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## SMART CITIES CHALLENGES

SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

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## SMART ENVIRONMENT

## FOR SUSTAINABLE RESOURCE MANAGEMENT

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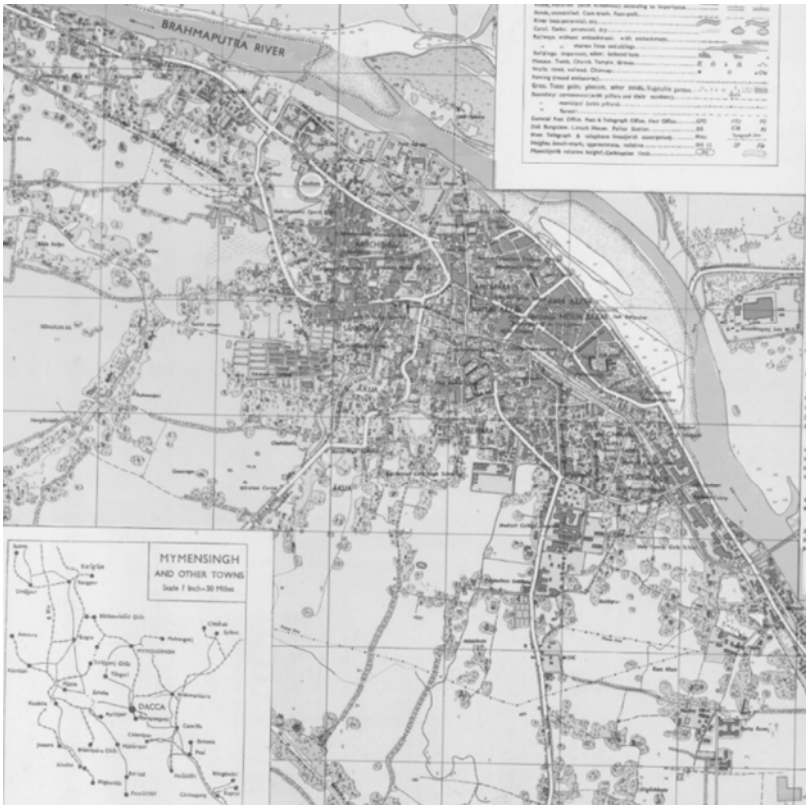


# PREDICTION OF MYMENSINGH TOWN FUTURE EXPANSION

## USING SPACE SYNTAX

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ABSTRACT

Urban space changes according to different space use with the passage of time, as seen in land use, location, and land value distribution. The paper intends to analyze the change of integration core related to the growth of commercial land use through different time periods. Two phases of Commercial land-use pattern is studied. The phases are i) 1974, ii) 2013.
The entire spatial structure of the commercial land use of Mymensingh reacts to the entire city system, particularly the road network pattern. In this context, this study aims to identify the influence spatial configuration exerts on the location of different types of commercial activity in terms of land use. The results of this study will help to interpret and predict the future commercial land use related to its road network. In this paper the process was conducted in the following steps: Step-01: A field survey was conducted to collect data regarding locations of commercial activity, Step-02: Land-use maps of two phases were collected to analyze the relation between commercial activity and road network, Step-03: Space syntax theory was applied to simulate the data to analyze the relationship and Step-04: Proposition.

KEYWORDS:
Integration-core, urban economy, spatial expansion, axial- analysis

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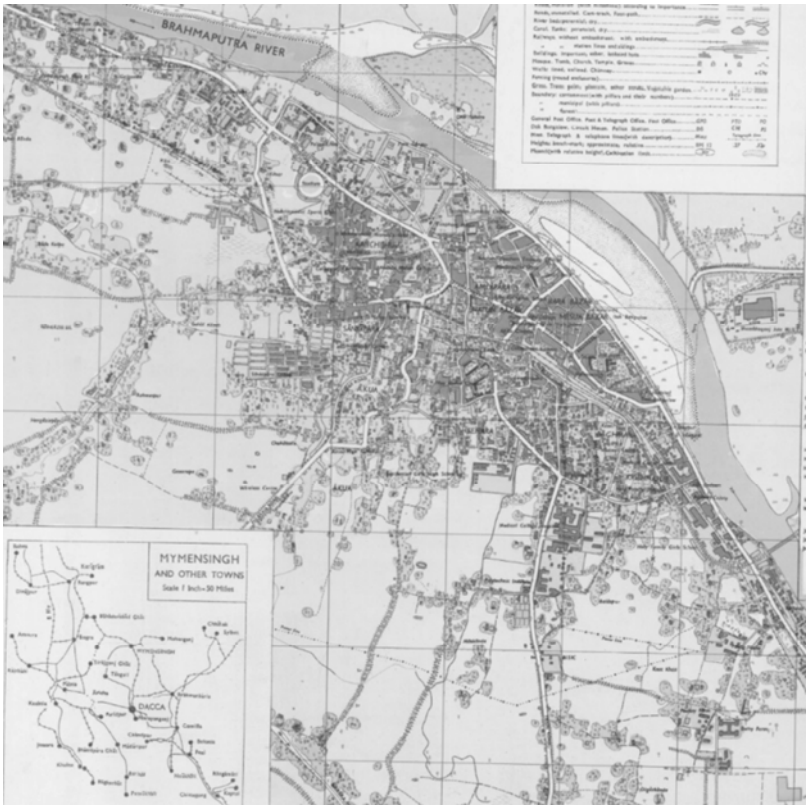


# 利用空间句法（SPACE SYNTAX）预测迈门辛县（MYMENSINGH TOWN）的未来扩张

SILVIA ALAM

蒂帕特蒙-奥夫-阿奇太科特。阿萨努阿-尤尼维西提-奥夫-西昂斯-安德-泰克诺劳及
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摘要

