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**Chandigarh: From a Designed to an Evolved Capital City
from Political, Architectural and Spatial Perspectives**

by

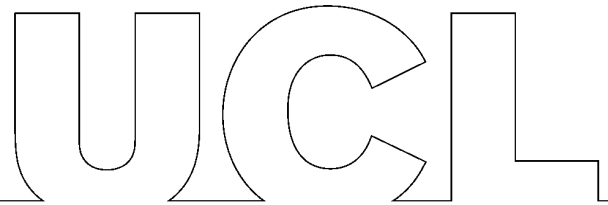
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September 2023

Supervisor: Prof. Sophia Psarra

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Space Syntax: Architecture and Cities**

**Bartlett School of Architecture
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Abstract

Chandigarh was built as a political city focused on accommodating refugees after the independence and partition of India in 1947. As a significant city, it has faced criticism for its rushed development that ignored the social fabric of India. The current study aims to contribute to the spatial and socio-political understanding of India's first post-independence planned city by analysing its planning principles and development from 1951 to 2023. Due to political unrest in Punjab, it was divided into three parts: Punjab, Haryana, and Himachal Pradesh in 1966. This led to the establishment of the satellite city of Mohali in 1967 and Panchkula in 1970 which together form the 'tri-city' area. By 1986, urbanisation processes had reached the green buffer zones around the city, and they had begun to exhibit signs of unplanned expansion. Today, all attempts of planned development around Chandigarh are compromised and the regional plans hold no legal status in proving its prominence. The thesis examines the following stages of Chandigarh's urban history: a. the initial plan of Chandigarh by Albert Mayer and the plan by Le Corbusier as it was finally executed; b. four phases of development in 1966, 1986, 2006 and 2023 as documented in the master plan. Using Julienne Hanson's distinction between order and structure and Hillier's theory of 'cities of reproduction' the study examines the transformation of Chandigarh from a designed city to an evolved city in the 75 years of its establishment, raising the following queries: What does the evolution of spatial structure of Chandigarh reveal about the spatial and political history of its development, its present condition, and its future? What were the political and architectural influences of Chandigarh's planning and evolution from 1950 to today in the context of post-colonial India? The study has determined the following results: The city's structure has remained strong since its establishment, implemented top-down. However, local centres have shifted during its evolution. In the past, the city's population was distributed based on income in a hierarchical manner. Due to the expansion of the city and the emergence of satellite areas, the population distribution has become more dispersed. Today, the presence of multiple governing authorities in and around the city has shifted the responsibility of accommodation to private as well as government entities changing the overall fabric of the city from the designer's inception.

Keywords: Space Syntax, Post-independence, Planned cities, Socio-political, Spatial evolution, Architectural, Chandigarh

Contents

Abstract	1
List of Illustrations	3
List of Tables	6
Acknowledgements	7
1. Introduction	
1.1 The context	8
1.2 Aim and scope of research	11
2. Research Questions	13
3. Theoretical Framework	
3.1 Planning in post-colonial India	15
3.2 Symbolism through architecture for political agendas	19
3.3 Evolution of spatial structure: A syntactic approach	21
4. Case Study	
4.1 Planning principles	23
4.2 U.T. and the periphery (establishment of Mohali and Panchkula)	25
4.3 Initial visual overview of evolution	26
4.4 Demographic changes	26
4.5 The political centre	28
4.6 Socio-economic structure	30
4.7 Overview	33
5. Methodology	
5.1 Axial and segment model analysis	34
5.2 Spatial analysis and evolution	35
5.3 Demographic analysis	36
5.4 Local-global integration and land-use	36
5.5 Limitation of study	37
6. Analysis and Results	
6.1 Order and structure	37
6.1.1 Comparing the initial plans of the city by Albert Mayer with Le Corbusier	38
6.1.2 Chandigarh from conception to evolved city	40
6.2 The role of the symbolic axis with the city as it evolved	48
6.3 Demographic changes and socio-economic changes as per spatial model	54
7. Discussion and Conclusion	58
References	61
Appendix	65

List of Illustrations

Figure 1:	India Under British rule (Left); India-Pakistan after Independence and Partition in 1947 (Right).....	8
Figure 2:	Late colonial-Rashtra Pati Bhawan-1931(Left); Early Independence - Central Post office-1954 (Right)-New Delhi Source: RIBA collection.....	9
Figure 3:	Initial Plan by Albert Mayer and Team; Source: Chandigarh Master plan 2031..	9
Figure 4:	Initial Plan by Le Corbusier and Team; Source: Chandigarh Master plan 2031...9	9
Figure 5:	Location of Chandigarh in the context of reorganised state; Source: Author.....	11
Figure 6:	Chandigarh Capital Region Plan showing periphery; Source: Office of Senior town planner, U.T., Chandigarh.....	11
Figure 7:	The basic components of Clarence Perry's Neighbourhood Unit; Source: A. Sharifi/ Sustainable cities and society (2016)	16
Figure 8:	Le Corbusier's Chandigarh Plan of 1951. Overlay description by the author. Base map Source: Chandigarh Museum Archives.....	23
Figure 9:	Phase-wise development plan; Source: Department of Urban Planning Chandigarh (2013).....	24
Figure 10:	UT and the Periphery in relation to its satellite cities (1986) Source: Author..	25
Figure 11:	Plan of the city-1966 (Phase 1); Source: Author.....	27
Figure 12:	Plan of the city in the year 1986 (Phase 2) and formation of satellites; Source: Author.....	27
Figure 13:	Plan of the city in the year 2006 (Phase 3) and growth of satellites; Source: Author	27
Figure 14:	Plan of the city and the satellites today (2023); Source: Author.....	27
Figure 15:	Aerial Photo of Chandigarh (tri-city area) today; Source: Google Maps.....	27
Figure 16:	Palace of Assembly in Capitol Complex; Source: Google Images.....	28
Figure 17:	Open-Hand Monument; Source: Chandigarh Administration website.....	28
Figure 18:	Punjab- Haryana High Court in Capitol Complex; Source: Google Images.....	28
Figure 19:	Barricading by police to enter the Capitol Complex (Left) and patrolling by police inside the complex (Right); Source: Google Images.....	29
Figure 20:	New secretariat building in sector 9 for government of Punjab constructed in 2023; Source: The Tribune.....	29
Figure 21:	Secretariat building for government of Haryana in Capitol complex; Source: Google Images.....	29
Figure 22:	Extension of High Court behind the main building; Source: Chandigarh Master plan 2031.....	29
Figure 23:	Chaos behind the High court building;Source: Chandigarh Master plan 2031..	28
Figure 24:	Government housing built by the administration to house government officials in sector 22 (Phase I); Source: Author.....	31
Figure 25:	Institutional housing in sector 27 (Phase I); Source: Author.....	31
Figure 26:	Private housing built on small plots in sector 33 (Phase II); Source: Author...31	31
Figure 27:	Private housing built on large plots in sector 9 (Phase I); Source: Author.....31	31

Figure 28:	Housing by CHB for middle to lower income social group in Phase III; Source: CHB website.....	31
Figure 29:	Housing by CHB for slum-rehabilitation colonies in the periphery; Source: CHB website.....	31
Figure 30:	Unauthorised temporary housing- Urban Sprawl in unsupervised pockets of the city (today -2023); Source: Author.....	32
Figure 31:	Housing in Urban village of sector 45 (Phase II) Source: Author.....	32
Figure 32:	Private housing built on small plots in sector-69 (Mohali); Source: Author.....	32
Figure 33:	Private housing in sectors sold to private builders (Mohali); Source: Author.....	32
Figure 34:	Private high-rise housing in Mohali sector 66A (Present); Source: Author.....	32
Figure 35:	Flats by housing board in Mohali (Sector 63); Source: Author.....	32
Figure 36:	Private High-rise housing in Panchkula Sector 22; Source: The Tribune.....	32
Figure 37:	Flats by Haryana Housing Board in Panchkula Sector 15;Source: The Tribune.....	32
Figure 38:	Axial map drawn over historical map of Chandigarh (Methodology).....	34
Figure 39:	Four-star model representing the values of mean and maximum NAIN and NACH; Source: Hillier et al. (2012).....	35
Figure 40:	Land use map; Source: Manually digitised using open street map information (Methodology).....	36
Figure 41:	Initial Plan by Alber Mayer-1950; Analysed: NACH Rn.....	39
Figure 42:	Initial Plan by Le Corbusier-1951; Analysed: NACH Rn.....	39
Figure 43:	Star Model.....	39
Figure 44:	Star Model.....	39
Figure 45:	Chandigarh plan- 1966; Analysed: NACH Rn.....	44
Figure 46:	Chandigarh plan- 1966; Analysed: NACH Rn_1.3 Structure.....	44
Figure 47:	Chandigarh plan- 1966; Analysed: NACH Rn_1.4 Structure.....	44
Figure 48:	Chandigarh plan- 1966; Star Model.....	44
Figure 49:	Chandigarh plan- 1986; Analysed: NACH Rn.....	45
Figure 50:	Chandigarh plan- 1986; Analysed: NACH Rn_1.3 Structure.....	45
Figure 51:	Chandigarh plan- 1986; Analysed: NACH Rn_1.4 Structure.....	45
Figure 52:	Chandigarh plan- 1986; Star Model.....	45
Figure 53:	Chandigarh plan- 2006; Analysed: NACH Rn.....	46
Figure 54:	Chandigarh plan- 2006; Analysed: NACH Rn_1.3 Structure.....	46
Figure 55:	Chandigarh plan- 2006; Analysed: NACH Rn_1.4 Structure.....	46
Figure 56:	Chandigarh plan- 2006; Star Model.....	46
Figure 57:	Chandigarh plan- 2023; Analysed: NACH Rn.....	47
Figure 58:	Chandigarh plan- 2023; Analysed: NACH Rn_1.3 Structure.....	47
Figure 59:	Chandigarh plan- 2023; Analysed: NACH Rn_1.4 Structure.....	47
Figure 60:	Chandigarh plan- 2023; Star Model.....	47
Figure 61:	Star Model showing all phases of the city and different plans.....	42

Figure 62:	Correlation NACH Max (structure)- NACH mean (order) across phases of the city included in Hillier's and Orama-Dorta's modified database (2012) (See Appendix 1).....	43
Figure 63:	Chandigarh plan- 1966; Analysed: NAIN Rn.....	50
Figure 64:	Chandigarh plan- 1986; Analysed: NAIN Rn.....	50
Figure 65:	Chandigarh plan- 2006; Analysed: NAIN Rn.....	50
Figure 66:	Chandigarh plan- 2023; Analysed: NAIN Rn.....	50
Figure 67:	Chandigarh plan- 1966; Analysed: NAIN R1200.....	51
Figure 68:	Chandigarh plan- 1986; Analysed: NAIN R1200.....	51
Figure 69:	Chandigarh plan- 2006; Analysed: NAIN R1200.....	51
Figure 70:	Chandigarh plan- 2023; Analysed: NAIN R1200.....	51
Figure 71:	Chandigarh plan- 2023; Analysed: NAIN R1200 _ 2.1 Values.....	52
Figure 72:	Chandigarh plan- 2023; Analysed: NAIN R1200 _ 2.1 Values with land use.....	52
Figure 73:	Sector 22 (Chandigarh- Local Centre).....	53
Figure 74:	Industrial Area (Chandigarh- Local Centre).....	53
Figure 75:	Retail Street (Panchkula - Local Centre).....	53
Figure 76:	I.T. Park (Chandigarh- Local Centre).....	53
Figure 77:	Commercial Link (Mohali- Local Centre).....	53
Figure 78:	Industrial Area (Mohali- Local Centre).....	53
Figure 79:	Correlation between population density and NAIN_Rn based on social categorisation-1966 (See Appendix 2).....	55
Figure 80:	Correlation between population density and NAIN_Rn based on social categorisation-1986 (See Appendix 2).....	55
Figure 81:	Correlation between population density and NAIN_Rn based on social categorisation-2006 (See Appendix 2).....	55
Figure 82:	Correlation between population density and NAIN_Rn based on social categorisation-2023 (See Appendix 2).....	55
Figure 83:	Population Density- UT and Periphery-1975; Source: European Commission, Joint Research Centre; digitised by Author.....	56
Figure 84:	Population Density- UT and Periphery-1990; Source: European Commission, Joint Research Centre; digitised by Author.....	56
Figure 85:	Population Density- UT and Periphery-2000; Source: European Commission, Joint Research Centre; digitised by Author.....	56
Figure 86:	Population Density- UT and Periphery-2015; Source: European Commission, Joint Research Centre; digitised by Author.....	56
Figure 87:	Socio-economic distribution based upon type of housing -1966; Source: Chandigarh Maste plan-2031; digitised by Author.....	57
Figure 88:	Socio-economic distribution based upon type of housing -1986; Source: Chandigarh Maste plan-2031; digitised by Author.....	57
Figure 89:	Socio-economic distribution based upon type of housing -2006; Source: Chandigarh Maste plan-2031; digitised by Author.....	57

Figure 90: Socio-economic distribution based upon type of housing -2023; Source: Chandigarh Maste plan-2031; digitised by Author.....57

List of Tables

Table 1: Summary of Major Planning Period in India; Source: Kumar et al., 2020..... 18

Table 2: Population of tri-city area over the years (Chandigarh, Panchkula, Mohali); Source: Census of India; digitised by author.....26

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Tamanna Sethi

1. Introduction

1.1 The Context

India, a developing country gained its independence from British rule (British Raj) in the year 1947. The independence led to the division of the country into two parts, namely India and Pakistan (Figure 1). Following this, the state governments all over India were enabling the task of resettling the refugees but at the same time, the political leaders were establishing the image of a new India searching for its domains such as politics, economics, architecture and planning. As per Annapurna Shaw (2009), after independence, India was on a trajectory moving away from colonialism to modernity. This was essentially due to the vision of its political leader Pandit Jawaharlal Nehru, a nationalist who focused on maintaining the traditions but at the same time was modern in spirit. Nehru aimed to modernise¹ India and focus on its future, rather than its past (Shaw, 2009).

