College of Environmental Design

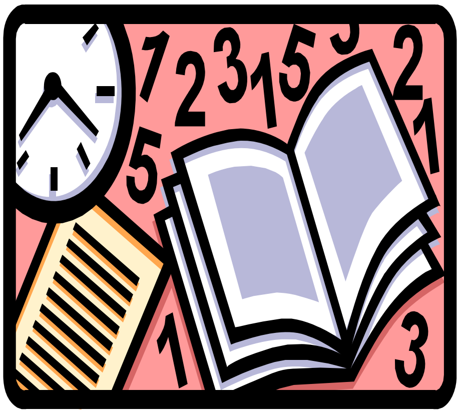
City and Regional Planning Department

Computer Aided Planning, CRP-507

Understanding the Spatial Configuration measures of CALCUTTA City using Space Syntax Program

(Term Project)

Submitted To
Dr.Baqer Al-Ramadan



By
Mohammed Riaz Jaweed
(200875)

Term 012

King Fahd University Of Petroleum and Minerals
Dhahran-Saudi Arabia

INTRODUCTION

Space Syntax is a way of examining the way Space is liable to be traversed by a mass of people and it takes a computer to do it. Space syntax software is used to check the intuition about organic growth or as a planning tool to mimic organic development in future schemes. The first sentence in any discussion about the science of cities usually contains the word “complexity”. One of the most obvious forms this takes is the sheer physical and spatial complexity of the city as an object. There is however, in most urban research, a strange silence on this aspect: the reason is simple; no one knows how to control the physical complexity variable. There is no formal language, which differences between one form of complexity and another can be described with the required rigor and consistency, and without controlling the variable we cannot measure its effect, what we cannot measure we prefer not to discuss.

However, Space syntax research about cities (1) seeks to redress this balance. It addresses first a problem of description: how can the physical complexity of the city be described with sufficient rigor and consistency to permit it to be controlled as variable in research. It gives what to some is a surprising answer: that it is best captured by representing it not as a physical stuff, but as the system of space created by the physical stuff. Buildings are physical things, but their purpose is to create the spaces and interconnections that we use. The effect of every physical intervention is to create or modify the space patterns. Cities may be aggregated of physical stuff, but space is the universal stuff, which holds the physical stuff together and gives it its overall form.

The irregular patterns of traditional settlements are difficult to describe in any precise way, even though we can, with careful observation, identify some of their underlying properties. If however, we want to study settlement patterns in a systematic comparative manner, then we must develop much more precise descriptive tools. Space syntax is one such tool, which offers quantitative and parametric description of some properties of urban layouts that have demonstrable social implications. Quantification is important because it helps us to make statements not only about the extent to which these properties exhibited by urban layouts but also about the extent to which these properties are present, thus bringing comparison to much sharper focus.

OBJECTIVES

- To study the spatial form and the underlying spatial configuration measures of Calcutta City.
- To find the 10% most Integrated area of Calcutta City.
- To find 10% most segregated area of Calcutta City.

STUDY AREA

- A Portion of Calcutta City is used as a study area to analyze its spatial configuration measures. The area of analysis is focused on developing axial lines for the selected portion and finding the 10% most Integrated area and 10% most segregated area in the selected portion.

LITERARTURE REVIEW

Physical planning involves the spatial distribution of goals, objects, functions and activities in urban areas. The context of physical planning continues to change; yet it remains an inherently traditional approach.

Physical planning may be regarded as the nuts-and–bolts of the way the built environment is conceived. The traditional meaning of physical planning focused upon the design and regulation of the major public and private physical improvements.

It is a truism to say that how we design the city depends on how we understand them. Cities are the largest and most complex artifacts that human kind makes. It is widely acknowledged that to make cities sustainable we must base decisions about them on a more securing understanding of them than we have now.

Space Syntax provides a new, evidence-based approach to the evaluation and strategic design of buildings and urban areas. Space syntax is a set of techniques for the analysis of spatial configurations of all kinds, especially where spatial configuration seems to be a significant aspect of human affairs, as it is in buildings and cities.