城市空间根据不同的空间利用并随着时间的推移而改变，这种变化表现在土地利用、选址以及土地价值分配等方面。本文旨在分析不同时期与商业用地增长有关的整合核心的变化，对商业土地利用范式的两个阶段进行研究：阶段一为 1974 年；阶段二为 2013 年。

迈门辛商业用地的整体结构是对整个城市系统，特别是道路网络格局的回应。在此背景下，此项研究的目的在于就土地利用而言，确定空间配置对不同类型商业活动选址的影响。此项研究的成果将有利于解释与道路网络有关的未来商业土地的利用，并据此做出预测。

本文的研究步骤如下：第一步，通过实地考查搜集有关商业活动选址的数据；第二步，搜集两个阶段的土地利用地图，分析商业活动和道路网路之间的关系；第三步，使用空间句法理论来模拟数据，分析两者的关系；第四步，提出建议。

关键词

整合核心；城市经济；空间扩张；轴向分析

# 1 INTRODUCTION

The economic progress of Mymensingh City completely depends on the commercial hub that consists of Shopping Centers, Banks, Local Bazaars etc. Since there is no industry or other business activity that exists in the city, the development of this commercial hub and its pattern of future expansion have a significant impact on the local economy. Hence this paper intends to study the formation and growth of the commercial hub of Mymensingh city over time and also analyze the possible direction for its future expansion. First, the commercial zones of the city were located through field survey and land-use data. Then the integration Core of Mymensingh city was identified by applying space-syntax theory. It was found that the formation of the Urban Core of the city (integration core) is codependent on the development of the Commercial Hub. Two of the city's economic phases (1974 and 2013) has been compared and analyzed for further results.

## 1.2 OBJECTIVES

- To find the relationship between the street patterns and the commercial land use patterns of a city on the basis of integrity of the roads
- To analyze the integration-core and the change of the most integrated route in relation to the economy of Mymensingh city.

# 2 METHODOLOGY

The methodology for the process of analysis and evaluation can be described in a structured way. The initial step is to acquire the basic information of the Mymensingh Paurashava, as such the historical background of the evolution of the city, the present dimension, the natural and geographical settings which influences the growth and expansion of the city.

The basic information of the land use patterns and street network is collected from the local authority of Mymensingh Paurashava. The land use maps include the different types of land use patterns and total areas. The depth map is used for simulation to generate the integration pattern of the streets of Mymensingh Paurashava. From this simulation the maximum and minimum integration of the streets can be generated and plotted through a map. Thus the maximum integrated part of the city or the urban core can be marked.

The comparison between the both simulated map and the land use map of 1974 and 2013 helps to understand the inner relationship of the different types of land uses and the integrity of the adjacent streets. It also helps to understand the reason of concentration and expansion of different parts of the city. The possibilities of future expansion of urban core and change of land use patterns can be assumed from the simulations and comparison of the land use pattern.

# 3 LITERATURE REVIEW

## 3.1 HISTORY OF MYMENSINGH CITY

Mymensingh (Bengali, pronounced *moy-mon-shing-haw*) is a city of Bangladesh situated on the river Brahmaputra. Since the 1980s the city has expanded with fast urbanization. Mymensingh city is clearly marked by the old Brahmaputra River flowing along its north. Shambhuganj is situated on the other side of the Brahmaputra, connected by the Shambhuganj Bridge. The other ends of the city are marked respectively by the beginning of the Agricultural University campus, the Medical College, Army cantonment and, finally, Sultanabad, a township built for the followers of Aga Khan. A railway line connecting Dhaka with northern districts, built between 1885 and 1899, passes through the city and divides it into two sides. The entire area between Durgabari Road, and Maharaja Road comprises the core commercial area. There are places like Ganginarpar, Boro Bazaar, Choto Bazaar, Mechua Bazaar within this area. There are spots like 'Jilapi Patty'

which is for making and selling 'jilapis'. The main road from Notunbazar to the railway station hosts a number of shops for manufactured products and clothing on the two sides.