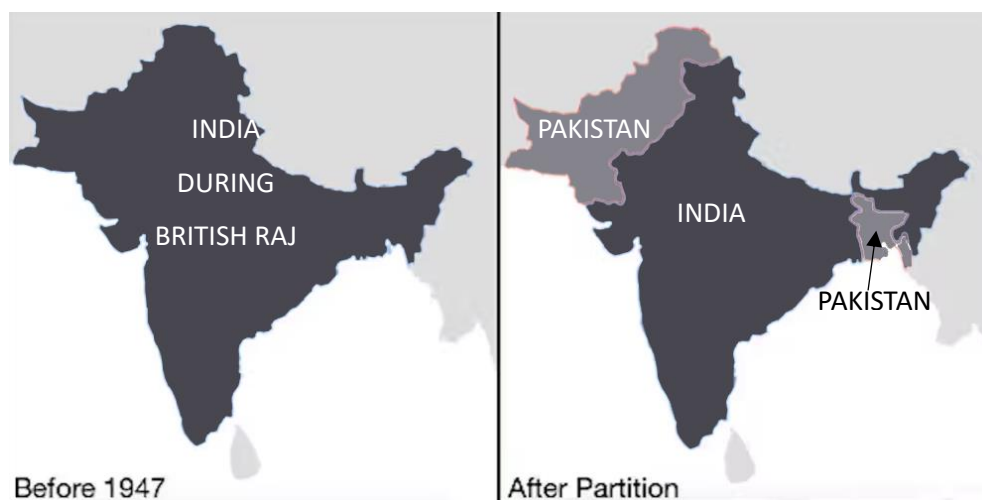


Figure 1: India under British rule (Left); India- Pakistan after Independence and Partition in 1947 (Right)

Before independence, the socio-political and economic decisions were under imperial rule. The first school of Planning and Architecture was established in mid-1950s in New Delhi. The lack of a professional base for indigenous architects led to a reliance on foreign architects to construct new towns and capital cities. This, combined with the desire for modernization, resulted in the widespread acceptance of Modernism in town planning and architecture in India (Shaw, 2009). Although modernism arrived in India in the 1930s and influenced

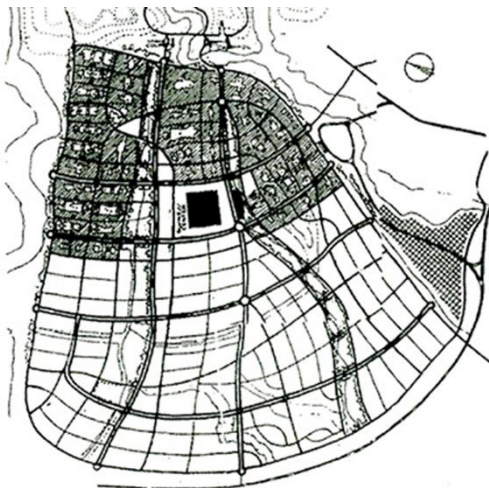
¹ Modernism: The process of modernisation refers to the social changes that occur as less developed societies adopt characteristics of more developed societies. (Daniel Lerner, 1958).

architects during the late colonial and early independence periods, its impact was mostly limited to individual buildings of Raj and small portions of Central Business Districts in larger cities like New Delhi. (Figure 2)

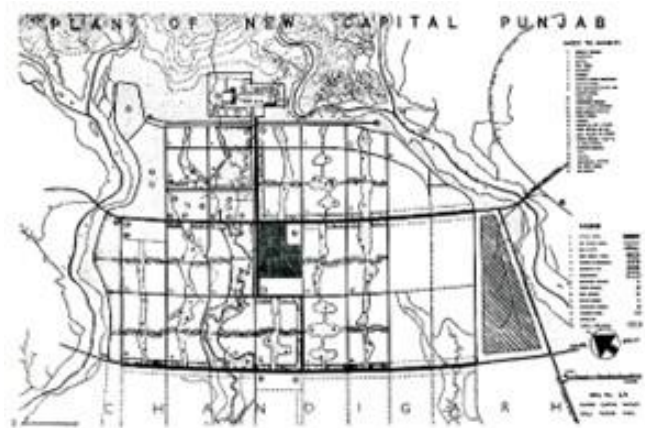


*Figure 2: Late colonial-Rashtra Pati Bhawan-1931(Left); Early Independence - Central Post office-1954 (Right)-New Delhi
Source: RIBA collection.*

Post-Independence, Nehru commissioned the construction of many new capital towns such as Chandigarh, Bhubaneshwar, Gandhinagar, and more, which were modern and free from the imperial arrogance of British rule. Chandigarh also known as the ‘City Beautiful’ was found in March 1948, right after independence. The city was established as the new capital of Punjab since the previous capital, Lahore, became a part of Pakistan after partition. The state of Punjab had to start functioning without an administrative centre and found its initial temporary lodging in Shimla, the British summer capital. The hunt for a new capital from existing cities in Punjab to be the new capital initially began. Nehru suggested that for the rehabilitation of Punjab, a new grand capital city was both practical and symbolic to make up for the psychological loss. This became a key factor in establishing the city in terms of its social, political, and economic structure (Prakash, 2002).



*Figure 3: Initial Plan by Albert Mayer and Team-1950
Source: Chandigarh Master plan 2031.*



*Figure 4: Initial Plan by Le Corbusier and Team-1951
Source: Chandigarh Master plan 2031.*

The initial master plan was drawn by the American lead planners Albert Mayer and Mathew Nowicki. They were briefed to follow low density in the city and were explicitly advised to use the garden city concept² by Ebenezer Howard (1898) to develop the plan (ibid.). Their design for the city followed a curvilinear fan-shaped plan and was submitted within six months of the city's approval (Figure 3). The central focus of Mayer's design was to prioritize the neighbourhood block³ and build upwards from there, resulting in a simplified urban centre. After Mathew Nowicki's untimely passing and insufficient administrative and financial support from the state government, Mayer decided to withdraw from the project (ibid.).

As a result, the project was handed over to Le Corbusier (Prakash, 2002). Taking note of Mayer's former design plans, Corbusier improvised the fan-shaped plan into grid-iron streets for movement. He designed the grid as a self-contained neighbourhood that had green urban spaces focusing on functions such as work, life, and socialisation along with the aesthetic appeal of the city (Figure 4) (Siddiqui et al, 2019). Chandigarh's impact on architecture and town planning in India was significant. It left a lasting impression on a generation of young practitioners who later became important contributors to the profession. The city's design became a symbol of Nehru's era (1947-1964) and served as a model for independent India for at least two decades.

November 1, 1966, the state of Punjab was restructured into three separate states: Punjab, Haryana, and Himachal Pradesh, (Siddiqui et al., 2019) (Figure 5). Chandigarh became a political and bureaucratic hub for the adjoining states. It has an area of approximately 114 sq. km. (70 sq. km. urban area with 44 sq. km. covering an area of 26 adjoining villages. The city today functions as a Union Territory under the direct governance of the main central government. Despite the initial plans for regulated growth as implicated by the Peripheral Control Act of 1952,⁴ the city experienced uncontrolled expansion in the peripheral areas. This indicates that the unrealistic vision of Le Corbusier of controlled development could not

² Garden City was where the central small town with 30,000 people would be supported by a rural population of 2,000 peasants producing food and providing a leisure landscape for the inhabitants.

³ Neighbourhood block is a self-sufficient unit that acts as an agent to address social problems of alienation, youth delinquency, and declining civic participation as common concerns in the urbanising areas.

⁴ The Periphery Zone of 8 km around the urban core was reserved as a greenbelt which was legally restricted from having any developments under the Punjab New Capital Control Act of 1952. In 1962, the periphery control area was changed and increased to 16 km.

respond to the urban sprawl due to the rising population (Figure 6). The city is currently faced with the simultaneous tension of maintaining its modernist legacy as a designed city and adjusting to the realities of an evolving city, that is, the demands of a constantly expanding population with changing needs of luxurious living standards in a smart ⁵urban setting (Indian Express, 2022).



Figure 5: Location of Chandigarh in context of reorganised state Source: Author

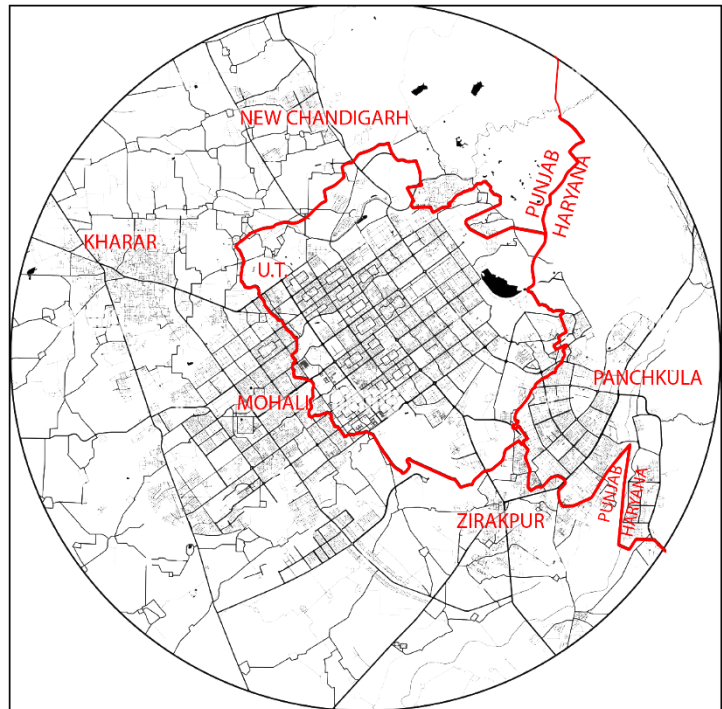


Figure 6: Chandigarh Capital Region Plan showing periphery. Source: Office of senior town planner; UT, Chandigarh

1.2 Aim and Scope of Research

The current study aims to contribute to the spatial and socio-political understanding of India’s first post-independence planned city by analysing its planning principles and development from 1951 to 2023. The primary objective is to comprehend how urban conceptual ideas manifest in patterns of lived experiences in a context where social complexity scenarios have been created overnight, as opposed to cities that have developed organically over time. By analysing the conceptual and lived realms and their interrelationship, the study employs

⁵ Implementation of smart city policies –use of information and communication technologies to increase operational efficiency to improve the quality of services for citizens and government in Chandigarh and its Satellite town.

spatial analytical methods to detect evidence of social processes in the city's current built environment and connect them to the spatial and political ideas that reinforce the original design.

To analyse these ideas in detail, the study forms a theoretical framework to understand socio-political contributions in the formation of post-colonial cities made upon a clean slate. It understands how political ideas are embedded into the structure of the city which influences the social structure of the city. It also understands the symbolic nature of the city and how the ideas are translated in a top-down manner through planning elements throughout the city. The study then examines these ideas using the spaces syntax theory of 'order and structure' by Bill Hillier and Julian Hanson (1986) and 'cities of reproduction' by Hillier et al. (2007) to understand these ideas. The study takes upon the history of the selected case study area to identify the growth patterns and influences of political and socio-economic factors that lead to uncontrolled population growth. It is important to recognize that cities are often subject to unexpected emergent forces and processes of adjustment from the very moment of their establishment. These forces are typically beyond the scope of the initial design considerations. However, it is equally important to acknowledge the powerful conceptual ideas that underlie the design of these cities, as they undoubtedly influence our understanding and experience of them.