Its specialty is to analyse urban areas to see how best to arrange buildings, streets and squares to maximize their use.

Historical approach:

A system of laying out cities with straight streets at right angles to one another, often called as the gridiron plan or a street grid, evolved in such diverse cultures as ancient Greece, China and pre-Columbian Mexico. It was particularly useful in establishing a new colony or a military encampment, when a whole settlement was planned at one time. The alternative was a street pattern created incrementally in response to topography and property subdivisions as a settlement grew; these tended to be much more irregular than grids, with more curved and more short streets or deadends.

The Romans created a system of city design based on a perimeter wall that was often rectangular, a street grid, and two main streets that met at or near the forum and other public buildings.

Definition and application

Space syntax has provided important computational support for the development of urban morphological studies based on the concept of axial lines which structure an urban streets network and measures of graph-theoretical properties.

Space syntax research treats the built environments as systems of space, analyzing them configurationally and trying to bring to light their underlying patterns and structure. Buildings are physical things, but there purpose is to create the spaces and interconnections that we use. The effect of every physical intervention is to create or modify these space patterns. Cities, if considered as the aggregates of physicals stuff, but space is the universal stuff, which holds the physical stuff together and gives it its overall form.

Over the past two decades, it being a set of theories and tools used in urban planning and design has provided important computational support for the development of urban morphological studies based on the concept of axial lines which structure an urban streets network and measures of graph-theoretical properties. It has been extensively researched with considerable amount of empirical and case studies. It has been widely used for pedestrian modeling, criminal analysis, and traffic pollution control and of course the way finding processes.

Space syntax provides a configurational description of the urban structures and attempts to explain human behaviors and social activities from a spatial configuration point of view. One of the most applied space syntax analysis starts from representing an urban system as an axial map.

Software:

Ax man is an application used to analyze maps of urban and architectural space. Ax man is shown to correlate movement with integration by coloring from red to blue. Ax man can be used to study urban and architectural forms, generating objective information, which can be used to think subjective information.

Ax woman is an Arc View extension for helping you discover and understand the morphological aspects of urban systems. This program is based on the theory of space syntax developed by Bill Hillier and his colleagues in the University College London. Beyond that, we are still under development of more functionality using graph theory, which may lead to more useful tools for urban planning professionals.

The same functionality has been implemented as an extension of ArcView3.0; we simply call it Ax woman. Apart from this, we have added more functionality, which cannot be simply done with Ax man. By integration of space syntax analysis, it improves the capability of Arc View in morphological and configurational analysis.

Space Syntax Principles

Space syntax is a set of theories and tools used for spatial morphological analysis with particular applications in urban science. However, the underlying principles that support space syntax theory have not been completely explained and disseminated throughout the GIS community. We believe that space syntax can be considered both as an alternative model of space at the cognitive level, and as a practical computational method for the analysis of urban structures and patterns. This coincides with the scope of many scientific studies such as morphological analysis, and modeling studies oriented to the representation of dynamic urban behaviors. In this article, we provide an introduction to the cognitive and modeling principles of space syntax, in particular to the different computational parameters that underpin many of the empirical studies conducted so far.