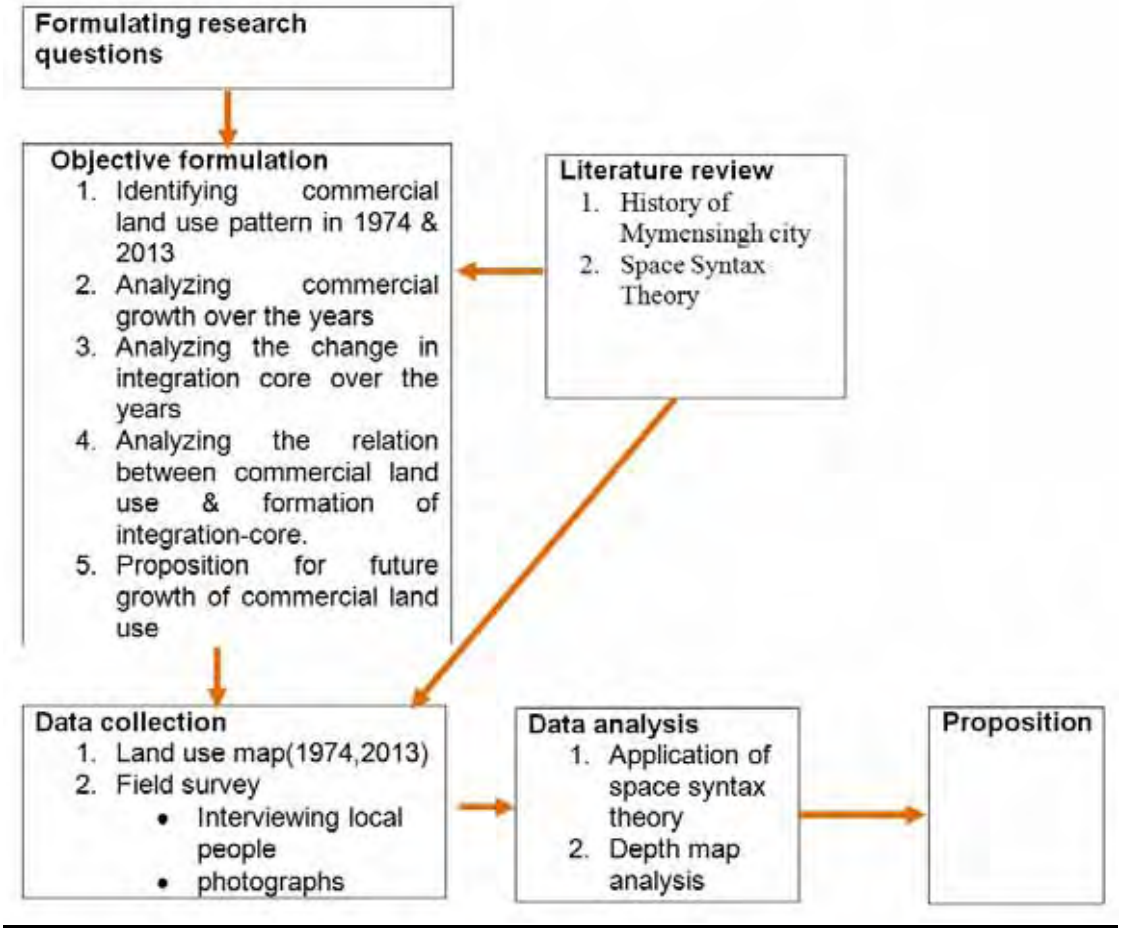


Fig. 1 Research methodology

## 3.2 SPACE SYNTAX THEORY

Space syntax is a methodology for measuring the relative accessibility of different locations in a spatial system by partitioning the spatial system into relatively independent but connected subspaces (Hillier and Hanson 1984, Batty and Rana 2004).

It adopts a configuration approach to study to what extent and in which conditions the social and spatial attributes are correlated. It analyzes the topological properties of the urban grid represented by urban street network, and compares that with the human movement including pedestrian and vehicle flow. Comprehensive mathematical models of the topology of urban street network, analyzed and supported by empirical data give deep insights into the functional patterns and settlements and cities (Hillier et al. 1993).

- Space syntax theory and technology were pioneered in 1970 by Prof. Bill Hillier and Colleagues at University of London.
- Built on quantitative analysis and geo-spatial computer technology, space syntax provides a set of evidence based techniques for the analysis of spatial configuration of all kinds, especially where spatial configuration seems to be a significant aspect for human affairs, as it is for buildings and urban areas.
- In this technique, the 'convex space' defined by polygons where no line is drawn between any two points in the space goes outside it. 'Axial line', defined as the longest and fewest straight lines of visibility and permeability that cover all the convex space represent the one dimensional organization of the spatial layout.

- In the context of a city, urban blocks or plots are considered as close spaces, while streets and squares as parts of the open spaces. Open space provides a unique vision in understanding the configuration of an urban system.
- There are ***four syntactic measures*** that can be calculated. These are used in quantitative representations of building and urban layouts:
- **Connectivity** measures the number of immediate neighbors that is directly connected to a space. This is a static local measure.
- **Integration** is a static global measure. It describes the average depth of a space to all other spaces in the system. The spaces of a system can be ranked from the most integrated to the most segregated.
- **Control value** is a dynamic local measure. It measures the degree to which a space controls access to its immediate neighbors, taking into account the number of alternative connections that each of these neighbors have.
- **Global choice** is a dynamic global measure of the 'flow' through a space. A space has a strong 'choice value' when many of the shortest paths, connecting all spaces to all spaces of a system, passes through it.

*Integration*

Among all the measures, the first and the most important measure of Syntactic analysis is integration. The integration of a space is a function of the mean number of lines and changes of direction that need to be taken to go to all other spaces in the system. Integration is therefore about syntactic and not about metric accessibility and the word depth rather than distance is used to determine how far a space lies. The integration value of a line is a mathematical way of expressing the depth of that line from all other lines in the system (Hiller & Hanson 1984). In integration, the relative depth and shallowness of any spatial system are seen from any Particular point within it. Integration is a global static measure in that, every axial line is assigned a value which is characteristic to its relation to all other lines in the and thus provides a global index of relative integration and segregation for that line relative to all others. These values that are well below 1 – out of the order of 0.4 to 0.6 – indicate more segregation, while the value ending to and above 1 show strong integration. The warmer color axial line has, high global or local integration value and vice versa. For example, the red line represents the highest integration value; the dark blue line represents the lowest integration value, in other words, the most segregation.

*Integration Core*

Once the integration of each space of the whole system has been calculated, the "integration core" which illustrates the important deep structure of a spatial system, can be identified. The integration core forms the pattern of 'the most integrated line' of an urban system. The nature of the integration core, its size, and space depends on the shape, connectivity, and geometry of the urban system and on its mode of growth.

## 4 DATA COLLECTION

Defining a methodology is imperative to directing any research work. In general, a method is the way of doing something and a methodology is a broad framework of systematically arranged various methods and techniques devised to conduct any research work or study (Jahan 2007). Here secondary data was collected. Like the Master plan on Land use zoning, Structure plan, Strategic plan, Spatial growth of Mymensingh town and Mymensingh town ward map, Road map of 1974 & 2013 from UDD and others demographic, geographical, economical, historical data from literature review.