2. Research Questions

With the above-mentioned ideas in mind, the thesis examines the transformation of Chandigarh from a designed city to an evolved city in the 75 years of its establishment asking the following questions:

1. What does the evolution of the spatial structure of Chandigarh reveal about the spatial and political history of its development, its present condition, and its future?

The research question aims to understand how the patterns of space manifest themselves throughout time and how they are influenced by designers' intentions. It analyses the city's spatial network configuration at each development stage to trace the interplay between socio-political realities that have redefined Chandigarh's planned political vision.

2. What were the political and architectural influences of Chandigarh's planning and evolution from 1950 to today in the context of post-colonial India?

This research question aims to explore historical and current governance, policies and population growth have had an impact on Chandigarh and its surrounding urban development. It aims to understand how the city's original egalitarian vision has changed due to ongoing liberalisation highlighting an interconnection between the conceptual planning ideas and the on-ground exigencies.

The following chapter is going to develop a theoretical framework which reviews the existing literature on post-colonial planning (Section 3.1) to address research question 1 from the point of view of politics and planned artefacts (Section 3.2) how ideas and designs are translated into space and how these spaces evolve over time (Section 3.3) to address research question 2.

3. Theoretical Framework

In the post-colonial era (1947-1980s), the newly independent India was in search of its own identity from its historical routes. It was burdened to be a new, robust 'Modern India' that is not just any other version of the colonial era. The Indian national architecture shifted to create an identity that was specific to the history and geography of the whole subcontinent. The period following independence was a crucial time for the development of the nation's politics and economy. This chapter reviews the existing literature on the post-colonial capital cities from the point of socio-political, architectural, and spatial representation of these features.

Several authors such as Ravi Kalia (2002) and Vikramaditya Prakash (2002) have conducted relatively new primary research on the development of the new capital city of Chandigarh right after the partition. They offer perspectives on political as well as social variables that played a crucial role in its planning and development. Annapurna Shaw (2009) offers a critical account of the capital through the historical background of town planning principles in post-colonial India as well as the political interventions by the state government of Punjab and Nehru's leadership for the modernist development of the city. Kalia (2002) focuses on the physical infrastructure of Chandigarh, specifically the built environment. He draws attention to the planning of residential units in post-colonial new towns such as Chandigarh, Bhubaneswar, and Gandhinagar, highlighting that the cities are planned to keep in mind the political aspect that separates the social aspect through their strict planning principles. This concerns the ways in which architects and planners operating in developing countries often overlook the important link between political and social issues. Kalia's views of the city give minimal consideration to the spatial characteristics of the city. It is always required to study the social, political, and spatial features of the city to understand the relationship among all attributes better. Bill Hillier (2007) and colleagues have developed a theory and a method that describes the spatial configuration of buildings and cities and relates them to social structures, patterns of use and cultural meaning (Hillier and Hanson, 1984, Hillier 1996). An analysis of the spatial structure of the city in relation to the distribution of social classes can inform us about whether social differences among these groups were spatialised, or whether they were not facilitating a mix of different groups and communities. Hillier and Hanson's configurational theory of society and space, known as 'space syntax', is centred on this concept (1984). This

analytical theory emphasises the importance of how social spaces are interconnected to form a cohesive whole rather than the individual spaces themselves. It is important to consider information that might not have spatial correlates when studying the socio-political context of cities, or buildings. Politicians' ideas or designers' intentions might or might not be embedded in space. This does not mean they are insignificant or that they do not play a role in the city's development. If they are not embedded in space, space syntax alone cannot capture them.

Therefore, Hillier and Hanson provide partial insight in such a context. There is a need to understand the historical context to address the research questions. To fully comprehend post-colonial capital cities and their evolution keeping in mind their spatial and human constructs, it is crucial to deeply analyse the relationship between space and society. The research utilizes Hillier and Hanson's theory (1984) as a fundamental theoretical and analytical framework to achieve this. The study of post-colonial capital cities demands an understanding of their unique socio-political realm and how specific political features are translated into these cities' architecture and spatial patterns.

3.1 Planning in post-colonial cities

This section aims to understand the socio-political influence in the context of planning new cities in India. For post-colonial India, building new cities was mainly political as they were conceived to realign power and establish a relationship between Western and indigenous concepts (Shaw, 2009).

Post-Independence India (1947-1980)

To address the needs of refugees, support state government operations, and ease the burden of overcrowded cities modern urban development was considered as a key approach to solve the pressing housing problem. The leaders viewed modernisation as a process of discarding traditional ideas and moving towards economic prosperity, social justice, and peace. Perceiving India's predominant rural society as backward, violent and unjust they identified modern development as a means and measure of progress towards the envisioned goal

(Kumar et al., 2020). These planned developments were state-sponsored⁶ and used the concepts of classification, standardisation and hierarchy for accommodating human activities into separate spatial districts like work centres, residential quarters and institutional areas emulating the post-war British and American planning system. These plans were projections for a better future through ‘objective’ reasoning insulated from the political process (ibid., p 109) that shaped the social-political dynamics of cities. The state widely used the Western concept of the Neighbourhood Unit plan developed in 1923 by Clarence Perry, an American urban planner in the conception of new towns. Perry’s reformed Neighbourhood Unit Concept, aimed to tackle social issues such as alienation, youth delinquency, and declining civic participation, all of which were common concerns in urbanising regions of the United States (Sharifi, 2015) (Figure 7) was used to resolve the problem of inflexing refuges in India after partition. This became the basic unit of planning in Indian Cities for new towns and city extensions (Vidyarthi, 2015). However, these centralised urban planning frameworks provide little space for people- and community-led plans also known as urban informal⁷ settlements, a major part of Indian culture. By 1970, the nation started to recognise the problems of urbanisation, its consequent implications, and the necessary provision of infrastructure for employment which could not be solely addressed by housing. The state-sponsored development led to balance of payment⁸ crises in the early 1990s. International monetary fund-forced structural reforms that brought economic liberalisation. This led to changes in investment policies in city planning and development policies (ibid.).

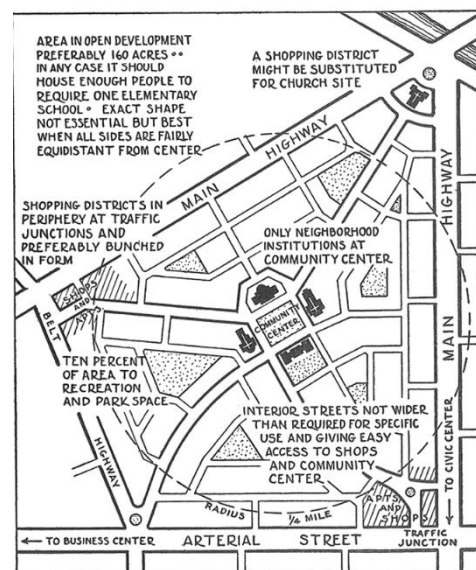


Figure 7: The basic components of Clarence Perry's Neighbourhood Unit Source: A. Sharifi / Sustainable Cities and Society (2016)

⁶ State-sponsored development is done by the government for the expansion of urban infrastructure.

⁷ Informality in the context of urban studies refers to the way of life for the poor in the global south, characterized by how they live, work, and get around. It is seen as a term for various social and cultural phenomena.

⁸ Balance of payment: the difference in total value between payments into and out of a country over a period.

Post-liberalisation period (1990s-present)

Since gaining independence, India's ruling elites have linked planning with the country's modernisation and economic development. This has resulted in liberalised trade and investment policies aimed at achieving higher GDP growth rates, with a strong focus on city-centric development strategies. To align with these shifts, economic development and finance policies have emphasized private sector participation in urban development. Meanwhile, India's socialist legacy has influenced the government's continued commitment to promoting welfare-oriented public policies, including the provision of basic support services and safety nets for the poor. The government has also established new institutes of higher learning and research in regional and secondary cities. However, the involvement of private firms in infrastructure development has challenged state-led development, despite progress in airports and metro systems. Balancing economic growth and public welfare, India's government has adopted place-based economic development, infrastructure building, and welfare increases. Nonetheless, India still faces significant challenges in providing quality basic infrastructure and services. Private sector involvement in infrastructure development has evoked mixed reactions and promoted private sector capacity but also fuelling social discontent and political protests. As a result, planning players from various sectors have emerged, with the intermediate and new middle classes becoming powerful actors in planning and development. Today, the emergent middle and aspirant classes, as well as civil society and environmental development, are calling for better city planning and development to address these challenges (Kumar et al., 2020).

Summary of major planning episodes in India					
Time Period	Broader social context	Political purpose	Urban order	Capital investment	Key planning features
Colonial rule (1800s-1947)	British colonial rule over diverse regions and native population	resource extraction and reparation	colonial cities such as Kolkata and Mumbai with 80% population living in rural area	Imperial authorities, local elites, colonial officials	Control over central places, socio-spatial segregation in colonies combined with European planning ideas and local adaptations
Post-independence (1947-1990s)	Post-colonial development state seeking all-around betterment	Nation-building and national development	65 new towns initiated, including the establishment of the modern capital city Chandigarh and industrial townships.	Elected leaders, state bureaucrats and agencies, educated class	Centralised planning approach, statutory master planning for cities and city extensions; many subversions of state planning efforts
Post-liberalisation (1990s-present)	Growth-oriented development state	Economic growth, national spatial development and economic integration via infrastructure building and project investment	Continuing growth of existing cities and development of new townships and industrial estates along the vastly expanded road network connecting country's numerous settlements	Many agencies: state-sponsored, public agencies, entrepreneurs, real estate developers, foreign investors.	Place-based economic development, infrastructure investment and business promotion move toward regularisation of informal and extralegal settlements

Table 1.: Summary of Major Planning Period in India Source: Kumar et al., 2020

3.2 Symbolism through architecture for political agendas

According to Hillier, there are spatial-temporal levels of politics that function together to ensure the reproduction of structure and social network through time by setting disputes and preventing the dispersal of the social group (Hillier, 2009). He suggests that there is transpatial logic to space defined by the liberation of space that belongs to conceptual interventions and can be labelled as an 'institutional level of conceptual representation' (Hillier, 2009, p 12). For new towns, in the post-colonial era, the conceptual intervention of 'modernism' as suggested by the planners of the city is widely embodied. Hillier further argues that there is a construction of social institutions in physical space that are embarked by pathways that embody a shift from the conceptual to the spatial-temporal realm (ibid.).

Planned cities like Chandigarh pose a unique challenge when it comes to understanding the institutional and cultural traditions that give meaning to a built environment. Unlike older cities with a rich history of spatial practice and ceremonies, Chandigarh was built from scratch, leaving little room for these traditions to emerge organically. Instead, the city's designers and authorities have had to take an active role in shaping its cultural and social life, using specific spatial strategies to create a sense of community and shared identity. Hillier (2007) refers to planned cities as 'strange cities' or 'cities of reproduction' (Hillier, 2007, p 264) as these cities act as centres for government and the primary function of these is to reproduce the essential structure of society. He suggests that there are basic properties of space, such as connectivity between spaces, the use of lines of sight to overcome metric or topological separation, and especially the role of the axes in these cities. Hillier (2007) refers to the predominant form of axuality in these cities as 'symbolic axes' since their primary function is to express social power like the planning ideologies for post-colonial new towns of India. Examining post-colonial cities of India, Shaw (2009) explains that the urban design decisions taken by Le Corbusier and the political leaders demonstrate the power of leadership and how institutions wanted to be perceived through its built environment.

Political capitals have utilised the built environment as a tool to communicate their national identity, symbolism, and power. Lawrence Vale (1992) posits that the decisions made in urban design carry significant weight, as they can send potent messages regarding how the

leadership desires the institution encapsulated with the built environment to be perceived. Interestingly, despite the varied governments and cultures that have occupied these planned political capitals throughout history, they have consistently employed comparable spatial strategies to convey meaning. This is particularly apparent in the monumental core, which serves as the most emblematic space in these cities (Vale, 1992).

According to Sophia Psarra (2009), architecture has a narrative embedded in it. This contributes to the creation of a distinct architectural identity. She argues that the design and layout of a city or urban environment convey cultural meanings and narratives that reflect the values, histories, and aspirations of its inhabitants (Psarra, 2018). For Chandigarh, there was no historical arrangement that could convey the narrative, just the presence of a political narrative of modernism. The ideas and narrative embedded in the design could not relate to the local population at the time it was conceived and how the institution wanted it to be perceived (Sarin and Walden, 2021). However, the city today has evolved over a period of 75 years and has formed a narrative that can be examined through the evolving configuration of the city.