Spatial Decomposition

An urban environment consists of two parts: spatial obstacles such as buildings, and free space within which human beings are able to move from place to place. The notion of free space, defined as the parts of an urban space available for movement of people (thus excluding by definition physical obstacles) is particularly important for space syntax approach. Space syntax focuses on free space and decomposes an entire area of free space into small pieces of space, each of which can be perceived from a single vantage point. As such, this representation constitutes the cognitive fundamental modeling reference of the space syntax approach. In other words, a visual distinction between different forms of the perceived space (free space versus physical obstacles). These modeling concepts differ from those generally used in GIS modeling: *i*.e., object- versus field-oriented paradigms, since the concept of free space is not represented as such by these models. Several space syntax representations can be applied, depending on the degree of linearity of the free space. The first space-syntax representation is oriented toward environments, which are relatively linear. This linear property represents the fact that the built environment is relatively dense, so that the free space is stretched in one orientation at most points. Common examples of this type of urban environment are a city, a town, a village or a neighborhood. When humans are walking in this type of free space, at most points (if not all) such a free space is perceived as a 'vista' that can be approximately represented as an axial line. The first representation, a so-called axial map, is defined as the least number of longest straight lines According to how each line intersects every other line, a connectivity graph, taking axial lines as nodes and line intersections as links, can be derived. In contrast, the second representation is more oriented toward environments in which the free space is non-linear. A typical example of this type of environment is a building's internal layout, where most rooms are stretched in two ways, although corridors may have linear characteristics. Therefore, the second representation partitions the free space as a finite number of convex spaces, which is represented by a convex polygon in 2D maps. A polygon is said to be convex if no line drawn between any two points in that polygon goes outside the polygon. For a standard building layout, each room or corridor can be approximated as a convex space . So the second representation, a so-called convex representation, should comprise the least set of the broadest spaces that covers the whole free space. A connectivity graph is derived by taking rooms as nodes and door connections as links. The third representation is also oriented to non-linear free space, but with a more precise spatial representation. This representation is based on the notion of isovist, which is defined as a visual field that is wholly visible from a single vantage point

Space Syntax Applications

In recent years Space Syntax has worked on a wide range of projects to:

- Advise property owners and investors on the functional performance of their building stock
- Construct spatial design strategies and design master plans for buildings and urban areas
- Form design-led solutions to problems of low footfall and poor trading in retail centers and public spaces
- Support planning applications for major building and urban design projects
- Present evidence at major planning enquiries
- Develop new guidelines for safer residential design
- Craft building and campus layouts that promote interaction and information-exchange

- Challenge received wisdom regarding land-use planning, zoning and layout design.

Spatial Analysis Parameters

For urban morphological analysis, space syntax provides a range of spatial property parameters derived from the connectivity graph. First, **connectivity** is the most apparent parameter for morphological analysis. **Connectivity** is defined as the number of nodes directly linked to each individual node.

The second parameter is the **control** value, which is defined as a parameter, which expresses the degree of choice each node represents for nodes directly linked to it.

The notion of depth can be defined as the number of steps from a considered node to all other nodes. A node is said to be deep if there are many steps separating it from other nodes. By contrast, a node is said to be shallow if only a few steps separate it from other nodes. Depth is not an independent parameter of the space syntax. However, it is an important variable for calculating the integration of a node.

The third parameter is **integration**. **Integration** of a node is by definition expressed by a value that indicates the degree to which a node is integrated or segregated from a system as a whole (global integration), or from a partial system consisting of nodes a few steps away (local integration). These parameters can be used to describe both local and global properties of a spatial configuration in the sense of integration or segregation. A space is said to be more integrated if all the other spaces can be reached after traversing a small number of intervening spaces; it is less integrated if the necessary number of intermediate spaces increases. This concept is measured by global integration. Similarly, connectivity and local integration measure the degree of integration or segregation at the local level.

Basically there is a correlation between these local and global parameters. Such correlation is ‘intelligibility’, which is used to describe the part–whole relationship within the spatial configuration. It is defined by the coefficient of correlation between local and global parameters. A local area is said to be intelligible if its coefficient value is higher than the one of global area.

METHODOLOGY

A base map of CALCULTA city is obtained.

Axman software was used to draw the axial lines and obtain the Axial Map.Axman is effectively a computer aided design program where you draw with space rather than solid blocks. The results of this are that we can make statements about the nature of the space and its relationship to other spaces, which form the system (urban or building) of interest. The space has a number of properties: size, shape, lighting conditions, average temperature, number of people walking through it, the number of shops, or their average rent.

A space has a number of global properties, it exists in relationship to the spaces it connects to, which in turn connect to other spaces. Ultimately, there is a route from each space to all other spaces in the system. Hence, there is a relationship between each space and its position in the rest of the system. In syntactical terminology this is called a global relationship.