## 4.1 LAND USE MAP 1974

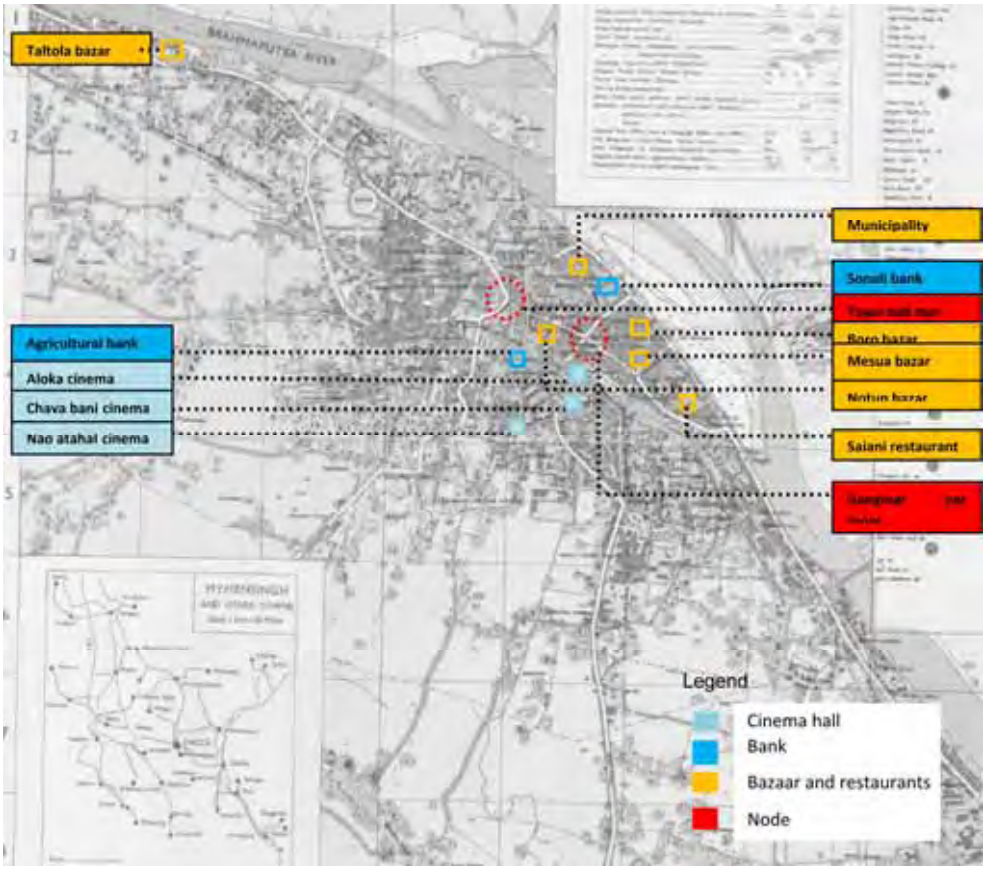


Fig. 2 Land use map of 1974

## 4.2 LAND USE MAP 2013


Fig. 3 Present name of the road and approximate locations of the selected commercial land use

## 4.3 LAND USE ZONING

According to the master plan, Mymensingh has attracted by the surrounding area which are treated as the hinterland and the development of Mymensingh adjacent with its near river "Bhrammaputra" and road. The **Ganginapar nodal point** and **Town Hall nodal point** is the main urban core that is connected with other roads and streets of the city. The movement from one part of the city to another part needed to pass these two nodes as the main road continues from east to west between these nodes and connected with Dhaka-Mymensingh highway (Mymensingh Master plan 2009-2013). The main commercial zone has been developed on both side of main road near the Ganginapar node after the establishment of Mymensingh Railway Station. The educational facilities have grown afterwards along the both side of main road near Town Hall node. The administrative facilities are established near the riverbank in an early period but the road connecting those buildings was not treated as main road of the city. The establishment of Agricultural University played an important role for expansion of the city on the east part though the development was slow comparing to southern part. At present the Dhaka Mymensingh highway is widened and the new commercial facilities are emerging along the connecting roads from Ganginapar node to Dhaka-Mymensingh highway.