According to Henry Lefebvre (1974), social spaces are composed of a conceptual triad. The first element is 'spatial practice' or perceived space, which concerns the urban and daily realities of a society produced and appropriated through a dialectical interaction between society and space. The second element is 'representation of space' or conceptual space, which is the space of scientists, architects, and planners. The third is 'representational space' or living space, which is the space seen through associated images and symbols for every member of the population. Hillier on the other hand argues that Lefebvre's theory (1974) lacks an understanding of cities at the level of design from a 'space first' perspective. Hillier and Hanson (1984) advocate from an 'environment first' perspective, where space is studied as a variable that is linked with social as well as economic variables that could provide a better understanding of the configuration.

The approaches of Hillier, Hanson and Lefebvre discussed above are representative of Western ideas and spaces but not of ideologies, spaces and patterns of living in a post-colonial context. This was a time in which the planning discipline was purely to set up a new way of building for

the entire country (See section 3.1). They took from the learnings of the West to create a context in a non-Western environment. Hence, to understand these concepts in a non-western environment is the core of this study.

3.3 Evolution of Spatial Structure: A syntactic approach

Julienne Hanson (1989) challenged the traditional categorisation of cities as either 'organic' or 'planned' and proposed instead a distinction between 'order' and 'structure' in urban systems. She argues that designers have simplified urban forms by employing orderly principles such as repetition, grids, symmetry, and rhythm, neglecting the complex socio-spatial realities of cities. According to Hanson, we experience the city from the ground level which represents its structure rather than its conceptual unity as depicted in plans or bird's eye views. Structure, as she defines it, pertains to the patterns of movement that we learn over time, which establishes a relationship between different parts of the city as a whole. Thus, a study of 'planned cities' should consider both order and structure.

To examine urban layouts as spatial configurations, she advocates for the use of 'space syntax,' a methodology introduced by Hillier and Hanson (1984). They contend that the configuration of the urban grid itself is the primary driver of movement patterns, influencing the intelligibility and defining the structure of the system. Expanding on Hanson's notions of order and structure, Hillier et al. (2012) introduce the concept of 'foreground' and 'background' networks to analyse the structure of cities. Every urban street network, in spite of cultural differences, has a dual form: a foreground network connecting urban centres and a background network of residential areas that the foreground network is embedded within. The above-mentioned concepts will be used to address research question 1.

Hillier et al. (2012) propose three key aspects for studying the structure of cities: the scale at which geometry is applied (whole city, area, or street level), the layer of the system primarily affected by geometry (foreground or background network), and the underlying reasons for applying geometry (economic or social factors). While the first two aspects are primarily spatial in nature, the last aspect attempts to bridge the gap between space and society by making general assumptions. However, Hillier et al. (2012) lack a thorough examination of how spatial properties relate to political and architectural aspects of symbolically planned

post-colonial cities. According to Psarra (2009), this representation includes two interconnected aspects: the geometric aspect that describes shapes, and the configurational aspect that outlines the relationships between spaces within a global pattern of space. Additionally, there is an aesthetic aspect that considers principles such as colour, materials, and textures. However, Hillier (2007) emphasizes that innovative conceptual design should aim to surpass cultural reproduction by being rooted in a universal and abstract comparative study of forms and configurations. When taking on a study of Indian cities, these aspects are important but what about the post-colonial cities built from scratch? Hillier's (1999) definition of centrality focuses on the concentration and mix of land uses and activities, particularly in retail, within a prominent location. According to Hillier, this centrality is a result of a 'movement economy process' influenced by spatial configuration and land use choices over time. Planned cities like Chandigarh experience continuous emergence processes of adjustment due to the presence of a larger population and rapid urbanisation which is accelerating the captivating capacity of these planned cities were designed to hold. These theories of space and society will aid in addressing research question 2.

Tania Oramas-Dorta (2012) in her study of 'planned political capitals' explores the spatial relationship of buildings in the monumental core and the evolution of such cities that help understand the principles that constitute these spaces. However, does not link the socio-economic elements that lead to these adjustments in the cities' configurational patterns. Authors such as Frederico De Holanda and Valerio Medeiros (2012) captured the modernity of Chandigarh by exploring spaces such as the monumental core and spatial configuration only for the city and not its surroundings and suggest that the city has formality⁹ embedded in its urban spaces but does not consider the evolution of the city and how it has corresponded with its satellites. Hence, it is important to understand not only the growth of Chandigarh in 75 years but also its surroundings which affect its socio-political, and spatial evolution.

To address this research gap, this study aims to investigate not only spatial configuration but also the socio-political, economic, and architectural values within planned post-colonial Chandigarh. It seeks to explore how different functional centres within these cities relate to each other and how spatial representation embodies identity and symbolic ideas.

⁹ Formality: formal spaces characterised by social solid asymmetries and authority.

4. Case Study

This section situates Chandigarh in a historical context exploring the planning concepts that drove its political, social, and economic background. As previously explained, after India gained independence, numerous new cities and towns were constructed to accommodate refugees and keep up with the swift pace of urbanization. Among these remarkable cities was Chandigarh, created by Swiss-French architect Le Corbusier. It is a critical example, especially as it was planned amidst the social and political chaos right after India's independence. Chandigarh's robust planning principles and pressing political exigencies make it a prime example of a city planned to advance the socio-political, economic, and architectural agendas of the newly independent India (See section 3.1).

4.1 Planning Principles:

Le Corbusier was a founding member of Congrès International d' Architecture Moderne also known as CIAM assorted by architects such as Gropius, Stam and Merckelius. Their key focus was to make cities a better and liveable place (Kalia, 1999). The plan created by Le Corbusier takes the form of a rectangle with a central cross-axis. The organic analogy Le Corbusier used in the design is evidenced by the metaphors he employed throughout. For example, he

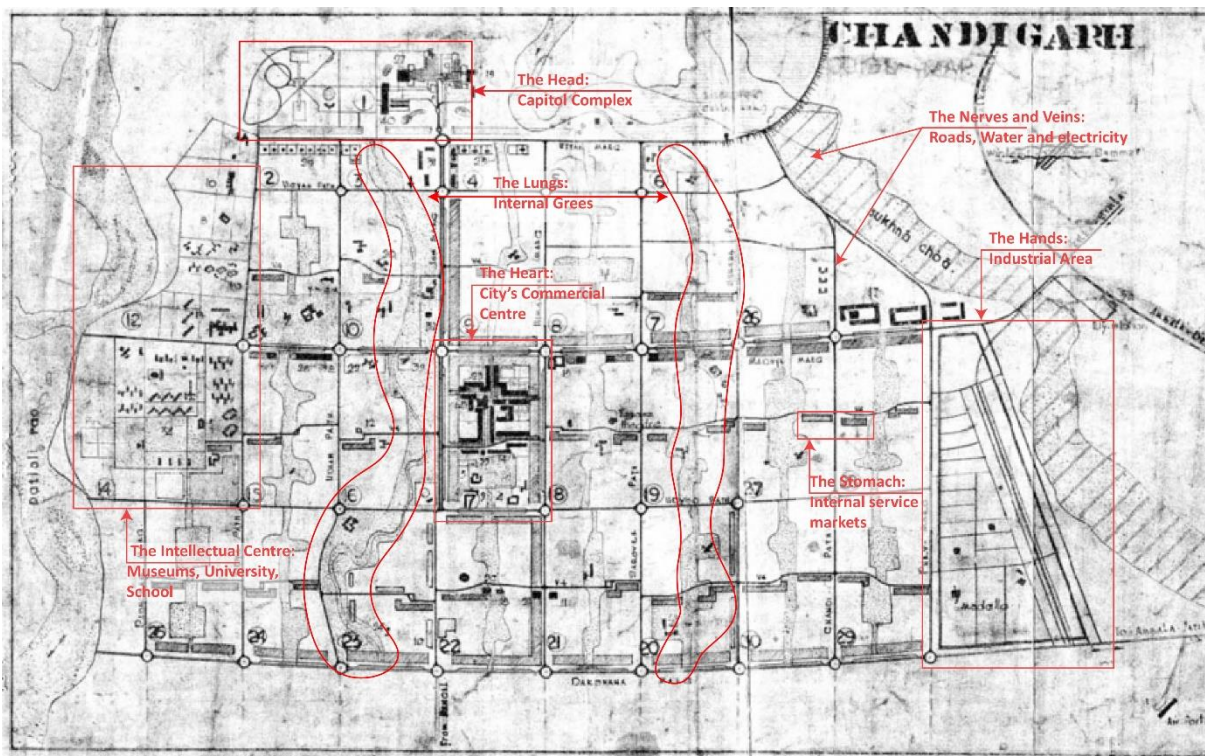


Figure 8: Le Corbusier's Chandigarh Plan of 1951. Overlay description by Author.
Base map source: Chandigarh Museum Archives

envisioned the capitol complex *as being the head*, and the city's commercial centre serving as *its heart*. The industrial area would serve as *its hand*, while the parkland, which is home to museums, a university, a library, and other facilities, serves as its *intellectual centre*. The city service centre, located in the central market, would serve as *its stomach*, with the roads, water, and electricity being *its veins and nerves* (Figure 8). The city was developed in three phases. Phase I included 30 sectors¹⁰ spread over 9000 acres, with an agenda of low density. Sectors 1-30, closer to the capitol complex, could accommodate a population of 1.5 lakh. Phase II had 17 sectors, with relatively higher density and capable of accommodating 3.5 lakh population in 6,000 acres of unbuilt land. Phase III had sectors 48-56, covering an area of 1870 acres to accommodate 100 people/acre that was initially reserved as a green zone. The sector was the smallest unit, with a population varying between 3,000 and 20,000 people. (Siddiqui et al., 2019) (Figure 9).

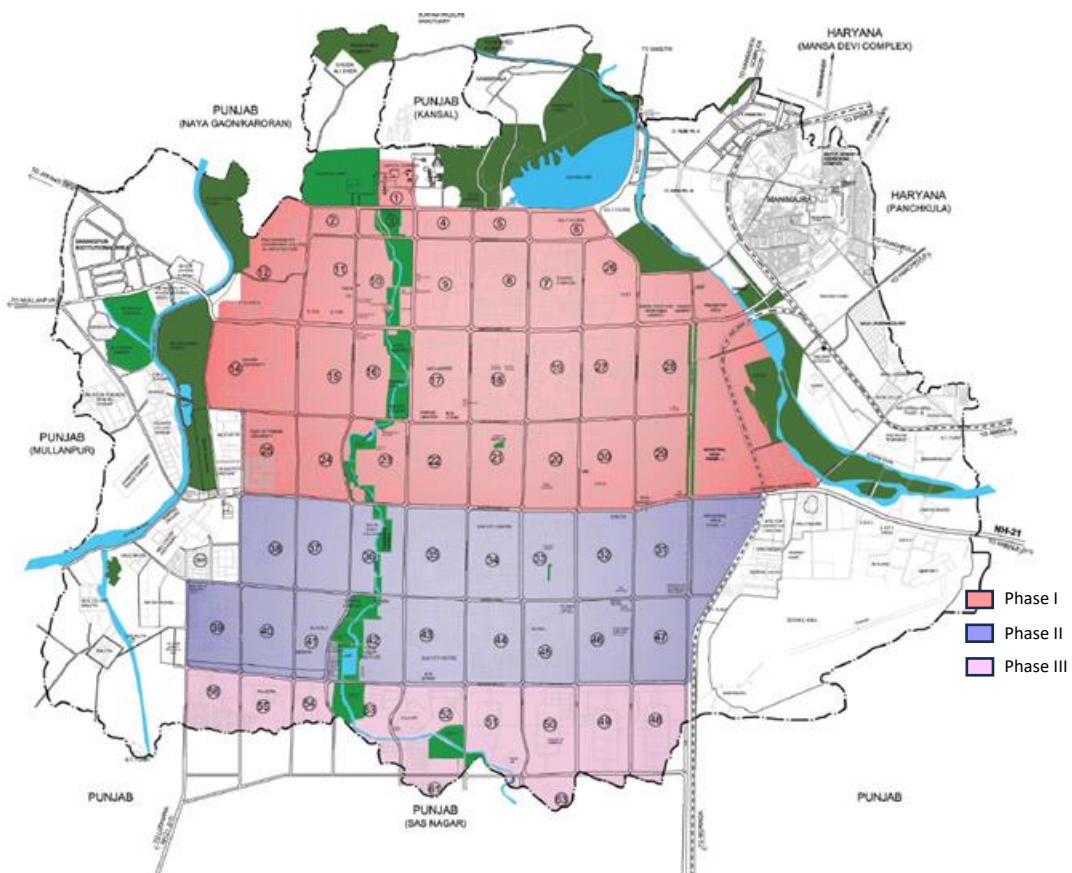


Figure 9: Phase-wise development plan Source: Department of Urban Planning Chandigarh (2013)

¹⁰ Sector: A sector is a unit of neighbourhood unit of (1200 x 800) m comprising residences, a small daily need market, schools, dispensaries and open green spaces. It is a container of family life.