Using special mathematical theories Axman constructs global measures, which are different for each space. These measures have already been discussed. The utility of space syntax is that there are a number of interesting relationships between global and local measures of space. Axman was designed as a tool to explore and research these relationships.

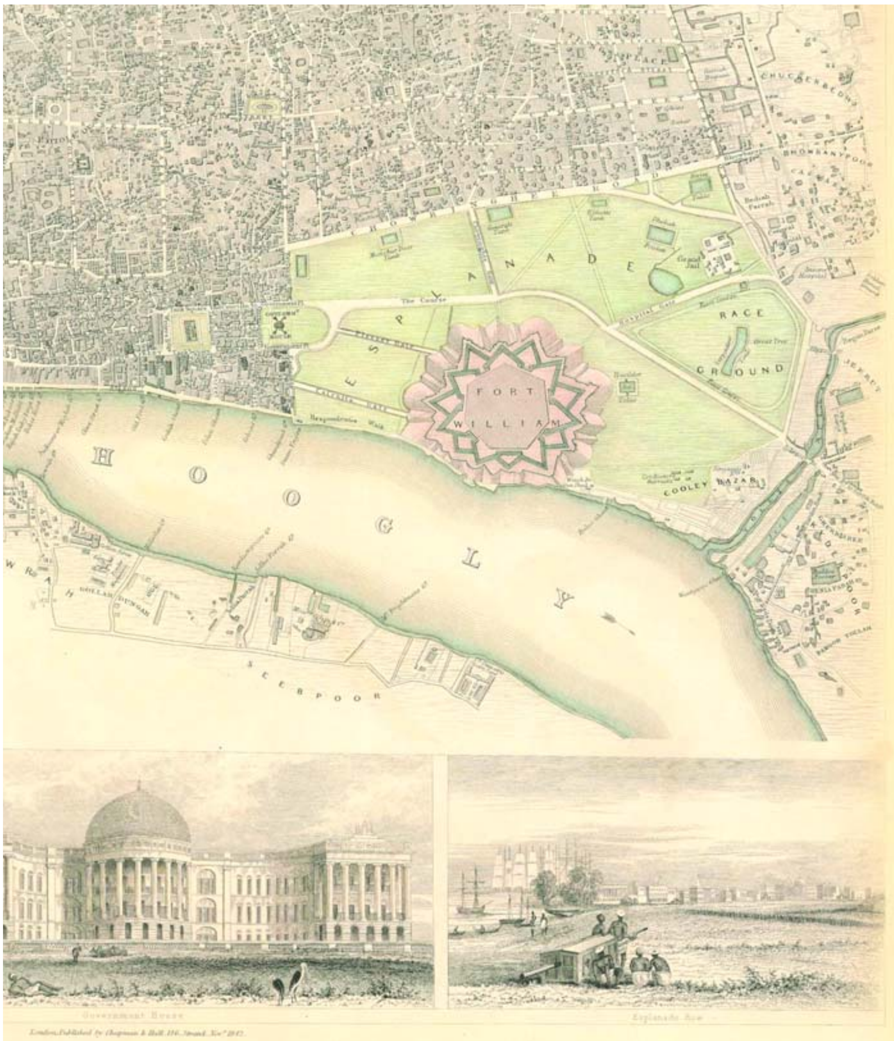
The axial maps are prepared for a portion of Calcutta city. The 10% most Integrated Area and 10% most segregated area was obtained by transferring axial map in Adobe Illustrator and working on it.