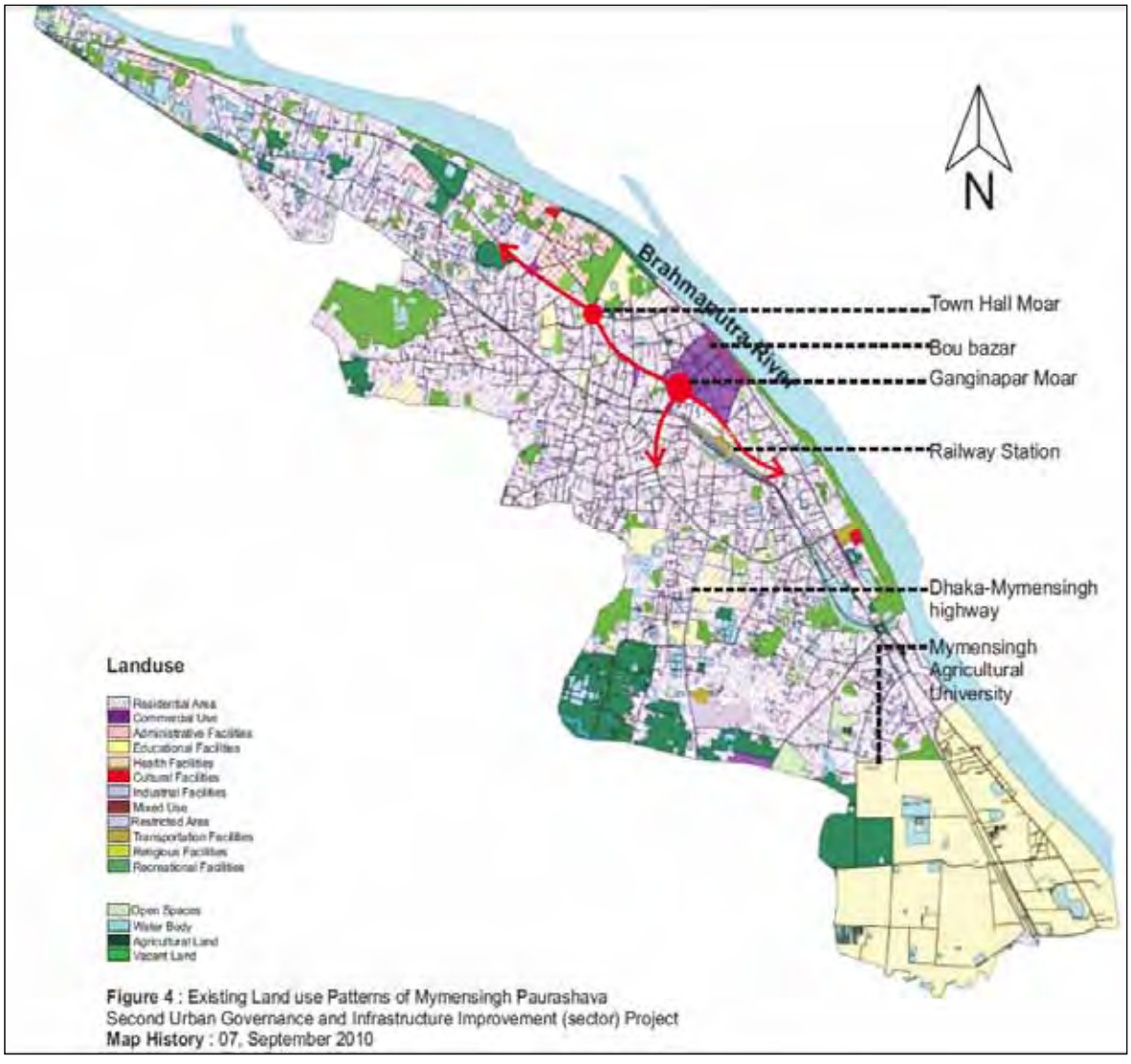


Fig. 4 Existing land use patterns of Mymensingh Paurashava, 07 Sept. 2010

*Street Patterns*

Mymensingh Paurashava is divided into 21 wards alongside the river of Brahmaputra. The main accessibility to the city center is from Dhaka-Mymensingh highway,Shamvuganj Bridge over the river Brahmaputra connecting Netrokona, Mymensingh-Tangail Road and from Fulbaria to Mymensingh road. The Ganginapar nodal point and Town nodal point are the main urban core that are connected with other roads and streets of the city. The movement from one part of the city to another needed to pass these two nodes as the main road continues from east to west between these nodes and connected with Dhaka-Mymensingh highway.

*Town Hall Nodal Point*

The major dynamic driving forces of the cities in developing countries are economic and social forces to change the urban system with the growing demand of population and urbanization. Of course all the urban problems are different and unique to a particular city based on the city growth pattern, economic and social character. The centre of economic hub of the city is “boro bazaar” and “notun bazaar” area. The changing city form gave “Boro Bazaar” the shape of mixed use zone rather solely commercial or business zone. As a central economic hubs in the city centre, Boro Bazaar needs to be more dynamic to response to the city economy and its growth pattern. For last one decade Boro Bazaar has faced compact unplanned haphazard development even along the riverside just to meet the demand of rapid urbanization process. Therefore it is now become an urban challenge to revitalize the Boro Bazaar area to make more effective response to the rapid economic growth and to ensure better urban environment for the residents, businessmen and the employers.

*Ganginar Par Nodal Point*

As a new economic hub, “Ganginar par” node has a great importance. At this node all kinds of mixed commercial business are running. All kinds of luxuries office and private Bank, insurance, show room has established. So, it has its own importance. The maximum traffic congestion occurs in some areas in different time period of the day. From morning 7 am to 9 am and 12 to 2 pm the traffic congestion can be seen in between Town Hall node to Ganginapar node as School and colleges are alongside the roads. The office vehicular flow for office going people is responsible for traffic congestion during 8 to 10 am and 6 to 8 pm. The main market and bazaar zone is along with the Station node and the connecting road towards Ganginapar node. The traffic congestion occurs here during 12 pm to 1 pm and 6-to 8 pm at the evening. The maximum pressure on the roads occurs at Ganginapar nodal point at all the rush hours because this point is passed by all types of vehicular flows for different purposes like educational, administrative and commercial. So it is clear that, the growth pattern of road runs with the city economy of Mymensingh. “Space syntax” has show; the transformation of the integrated core. This can be explained with the economic activities of the city.