4.2 UT and the Periphery (establishment of Mohali and Panchkula)

Back in 1967, the plan to develop Mohali Village as an industrial hub was conceived. The foundation stone for Mohali was laid on November 1st, 1975. The Industrial Estate in Mohali was allocated 5500 acres of land in Punjab. This development was a significant milestone for the industrial areas in Punjab. The design for Mohali was influenced by Chandigarh's grid-iron design, with less emphasis placed on sector designing and more on contiguity extension. In 1970, plans for Panchkula in Haryana were approved, it was located 4 km east of Chandigarh and had 500 acres of land. Mohali development lacked a buffer and was closest, while Panchkula maintained a slight buffer of 4 km and used a fan-shaped grid plan. It is often argued that Panchkula was inspired by the original plan of Chandigarh proposed by Albert Mayer. (Siddiqui et al., 2019). Chandigarh was more set built as a residential area, and Panchkula and Mohali both were set up as industrial establishments in their urban development strategy (ibid., p 419). Despite 'No Construction' in the Periphery, the two major satellites, Panchkula in Haryana and Mohali in Punjab were constructed in the periphery to accommodate the population influx. (Figure 10)

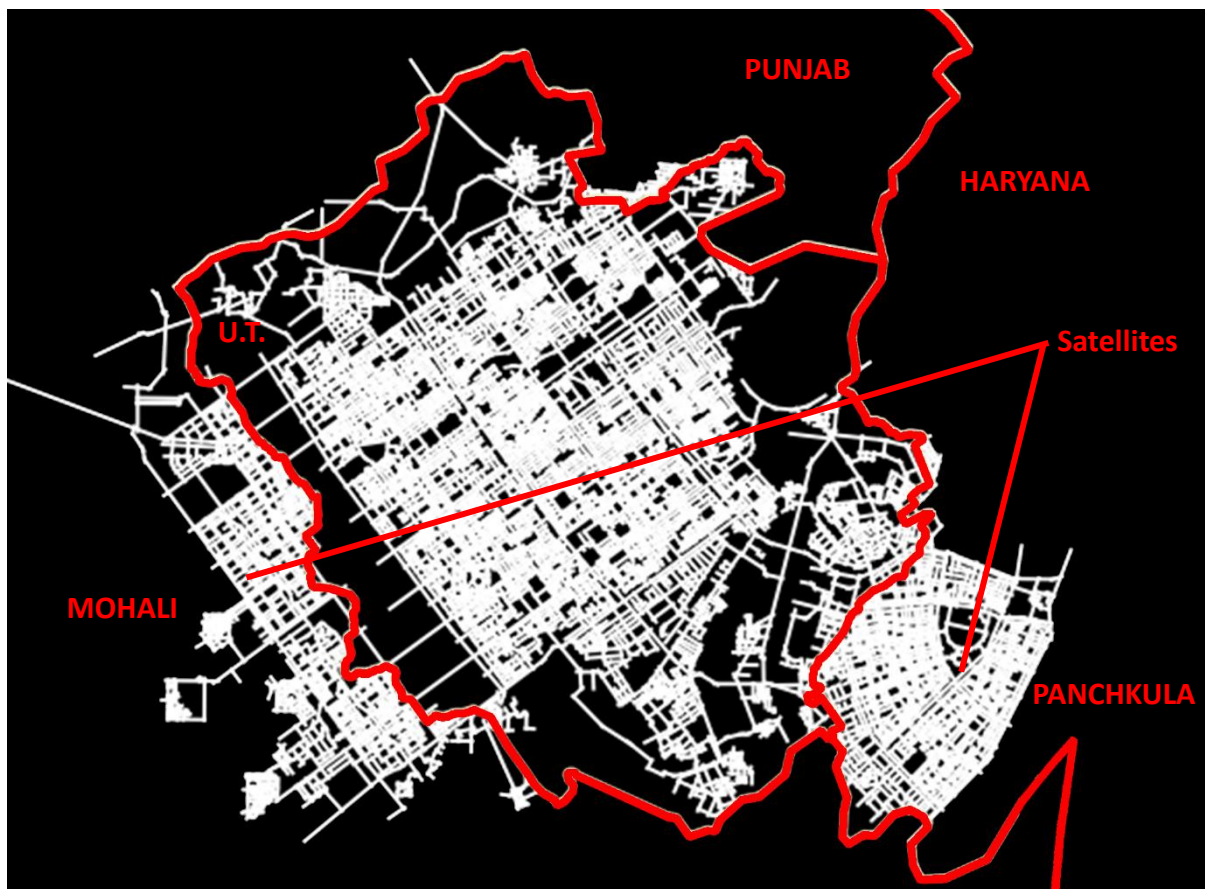


Figure 10: UT and the periphery in relation to its satellite cities (1986)

Source: Author

4.3 Initial visual overview of evolution:

Upon initial visual examination of the city, it is evident that strict planning principles have been implemented within its boundaries. However, the geometric layout of the city has been altered by the presence of villages and urban sprawl outside of these planned areas. Despite this expansion, the initial planning order in Chandigarh has been mostly maintained. While the surrounding satellite of Mohali has followed Chandigarh's planning principles to some extent, unauthorized development and villages have had an impact on the overall tri-city area, either due to a lack of planning control or political agendas of the state. (Figure 11- 15). Overall, the city in its initial visual overview looks structured and planned with fragments of organic developments.

4.4 Demographic Changes:

In the 75 years since the establishment of Chandigarh, the city has experienced physical, and social changes. These changes are discussed here in terms of demographics. Population statistics indicate that between 1951 and 1961, the decadal growth rate was 394.13%. This was largely due to the increased housing requirements in the post-independence era. Between 1951 and 1971, the population growth rate was 114.59%, which was one of the highest growth rates among any urban area at that time. By 1990, after the completion of Phase I and II, the population of Chandigarh had exceeded the estimated limit of 5 lakh¹¹ people. The population density of Chandigarh has increased by 9 times over the last 5 decades (1961-2011), from 1051 to 9252 persons per sq. km and the satellites have grown 3 times in population to cater to the excessive population of the main city. The Chandigarh Master Plan 2031 predicts even higher densities with further population growth, which poses a challenge in maintaining the quality of life and providing basic services to all residents. (Chandigarh Master Plan 2031, Demographics, 2013).

Year	Population				Phase
	Chandigarh	Panchkula	Mohali	Total	
1951	24261	-	-	24261	
1961	119881	-	-	119881	1
1981	451610	196939	32351	680900	2
2001	900635	468411	166864	1535910	3
2021	1169000	655800	229000	2053800	Present

Table 2: Population of Tri-city area over the years (Chandigarh, Panchkula, and Mohali) Source: Census of India; digitised by author

¹¹ 1 lakh= 100,000

Overview of the city's evolution

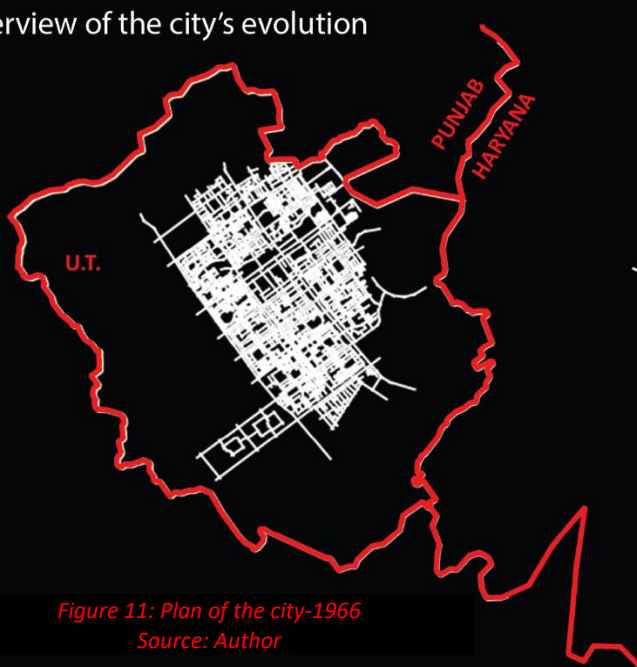


Figure 11: Plan of the city-1966
Source: Author

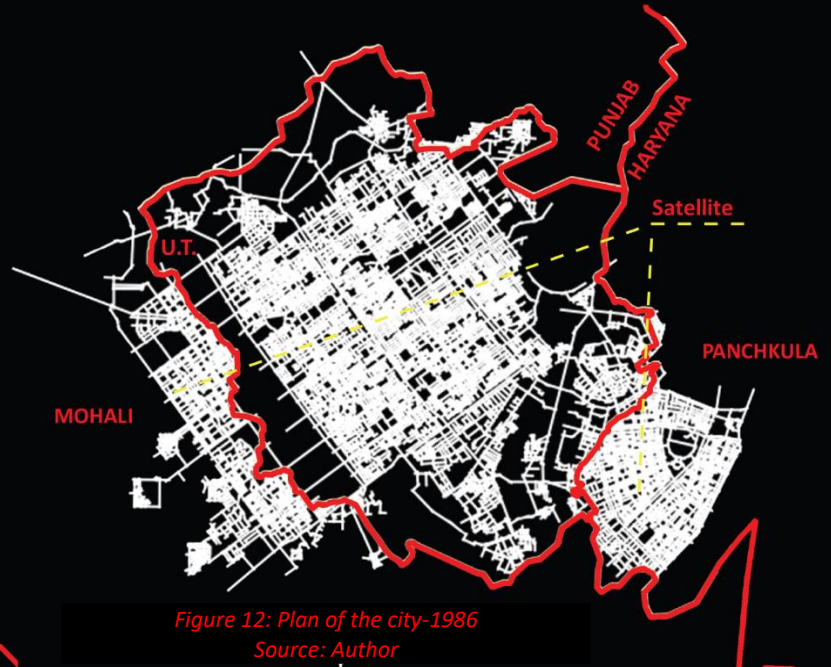


Figure 12: Plan of the city-1986
Source: Author



Figure 13: Plan of the city-2006
Source: Author



Figure 14: Plan of the city-2023
Source: Author

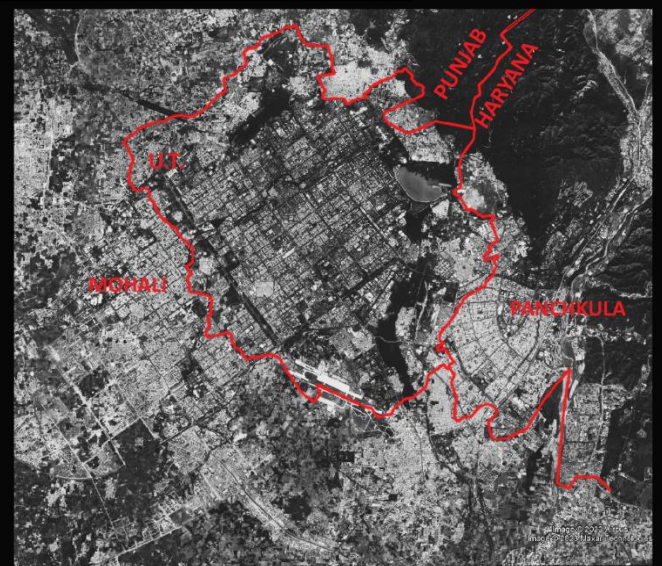


Figure 15: Aerial Photo of Chandigarh (Tri-city area) today
Source: Google Maps

4.5 The Political Centre:

The Capitol Complex is the head and has administrative buildings namely the Punjab-Haryana High Court, Palace of Assembly, and the secretariat along with certain monuments such as the geometric hill, Tower of Shadows, and the open-hand monument (Figure 16-19,21). The capitol complex is incomplete as the Governor's palace and Museum of Knowledge were never constructed considering the division of states. Today, there are two separate Governor's residences near the capitol complex to house the officials of separate states. In addition, the Open Hand Monument was built as a place for citizens to discuss and address each other's problems symbolising 'giving and receiving' idea of democracy. This correspondence between political ideals and architectural vision laid the foundation for Chandigarh's unique design (Khosla, 2015). However, today the capitol complex is barely open to the public hence defying the main ideology of the designer. New High Court (Figure 20) and Secretariat buildings (Figure 22) have been constructed behind the main capitol complex and in sector 9, respectively, to accommodate the growing requirements. However, despite additional constructions, there is still a shortage of space for courtrooms and ancillary functions due to strict architectural and heritage control, large open spaces in and around the complex cannot be utilised (Figure 23).