SPATIAL ANALYSIS

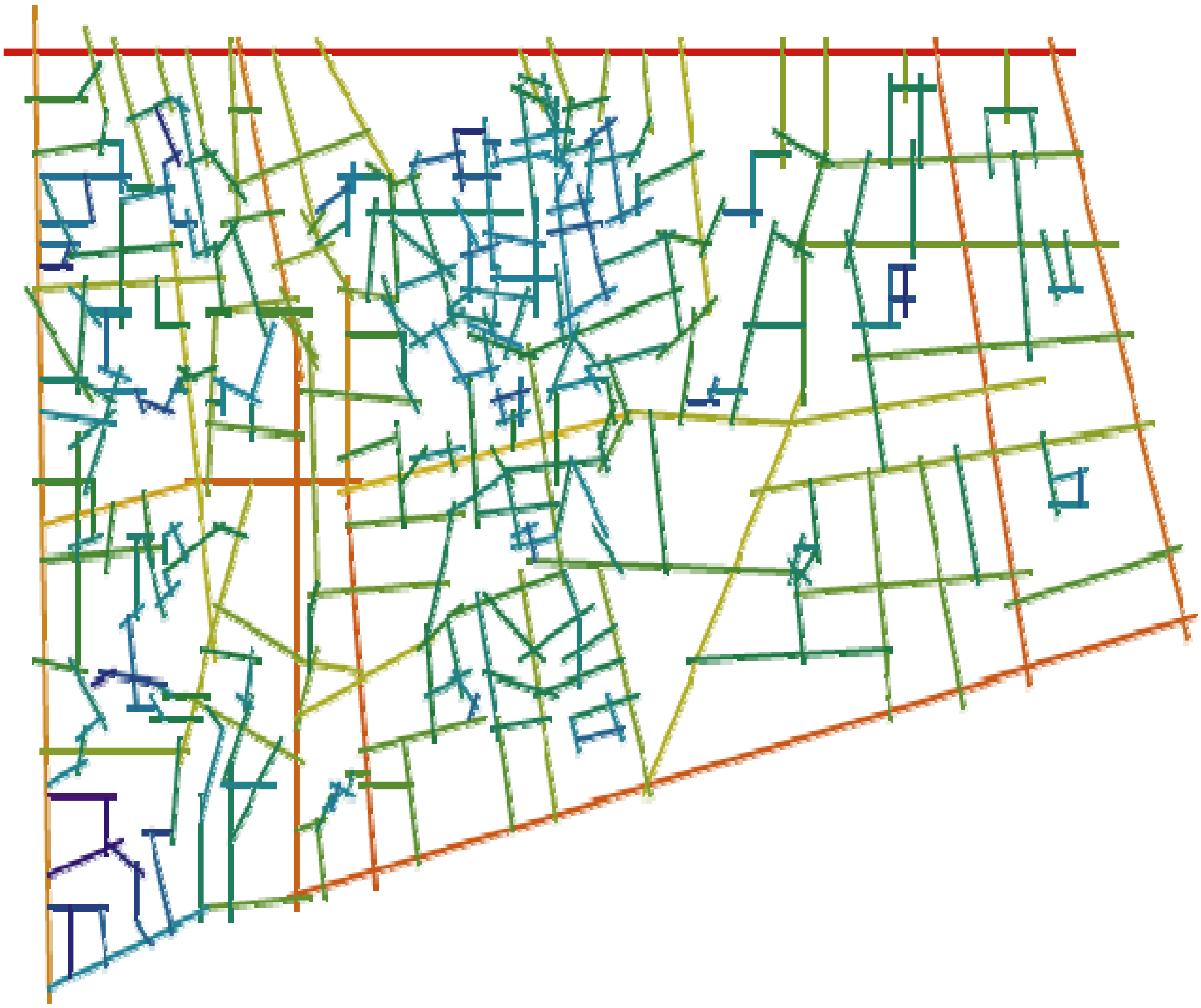
Processing the Axial map

The axial map has been processed using Axman PPC2.5d software in Macintosh environment. The processed maps for Integration show different colors. In general Red color means highly integrated streets followed by Orange, Yellow, Green, Light Blue and Dark Blue, which means highly segregated streets or very least integrated streets.