## 4.4 FIELD SURVEY

Fig. 5 Bari plaza

Fig. 6 Notun bazaar node

Fig. 7 Ganginar par node

Fig. 8 Station node

Fig. 9 Charpara node

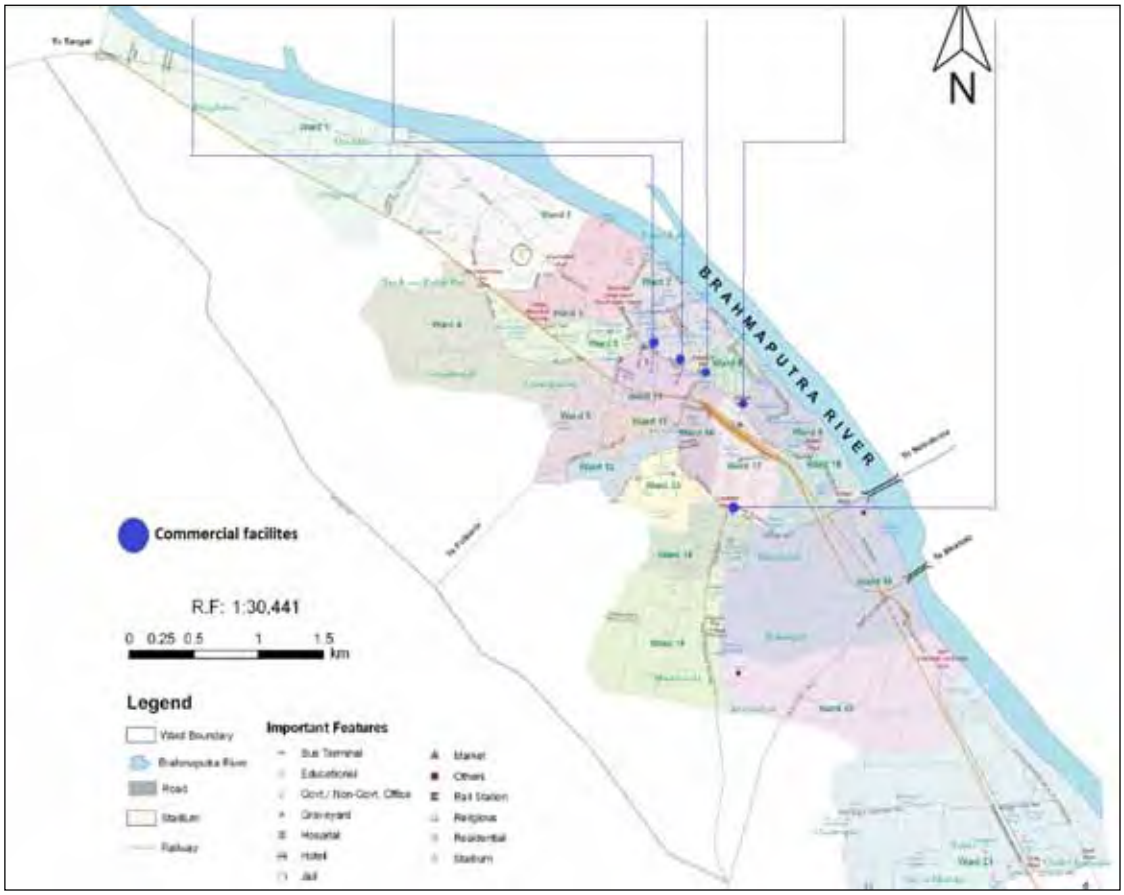


Fig. 10 Location map of Mymensingh town, 07 Sept. 2010

## 4.5 GENERATING AXIAL MAP

Fig. 11 1974 Road network layout drawn as convex space

Fig. 12 2013 Road network layout drawn as convex space

# 5 SIMULATION

## 5.1 IDENTIFYING INTEGRATION CORE

The space syntax simulation of the Mymensingh town is done with the help of depth map to create an axial map of the existing street patterns. The axial map is created by axial spaces or axial lines which are straight lines ("sight line"), possible to follow on foot. From the axial map the integration values of the streets are generated. The integration of a space is a function of the mean number of lines and changes of direction that need to be taken to go to all other space in the system. Integration is therefore about syntactic not about metric accessibility and the word depth rather than distance is used how far a space is lies.

The integration value of a line is a mathematical way of expressing the depth of that line from all other line in the system (Hiller & Hanson 1984). In integration, the relative depth and shallowness of any spatial system are seen from any particular point within it. This analysis has considered on the basis of Global theme (R= n).