*Figure 16: Palace of Assembly in Capitol Complex
Source: Google Images*



*Figure 17: Open-Hand Monument
Source: Chandigarh Administration website*



*Figure 18: Punjab-Haryana High Court in Capitol Complex
Source: Google Images*



*Figure 19: Barricading by police to enter the capitol complex(Left); and patrolling by police inside the complex(Right)
Source: Google Images*



Figure 20: New secretariat building in sector 9 for government of Punjab constructed in 2023; Source: The Tribune



Figure 21: Secretariat building for government of Haryana in Capitol complex; Source: Google Images



*Figure 22: Extension of High Court behind the main building
Source: Chandigarh Master Plan 2031*



*Figure 23: Chaos behind the High Court Building
Source: Chandigarh Master Plan 2031*

4.6 Socio-economic structure

The main goal as set for the city was to provide good quality housing that would offer 'all amenities to the poorest of the poor to lead a dignified life' (Chandigarh Master Plan 2031, Housing, 2013, p 31). Initially, two main categories of housing were planned in the city – Public and Private. The public housing was for government employees of all classes and was given to them at subsidised rents (Figure 24-25). This category of housing was built in the early years of the city (1951- 1966) and is owned by the government to date. The size of the house given to the government official was decided as per their rank or position in the government. Parallel to this, private housing – residential plots of varying size from 125 sq. yds. to 4000 sq. yds. were made available at a minimum cost price of Rs. 4/ sq. yds. for bigger plots and Rs. 12/ sq. yds. for smaller plot for individual buyers to build their own houses (Figure 26-27). The ownership of these houses was freehold¹². About 70 % of housing in the city was set up to be built privately in Phase I and Phase II. The city did not take into consideration the labour that had migrated to build the city (Sarin and Walden, 2021). They were living in temporary homes scattered all over the city (Figure 30). They were then moved into labour colonies that were built on the outskirts of the city by the Chandigarh Housing Board (CHB) which was set up in 1976 by extending the Haryana Housing Board Act of 1971 to the union territory and had a mandate to rehabilitate the residents of unauthorised settlements in the city (Figure 29,31). The CHB was made responsible for building affordable, reasonably priced dwelling units for different socio-economic categories of the city's residents in Phase III (1986-2006) (Figure 28). Chandigarh today hold a large percentage of institutional housing and government as it had to accommodate this social group for the tri-city area as mandated in Chandigarh master plan (Chandigarh Master Plan 2031, Housing, 2013). Also, the residences built by CHB are leasehold.¹³

For the satellites, the initial phase (1975-2000) similar planning principles were followed to accommodate the elite population followed by the middle-class population to gain capital for further development of the city (Figure 32). There is a small percentage of housing by municipal corporations in Panchkula (Figure 35). For Mohali, there are urban villages

¹² Freehold refers to a land ownership style where the owner has complete and indefinite ownership of the land and the building on it. The owner has the right to use, sell, or transfer the property as they wish.

¹³ Leasehold refers to a land ownership style of long-term tenancy where someone buys the right to live in a property for a certain period, usually 99 to 125 years.

contained inside the sectors where the government could not acquire land from the villagers (SAS Nagar master plan 2031). The Punjab government is in charge of developing Mohali, and they have sold sectors of land to private builders. These builders have been given permission to construct high-rise residential and commercial buildings, which have significantly transformed the physical and socio-economic landscape of Mohali (Figure 33). This contradicts the main city's principles of low-rise development (Figure 34, 36) (See section 3.1)



Figure 24: Government housing built by the administration to house government officials in sector 22 (Phase I) Source: Author



Figure 25: Institutional housing in sector 27 (Phase I) Source: Author



Figure 26: Private housing built on small plots in sector 33(Phase II) Source: Author



Figure 27: Private housing built on Large plots in sector 9 (Phase I) Source: Author



Figure 28: Housing by CHB for middle to lower income social group in Phase III Source: CHB website



Figure 29: Housing by CHB for slum-rehabilitation colonies in the periphery Source: CHB website



*Figure 30: Unauthorised temporary housing - Urban Sprawl in unsupervised pockets of the city (today-2023)
Source: Author*



Figure 31: Housing in Urban village of sector 45 (Phase II) Source: Author



Figure 32: Private housing built on small plots in sector-69 (Mohali) Source: Author



Figure 33: Private housing in sectors sold to private builders (Mohali) Source: Author



Figure 34: Private high-rise housing in Mohali sector 66A (Present) Source: Author



Figure 35: Flats by housing board in Mohali (Sector 63) Source: Author



*Figure 36: Private High-rise housing in Panchkula Sector 22
Source: The Tribune*



Figure 37: Flats by Haryana Housing Board in Panchkula in sector 15; Source: The Tribune

4.7 Overview

The city was built with a strong functional and socio-economic separation between the residential and administrative areas. The phase-wise development of the city was done to have a controlled development. However, this planned development could not accommodate the rapid increase in population over decades. This led to the establishment of Mohali and Panchkula infringing in the peripheral zone. Upon viewing the historical maps over the years, the city maintained its spatial character. Its incomplete monumental capitol complex symbolised the new nation but lacks public access. Labour colonies and commercialisation catered to the influx of migrants and the middle class. While the city's organic public housing and private plot policies sought an egalitarian vision, the satellites have seen intensified commercialisation by private builders. The shifts in population distribution highlight the deviations between Chandigarh's modernist planning ideas and ground realities.

5. Methodology

A comparative analysis of the initial plan of Alber Mayer for the city and those by Le Corbusier is done to understand the differences in order and structure between the two plans. The research uses axial and segment analysis and the relationship of spatial configuration properties to the distribution of land uses in the city and how it evolved in 75 years.

5.1 Axial and Segment Map Analysis

The initial step is to establish the spatial design ideas that have shaped the city's physical form over the years. Simple line representation also known as axial lines are used to generate an axial map. These consist of the least set of intersecting longest lines of sight and access that cover the urban layout (Hillier and Hanson, 1984). The axial map was manually generated for the case study area. The axial lines are converted to segment lines when broken at their intersection and joined back as a network. (Turner, 2004).

The study area was analysed in four stages: Phase 1, 1966 when the state was reorganised into three parts; Phase 2, 1986, when the city added 16 more sectors along with two satellites; Phase 3, 2006, the addition of 8 more sectors in Chandigarh and extension of satellites; Current state 2023, the city in its evolved form for future growth.

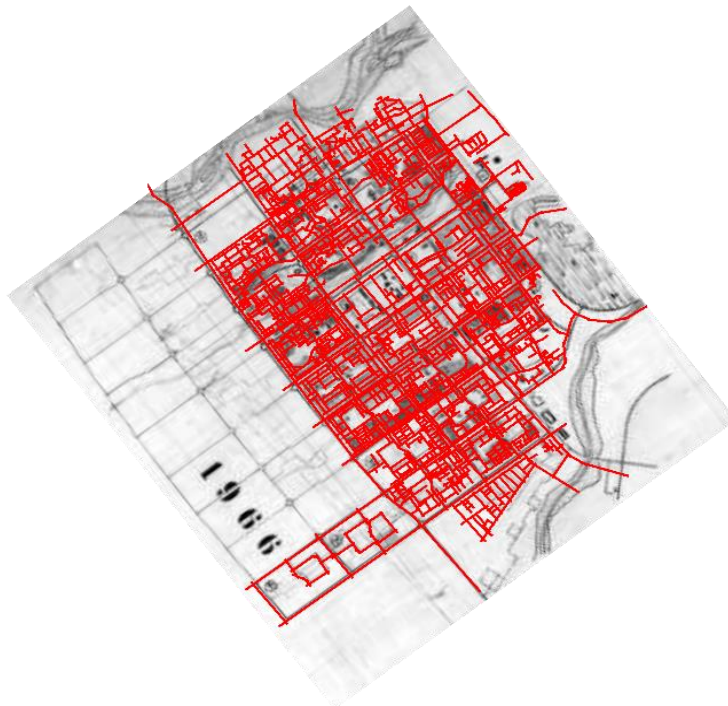


Figure 38: Axial map drawn over historical map of Chandigarh (Methodology)

The maps used in the study for the first three phases were based on the Chandigarh master plan of 2031. These maps were generated manually and then analysed using Depthmap software (Turner, 2004) to perform spatial network analysis. Segment map was used to have a more detailed analysis at a finer scale.

5.2 Spatial Analysis and Evolution

The analysis involved two crucial measures from ‘space syntax’ namely integration and choice (Hillier and Hanson, 1984). Integration evaluates the accessibility of each spatial element to all others in the system, while choice measures the amount of movement passing through each element of the shortest routes between all pairs of elements. The study also makes use of normalised angular choice (NACH) and normalised integration (NAIN) in the least angle choice analysis which implies that the paths between each segment in a system and all others can be assessed in terms of least length (Hillier et al, 2012). Fewer turns and least angle paths enable the comparison of the city of different sizes (Hillier and Lida, 2005). The first set of analyses focuses on comparing NACH values by generating maps based on 1.3 and 1.4 values¹⁴. The four-pointed star model from Hillier et al. (2012) is used to graphically represent and easily compare the syntactic values of the different cities (Figure 39). Depthmap’s measures are transformed into standard scores to allow comparison between NACH and NAIN values.

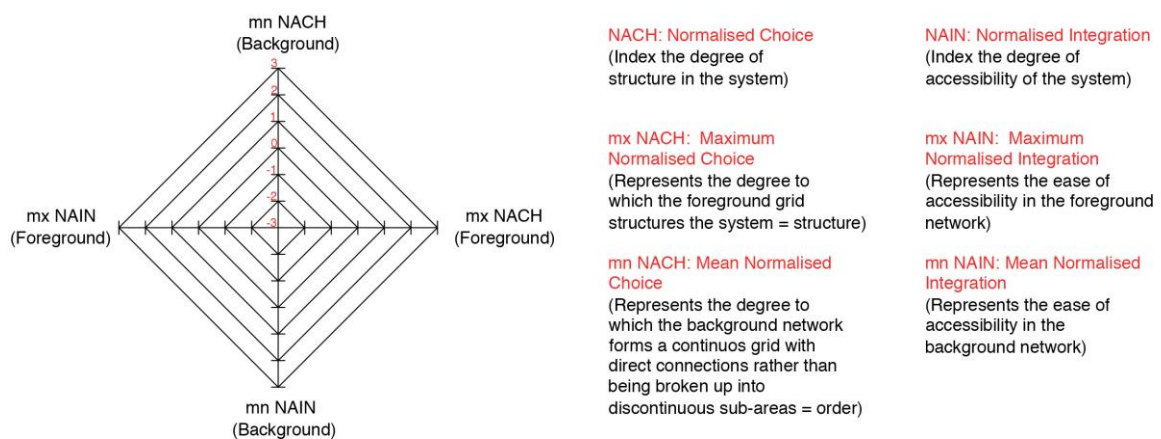


Figure 39: Four-point star model representing the values of mean and maximum NAIN and NACH
Source: Hillier et al. (2012)

¹⁴ These maps were generated on a GIS platform (QGIS) by selecting all the segments with values over the chosen threshold. Hillier et al. (2012) propose that the maximum NACH value in cities lies between 1.5 and 1.6. However, these values were found not to be representative across all the time periods of the city hence 1.3 and 1.4 values were used.

5.3 Demographic Analysis

The data obtained from the Joint Research Centre maps the population growth, and socio-economic categorisation data from Chandigarh Museum archives which provides data as per pin code¹⁵ area. The analysis is targeted using geo-processing with a polygon of sector pin code with average Rn. After mapping the data onto the spatial model, a Spearman correlation model, which analyses the degree and direction of the link between two ranking variables, is run. It essentially provides a measure of the monotonicity of a connection between two variables, i.e. how effectively the relationship between two variables can be expressed using a monotonic function. A correlation between these elements and the spatial model helped in understanding the social dynamics of the city.