City of Calcutta



Axial Line Map for Integration of Calcutta

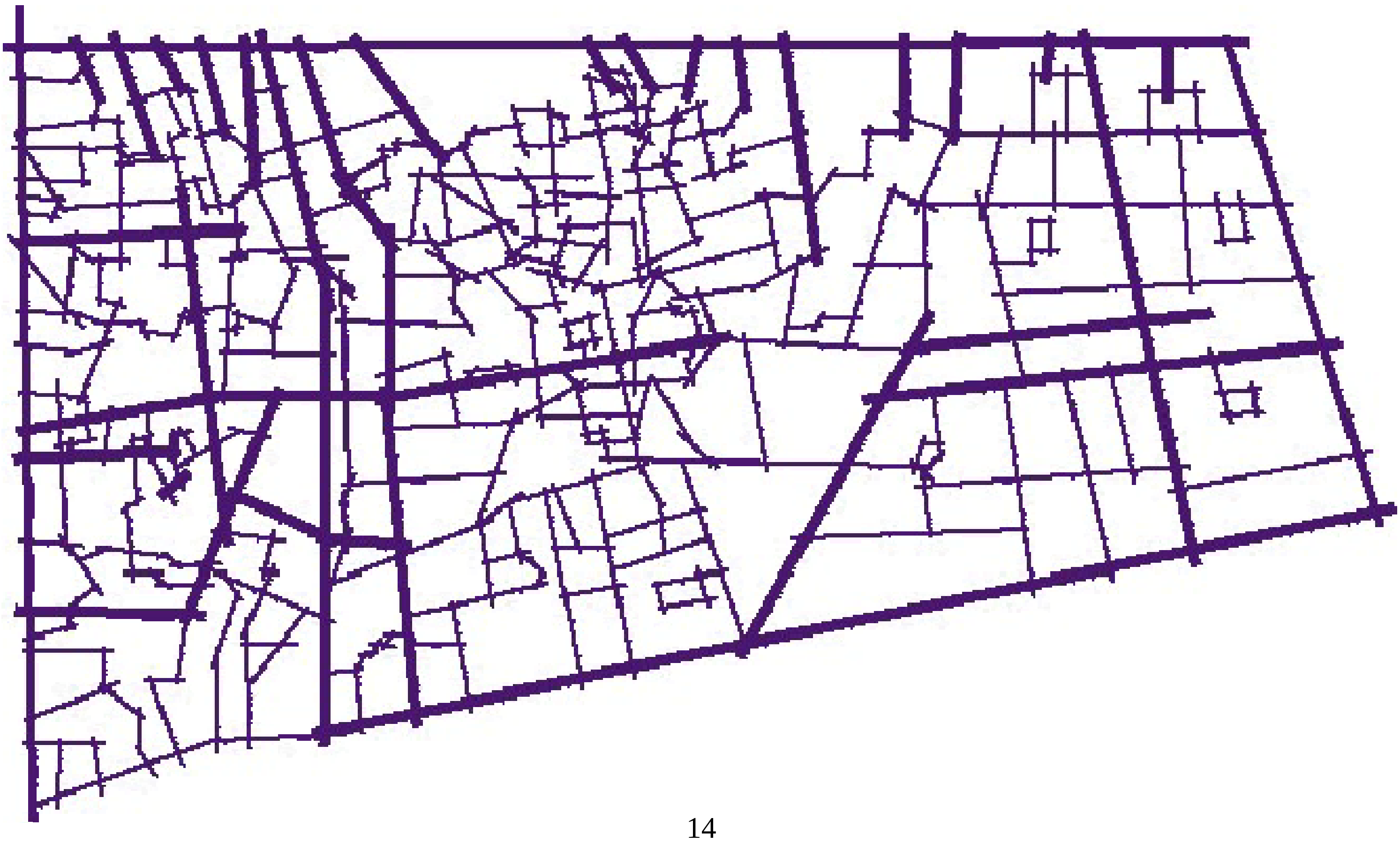


<u>10% Integrated and 10% segregated Area of a portion of Calcutta City</u>

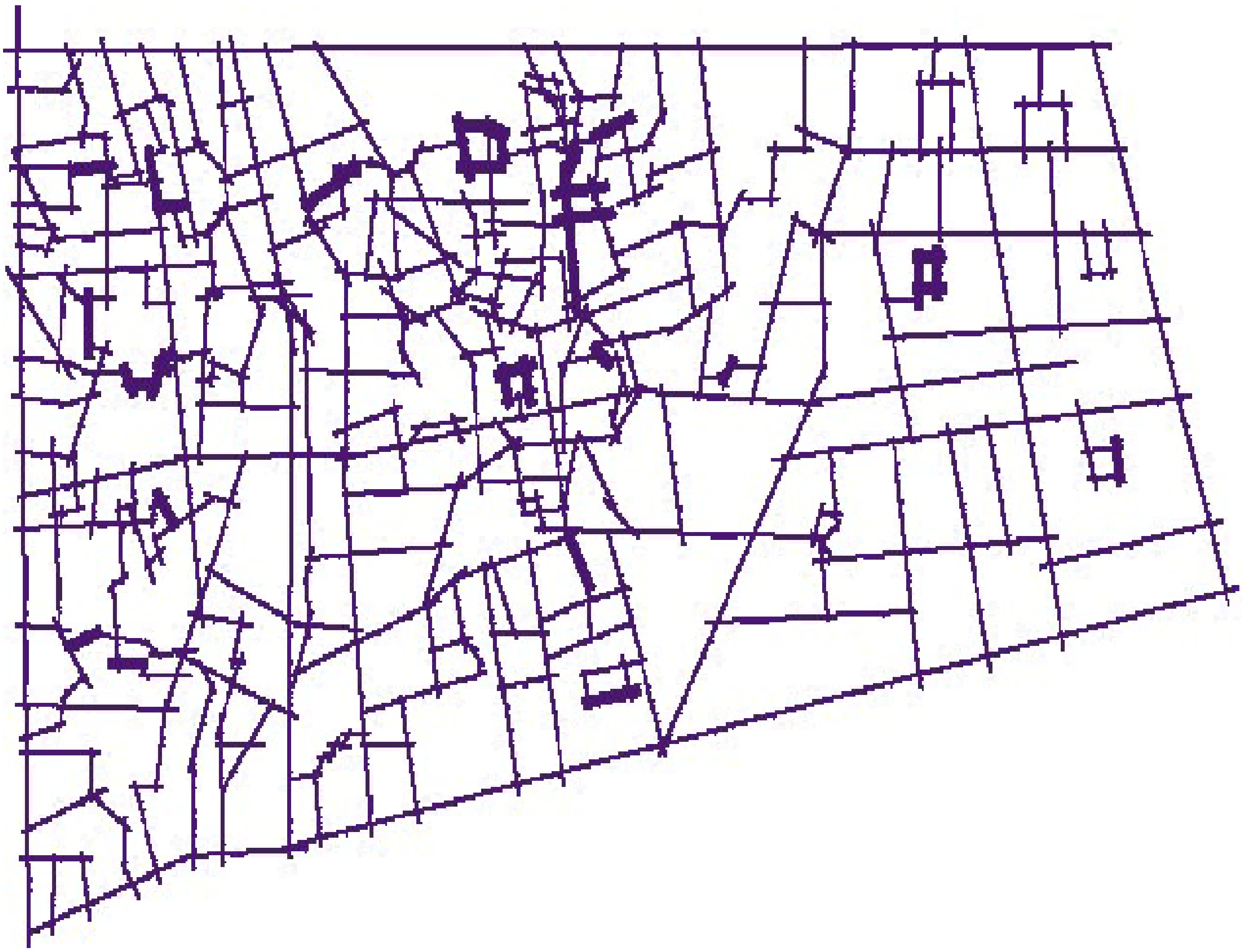
The processed axial map is exported to Illustration software Adobe Illustrator 7.0 where 10% most integrated lines are picked up and highlighted as thick lines. The same procedure is adopted to highlight 10% segregated streets.

Axial map showing the 10% integrated and 10% segregated streets for Vehicular movement.

10 % Most Integrated Streets



10% Most Segregated Streets



CONCLUSIONS

- The area in the outer top portion is well integrated whereas other part are not very well Integrated.
- The 10% most integrated lines lie on the outer periphery of the portion.
- The 10% most segregated lie on the inner top most portion of the area.