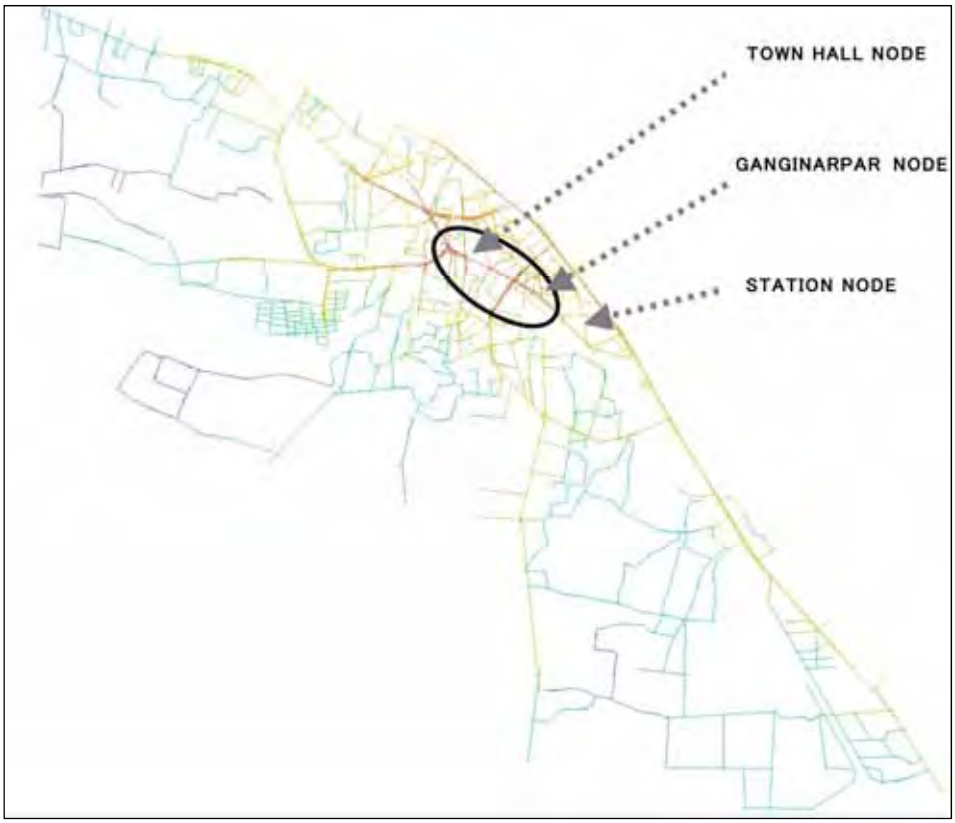


Fig. 13 1974 Axial map with global integration R=n

From Pouroshobha map of 1974 and 2013, it shows that each of the selected commercial zones is connected to a main road through a secondary access road. Global Integration, Connectivity of access road of commercial zone of 1974 & 2013 are given below.

From Tab. 1 it can be seen that Ganginarpar and Shemacharan roads were mostly integrated roads with the value of 1.38358 in the town and their connectivity were highest which is 34. Jubilee road was the second highest integrated road of the town as Borobazar and Chotobazar road were partially connected with it (Fig. 2). Chorpara road had the connectivity of 13 which had commercial buildings like Aloka cinema hall, Anondolok cinema hall and agricultural bank (Fig. 2) which was low down integrated road than Ganginarpar and Shemacharan roads.

Fig. 14 2013 Axial map with global integration R=n

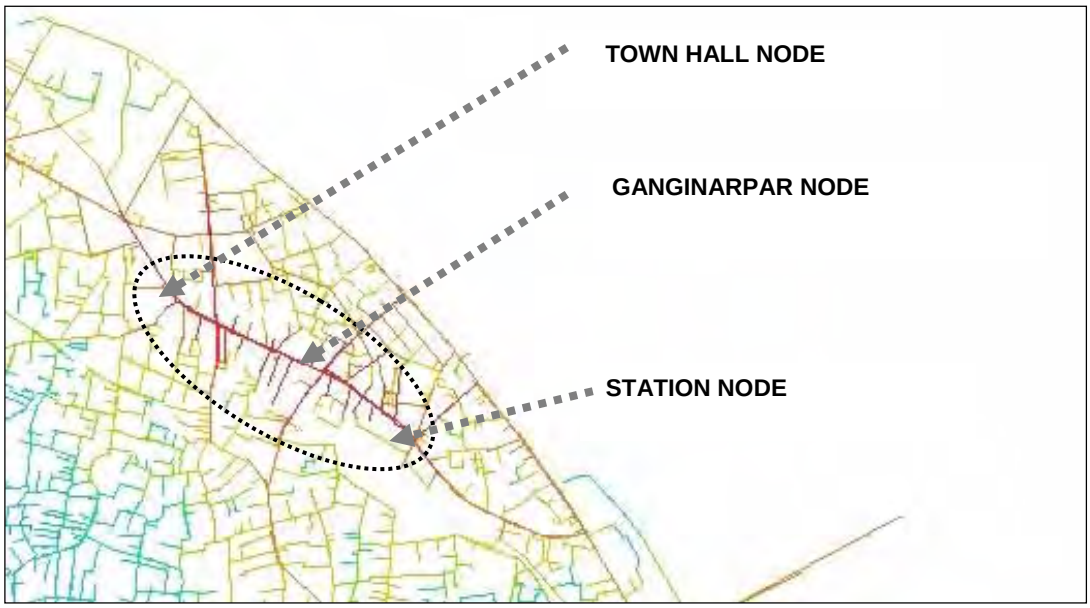


Fig. 15 Blow up of 2013 axial map with global integration R=n

## 5.2 ANALYSING AXIAL MAP OF 1974 & 2013

| SL No | NAME OF THE BUILDING | ADJACENT MAIN ROAD | REFF NO. | INTEGRATION (HH) | CONNECTIVITY |
|---|---|---|---|---|---|
| 1 | Boro bazar | Borobazar Road | 232 | 1.11073 | 6 |
| 2 | Choto bazar | Choto bazar Road | 231 | 1.0304 | 5 |
| 3 | Mesua bazaar | Ganginar par Road | 279 | 1.38358 | 34 |
| 4 | Notun bazar | Shemacharan Road | 279 | 1.38358 | 34 |
| 5 | sonali bank | Jubilee road | 295 | 1.21658 | 16 |
| 6 | Anonda lok cinema, aloka cinema, agricultural bank | Chorpara road | 272 | 1.07143 | 13 |

Tab. 1 Global integration, connectivity of access road of commercial zone of 1974

| SLNo | NAME OF THE BUILDING | ADJACENT MAIN ROAD | REFF NO. | INTEGRATION (HH) | CONNECTIVITY |
|---|---|---|---|---|---|
| 1 | Boro bazar | Borobazar Road | 1394 | .745529 | 6 |
| 2 | Choto bazar | Choto bazar Road | 1523 | .729942 | 5 |
| 3 | Mesua bazaar, uttara shopping mall, harun tower | Ganginar par Road | 1514 | .818697 | 30 |
| 4 | Notun bazar | Ram babu Road | 1919 | .843409 | 25 |
| 5 | Municipality market, sonali bank | Jubilee road | 1733 | .768198 | 8 |
| 6 | Nursery | Shemacharan road | 2574 | .810389 | 13 |
| 7 | Chorpara kacha bazaar, janata bank | Chorpara road | 1601 | .797153 | 22 |

Tab. 2 Global integration, connectivity of access road of commercial zone of 2013

From Tab. 2 it can be seen that in 2013 the Rambabu road is mostly integrated road with connectivity of 28 roads because of their land use pattern are converted from residence into commercially used buildings. The commercial mall like, Uttara shopping mall, Harun tower, Bari plaza, Banks, Restaurants, Mesuabazar, other companies outlets, retail stores are developing alongside of Ganginarpar road which leads towards station node (Fig. 3). The Chorpara road which is connected from Ganginarpar node at south east side is third highest integrated road with the connectivity of 22 roads. Janata bank, Hotel al Rifat, Panch Tara hotel, Chorpara bazaar were developed in this road.