5.4 Local-global Integration and Land-use

In order to gain a comprehensive understanding of the social instrumental and symbolic dynamics in the city, a detailed analysis of global and local integration segments overlaid with land use maps for varying phases of the case study area was conducted. This approach is in accordance with Hillier's (1999) concept of a 'live centre', which is determined by its global

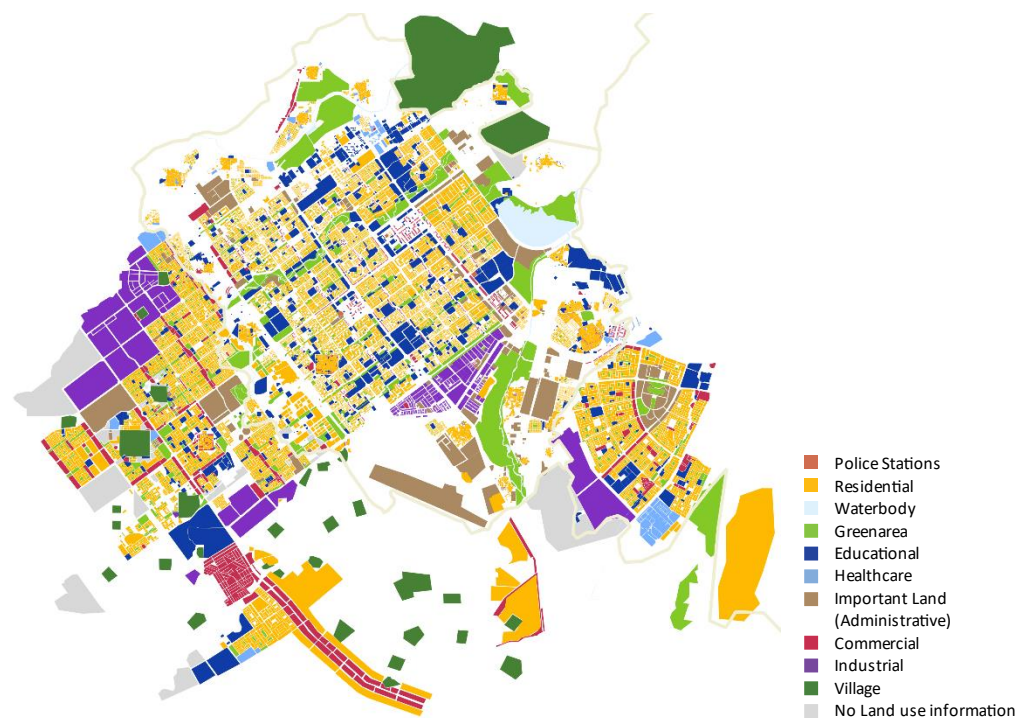


Figure 40: Land use map Source: Manually digitised using open street map information (Methodology)

¹⁵ Pin Code: same as postal code

integration values (NAIN radius N) and its local integration values (NAIN R1200 was selected as the best correlation between global and local measures across different phases of case study area is at this scale). The top values of NAIN n global maps were also highlighted to better grasp the patterns on centrality, where the similarity of values across phases allowed for the extraction of the same values for all. However, it is important to note that the top values of NAIN are not necessarily consistent across different phases. Upon generating integration segment maps, they were overlaid onto the land use map to determine whether the most syntactically integrated centres relate to the mix of activities that Hillier (1999) identifies, particularly about retail. Through this detailed analysis, a comprehensive understanding of the interplay between social dynamics, symbolic and practical centres, and land use was achieved.

5.5 Limitation of study

The study faced a major limitation in terms of acquiring GIS data for Indian cities. The necessary data such as land use map, population and socio-economic categorisation data for the tri-city area was not readily available. Hence, the data had to be manually digitised from the master plan documents individually. Once digitized, the maps were combined on QGIS using spatial joins overlaying one section over another to form a single, comprehensive map.

6. Analysis and Results

This part of the research reveals the results of different analyses and measures taken to address the research questions. The first section focuses on studying the evolution of order and structure across the different periods through the spatial structure of Chandigarh and subsequently comparing them to one another (research question 1). The second and third section focuses on the role of the political centre in planning land use which influences the symbolic axis and the socio-economic evolution of the city (research question 2).

6.1 Order and Structure

According to Hanson (1989), it is important to understand the role played by both order and structure¹⁶ in creating liveable cities. It is necessary to elevate structure to the level of

¹⁶ Order refers to principles such as repetition, grids, symmetry, and rhythm, neglecting the complex socio-spatial realities of cities. Structure pertains to the patterns of movement that we learn over time, which establishes a relationship between different parts of the city.

conscious understanding and relate it to order principles (Hillier et al., 2012). This can be achieved using segment maps at a global radius (R_n) and a four-star pointed model representing the maximum and mean values of NACH and NAIN. The mean NACH is particularly representative, with higher values generally corresponding to grid-like properties and measuring order. Meanwhile, the maximum NACH represents the structure of the system (Hillier, 2012).

6.1.1 Comparing the Initial plans of the city by Albert Mayer with Le Corbusier

The initial design by Albert Mayer (Figure 41) with 767 segments demonstrates that the structure of the city has a dominant foreground¹⁷ (1.50) network than the background (1.13). Upon placing the values of mean NACH and max NACH in Hillier's et al. (2012) and Oramas-Dorta's modified database (2012) of cities to understand the relative position, the foreground network is placed at number 55 and the background network is at number 4 (see appendix 1). This shows that there would be a structural hierarchy in the city and less order. The difference between max NACH and mean NACH was less in Mayer's plan. On the other hand, the initial design by Le Corbusier (Figure 42) with 268 segments also demonstrated a dominance of the foreground (1.37) network over the background (0.97) network. It is important to note that the structure shifts to number 66 in the foreground and 17 in the background when placed in the database (See Appendix 1) to understand the relative position. In this plan, the system has more difference in mean NACH and max NACH indicating more structural hierarchy, reduced spatial equality and stronger movement in the foreground than in the background. The star model (Figure 43-44) for both plans indicates the importance of the grid, this is the only thing Le Corbusier adapted from Mayer's plan of the city. (See section 1.1)

¹⁷ The long lines of high values, captured by maximum NACH (foreground), and many lines of low values, captured by mean NACH (background) (Hillier, 2001). When the background dominates over the foreground means that the differences between foreground and background are reduced, generating spatial equality, and thus minimizing structural hierarchy (Hillier et al. 2012).

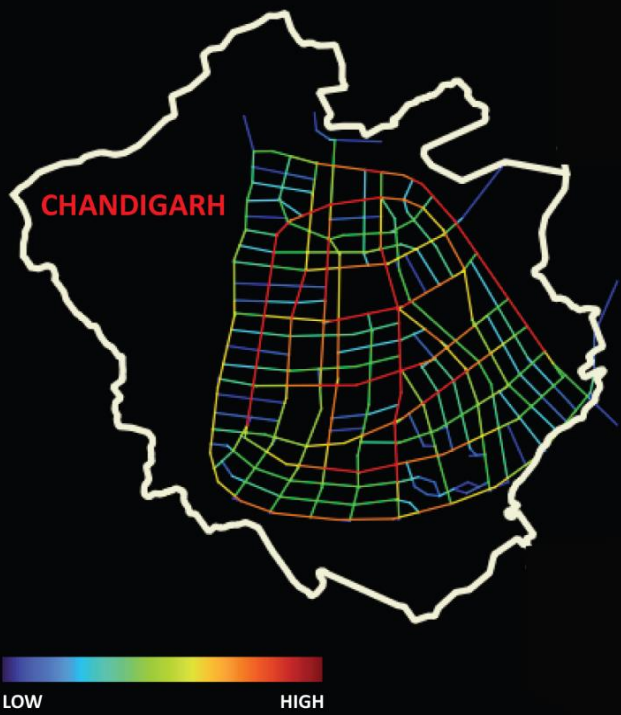


Figure 41: Initial Plan by Albert Mayer -1950;
Analysed: NACH Rn

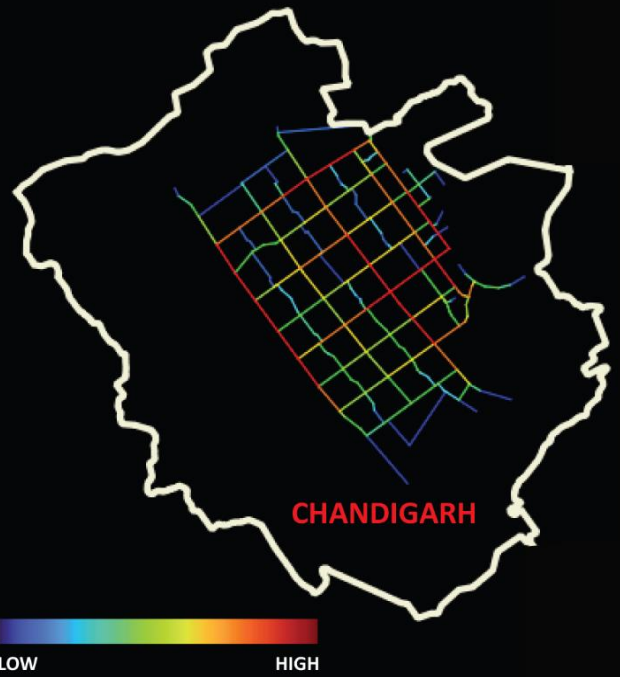


Figure 42: Initial Plan by Le Corbusier -1951;
Analysed: NACH Rn

Mayer's Plan 1950

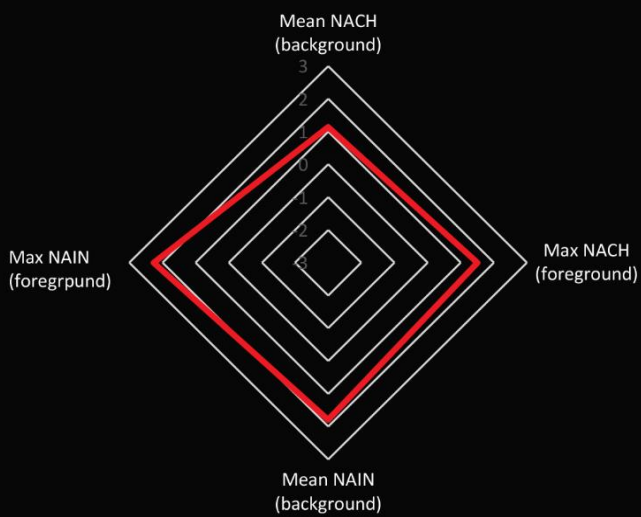


Figure 43: Star Model of initial Plan by Alber Mayer
-1950

Corbusier's Plan 1951

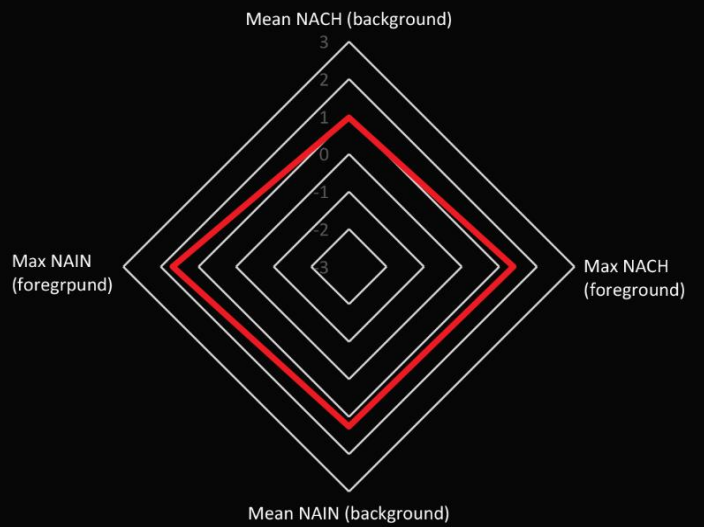


Figure 44: Star Model of initial Plan by Le Corbusier
-1951

6.1.2 Order and Structure_ Chandigarh from conception to the evolution of city

The first phase of the city - 1966 (sector 1-30)

As derived from the initial plan, the foreground network of the city was to remain dominant. After the completion of the first phase with 3734 segments, the foreground network with maximum NACH of 1.47 gained more importance over the background network with mean NACH of 0.82. The relative position of the city moves to 61 in the foreground and 55 in the background (see appendix 1). The 1.3 structure plan (Figure 46) picks up more vertical axis than horizontal. The three vertical axis – Jan Marg (symbolic axis) leading to the capitol complex, Udyan Path leading to the secretariat building and Vidhya Path connecting the education district are highlighted. The 1.4 structure plan (Figure 47) also picks up more vertical axis than horizontal, adding three more axis- Himalaya Marg leading to Sukhna reserve area, Sukhna Path leading to the lake and Chandi path connecting the Industrial area.

It is important to note that the shorter- horizontal paths are not highlighted that connect to the background networks. This shows that movement is structured to be stronger towards the north, connecting the city to the Capitol Complex. However, the axis end part of the axis that leads to the capitol complex remains segregated. The four-point star model (Figure 48) also reflects a higher maximum NACH value than the mean NACH indicating a strongly structured foreground movement than in the background.

