercial activity' found in the informal settlements in Santiago (Hillier, Greene & Desyllas,2000; Greene, 2003) in the case of Cochin where it is observed that residences prefer to be located away from the edges, in Santiago the potential for commercial activity along the edge provides financial benefits to the inhabitants and therefore becomes preferable.

As to why the internal structure of certain residential areas reflect a deformed wheel more distinctly and have greater number of dead ends while residential areas further away from the centre have lesser dead ends and resort to a different structure may have to do with growth and expansion of the city. With growing commercial activity and the expansion of the city, commercial establishments begin to locate themselves on streets with greater through movement potential in residential areas that are close to the city centre. This leads to the conversion of houses on these streets into shops or other commercial establishments and for new houses to move further away from these streets into dead end streets.

CONCLUSION

There are existing studies that have made use of the Space Syntax methodology and the theories behind them to compare cities from different regions of the world based on their configurational properties. These have shown that while, organic cities across the world follow various generic characteristics there are variations within them with difference in cultures. This research sets out to explain the organisation of space and the distribution of different land uses within the city of Cochin using the configurational approach and to be able to place Cochin within the comparison between cities across different cultures.

The study has shown that like cities across the world Cochin has a foreground network and background network but that instead of a foreground network approximating a deformed ring wheel pattern in Cochin it likens a ring with spokes at its corners. However, rather than being an exception the results suggests that the analysis captures a point in time of the city's development when a transformation appears to be in process.

In congruence with the idea of 'movement economies' and 'pervasive centrality', we find continuous commercial development along streets of higher 'through movement' potential and that the local centres align along these streets along the edges of residential areas rather than towards their geometric centres. In an effort to understand the spatial organisation of the city, the study appears to have identified a superimposed 3x3 grid within the city that has had effect on aligning the streets within the city along the cardinal directions.

The study in observing the differences in the organisation of blocks across Cochin Peninsula, Wellington Island and the mainland, identifies how each of these areas which have had different degrees of colonial influences upon their organisation of space, have distinct spatial distribution of streets and land uses. Comparison of syntactic values reveals how, while each area tends to align with the general character of the city, each of them are also variants because of the cultural differences of the people who occupied them in the past.

The study, in observing residential areas within the mainland at different locations within the 3x3 grid and outside it, and therefore at different distances from the coast which is known to have been the area occupied during the British times, finds that at increasing distance from the coast street networks within residential areas have either more cul-de-sacs, or are connected but even more sinuous and/or with greater direction changes within them. In finding that residential areas outside the 3x3 grid have even more number of cul-de-sacs and also have tree like structures within them, the study suggests that the natural tendency for residential areas in Cochin is to seek to distance itself from potential through movement so as to discourage strangers from using residential streets. It suggests that it is this tendency that is reflected in the very low values of connectivity, integration (global and local), synergy and intelligibility compared to those in other parts of the world. The study also makes an effort to identify the 'random generative process' that gives shape to settlement formation in Cochin having inferred from the study that residential areas seek to avoid streets with through movement.

Thus, in comparing the Mainland, Wellington Island and Cochin Peninsula; different residential areas within the city; and then the city as a whole with other cities in the world, the study is able to describe the spatial character of Cochin and in that process reiterates that while on one side cities across the world follow a common genotype cultural variations can produce phenotypic variations.

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