## 5.3 OBSERVATIONS

- Initially with the formation of the city the main commercial zone was located around town hall node during 1888 to 1889.
- The 1974 map shows that the business activity has shifted around Ganginar par node.

- At present time Ganginar par node is still important for its business potentiality. But at the same time this core has south ward pull to station node.
- Ganginar par node has become the integrated core.
- "Chorpara road" has gotten its importance which is connects towards Dhaka Mymensingh highway.

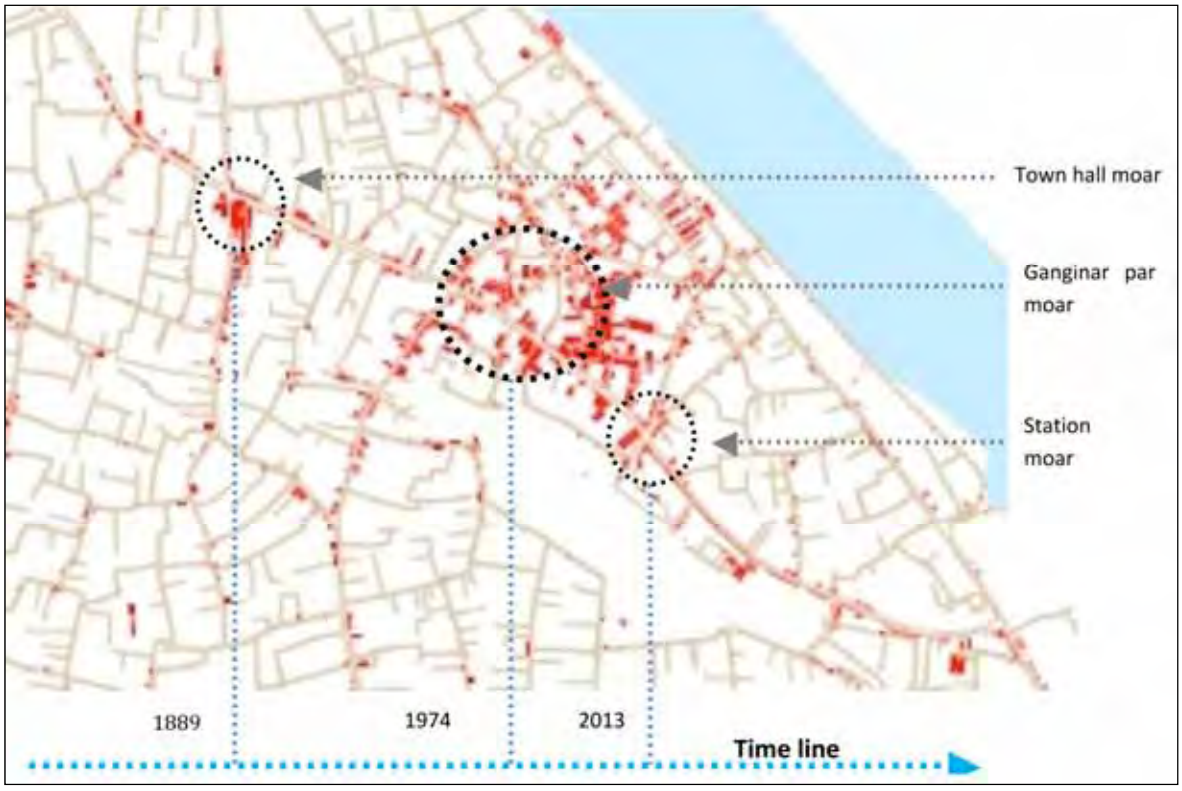


Fig. 16 Progression of commercial zone through time

## 6 PROPOSITION

A number of proposition can be illustrated from the analysis that are given below:

- The Axial Line Analysis explore that, the city integrated core has extended from north east to south west (Fig. 16).
- The shifting of the integration core can be assumed either towards i) the Dhaka-Mymensingh highway or ii) along Brahmaputra River through Station nodal point.
- Hence the possible future growth of commercial zone of Mymensingh city may take place towards Dhaka City or along with Brahmaputra River.

## 7 CONCLUSION

The objective of the paper was to analyze the relationship between the road network along with the commercial land use and its growth pattern in different time periods through space syntax. Two phases of axial maps are analyzed and it can be said that it has a strong relationship between commercial zones with mostly integrated cores. The survey data and the space syntax simulation help to represent this comparative analysis of the past with the present situation and possible future changes in the urban area. The future transformation and expansion of the city area in a logical and effective way can be plotted and necessary steps for city development can be assumed and suggested for the betterment of total urban area.


Fig. 17 Possible future expansion

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## WEBSITES

Space syntax laboratory web page, www. Space syntax.org

Mymensingh information - http://www.triposo.com/loc/Mymensingh

History of Mymensingh - http://en.wikipedia.org/wiki/History_of_Mymensingh

http://www.casa.ucl.ac.uk/working_papers/paper58.pdf

http://timstonor.wordpress.com/space-syntax-2/

http://www.bdresearchpublications.com/admin/journal/upload/09161/09161.pdf

http://www.banglapedia.org/

## IMAGE SOURCE

Fig. 10: Field Survey, 2010

## AUTHOR'S PROFILE

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