The Second phase of the city - 1986 (adding sectors 31-47)

For the second phase with 16161 segments, the foreground network again dominates the background conferring to the structure of the city with maximum NACH of 1.60 and mean NACH of 0.81. As the satellite town of Mohali extends to the southern edge of the city and Panchkula to the north-eastern side, the city moves its relative position to 21 in the foreground network and 50 in the background (see appendix 1). The 1.3 structure plan (Figure 50) picks up more horizontal axis of the background network in the main city and the satellites. The 1.4 structure plan (Figure 51) picks up the vertical axis- Udyan Path and parts of Jan Marg (symbolic axis) but also the horizontal axis-Uttar Marg and Vidhyan Path near the Capitol Complex appear to be dominant. For the southern satellite (Mohali), the horizontal axis although part of the foreground network appears to be prominent as the vertical paths leading to Chandigarh are not properly connected. The northeastern satellite picks up the foreground

network as well. As this satellite is assumed to follow Mayer's plan, the foreground network as established earlier (see section 6.1.1) remains strong in the 1.4 structure. The four-point star model (Figure 52) also reflects a higher maximum NACH value than the mean NACH indicating a strongly structure foreground movement than in the background.

The Third phase of the city – 2006 (adding sectors 48-63)

For the third phase with 32650 segments, the foreground network still remains dominant to the background network with a maximum NACH of 1.6 and mean NACH of 0.81 same as the second phase of the city. However, in the 1.3 structure plan (Figure 54), no main horizontal or vertical axis is highlighted but instead, the main inner sector axis from the background network appears to be strong both for the main city and the satellite in the south. The foreground axis for the northeastern satellite appears to be strong in the 1.3 structure. The 1.4 structure plan (Figure 55) again picks up the vertical axis- Udyan Path and parts of Jan Marg (symbolic axis) but also the horizontal axis-Uttar Marg and Vidhyan Path near the Capitol Complex appear to be dominant but also picks up some axis from the background network as well showing a shift in cities centres. The southern satellite also picks up more background axis than the foreground. For the northeastern satellite with 1.4 structure, the foreground network remains strong leading to the city centre. Although more background axes are highlighted in the main city, the satellites show a stronger foreground structure after 20 years of evolution. Therefore, the entire area remains strong in structure rather than order with the same mean NACH and maximum NAIN values. The four-star model (Figure 56) for this phase remains the same as the previous phase and the city moves its relative position to 20 in the foreground network and 59 in the background (see appendix 1).

The city today – 2023 (75 years of Evolution)

The city and its satellites today with 42320 segments continue to have a dominant foreground network than the background network. The maximum NACH is 1.58 and mean NACH is 0.81. The 1.3 structure plan (Figure 58) picks up the background network along with parts of the Udyan Path for the city. The southern satellite picks parts of the background network and the northeastern satellite picks mostly the foreground axis leading to the city centre. The 1.4 structure plan (Figure 59) again picks up the vertical axis- Udyan Path and parts of Jan Marg (symbolic axis) along with two axis near the industrial area. The horizontal axis-Uttar Marg and

Vidhyan Path near the Capitol Complex appear to be dominant again. A few more axis from the background network are highlighted showing a shift in city centres. The southern satellite also picks a mix of background and foreground axis. For the northeastern satellite with 1.4 structure, the overall foreground axis remains strong leading to the city centre. The four-star model (Figure 60) for this phase remains the same as the previous phase and the city moves its relative position to 29 in the foreground network and 57 in the background (see appendix 1). This again highlights that the city as a whole along with the satellites continues to be more structured than ordered.

Chandigarh and its satellites in 75 years since its establishment have a dominant foreground network which has maintained the structure of the city through higher maximum NACH values. The geometry in the city has been applied in a top-down manner from the background to the foreground network and has remained this way when seen in the four-star model through all the phases (Figure 61).

The correlation analysis between maximum NACH (structure) and mean NACH (order), when studied together with Hillier et al. (2012) and Oramas-Dorta's modified database (2012) (figure 62) confirms the independence of these two measures through r^2 value of 0.0695 as established by Hillier (2012, p 167) and confirmed by Oramas-Dorta (2012, p 59). The scatterplot confirms the above analysis that the city had order initially but lost it after the completion of phase 1 but the structure remained throughout its evolutionary history.

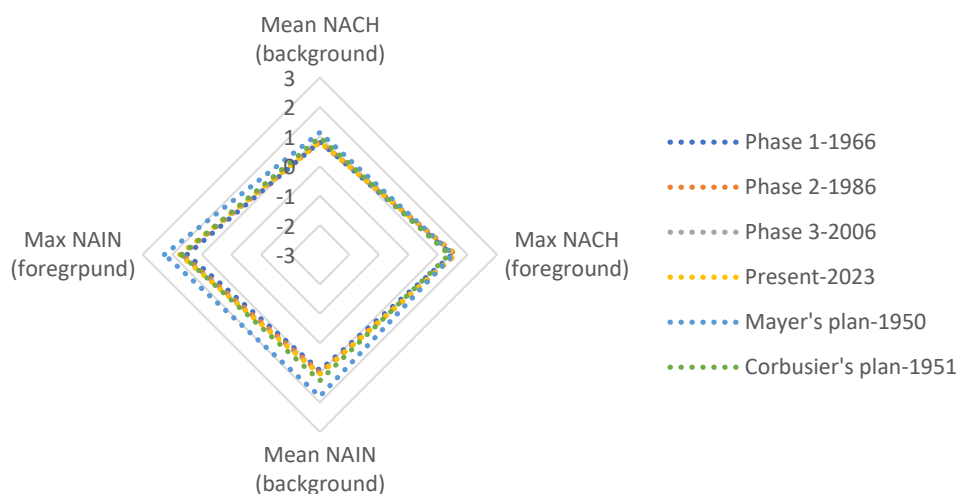


Figure 61: Star Model showing all phases of the cities and different plans.

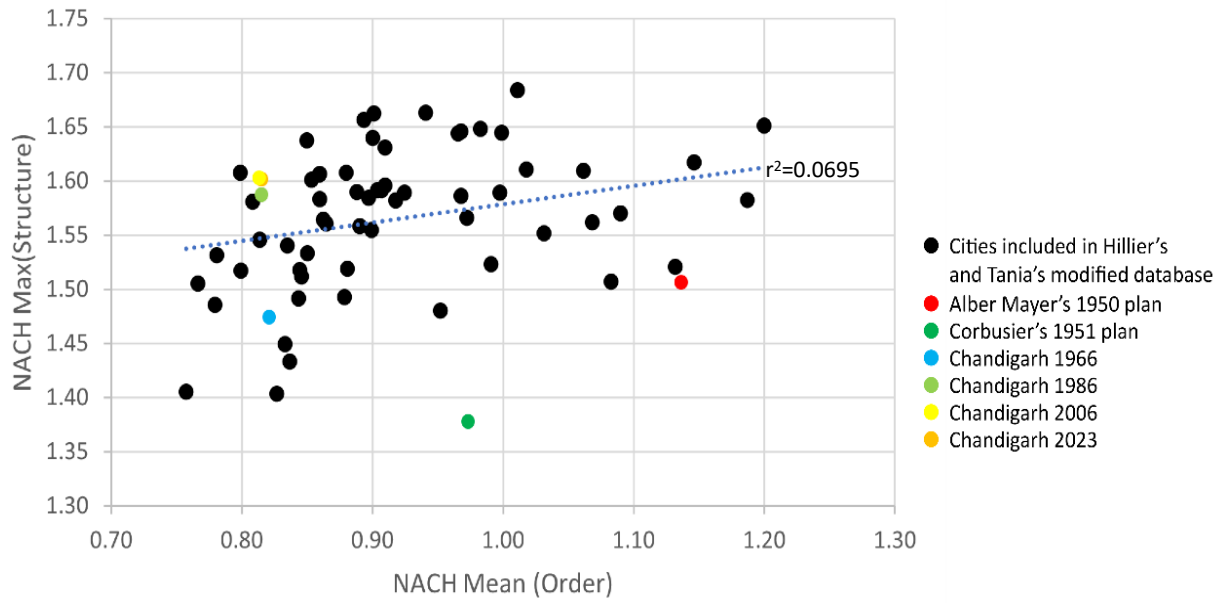


Figure 62: correlation NACH Max (structure) - NACH mean (order) across phases of the city included in Hillier's and Oramas-Dorta's modified data base (2012) (see Appendix 1)

The first phase of the city - 1966 (sector 1-30) _ Order and Structure

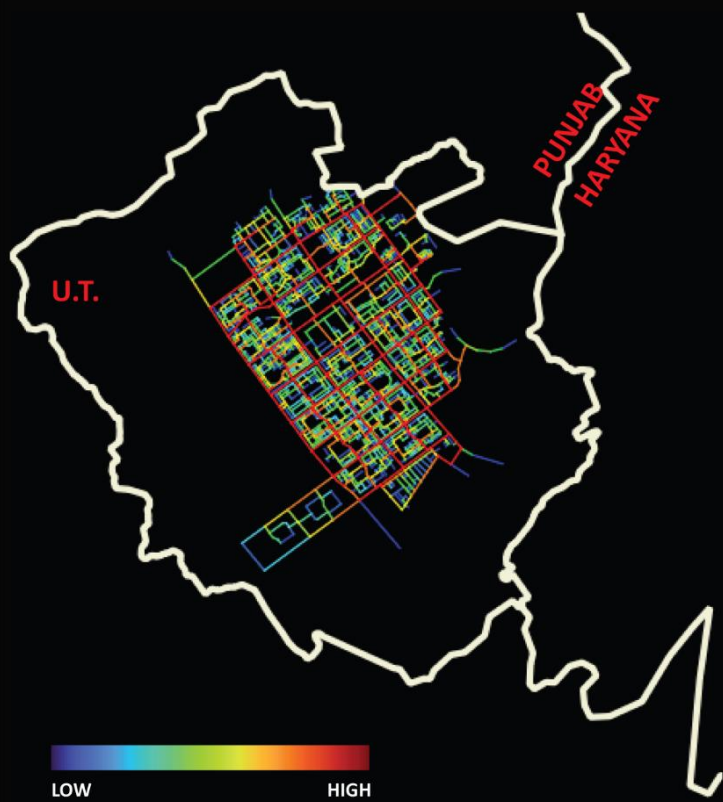


Figure 45: Chandigarh plan -1966.
Analysed: NACH Rn

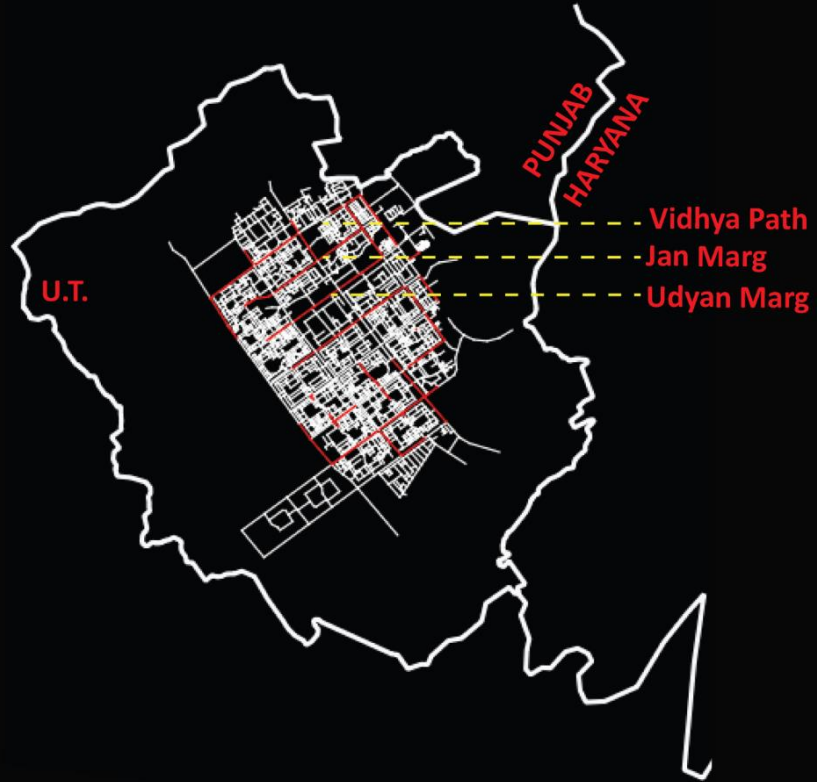


Figure 46: Chandigarh plan -1966.
Analysed: NACH Rn_1.3 Structure

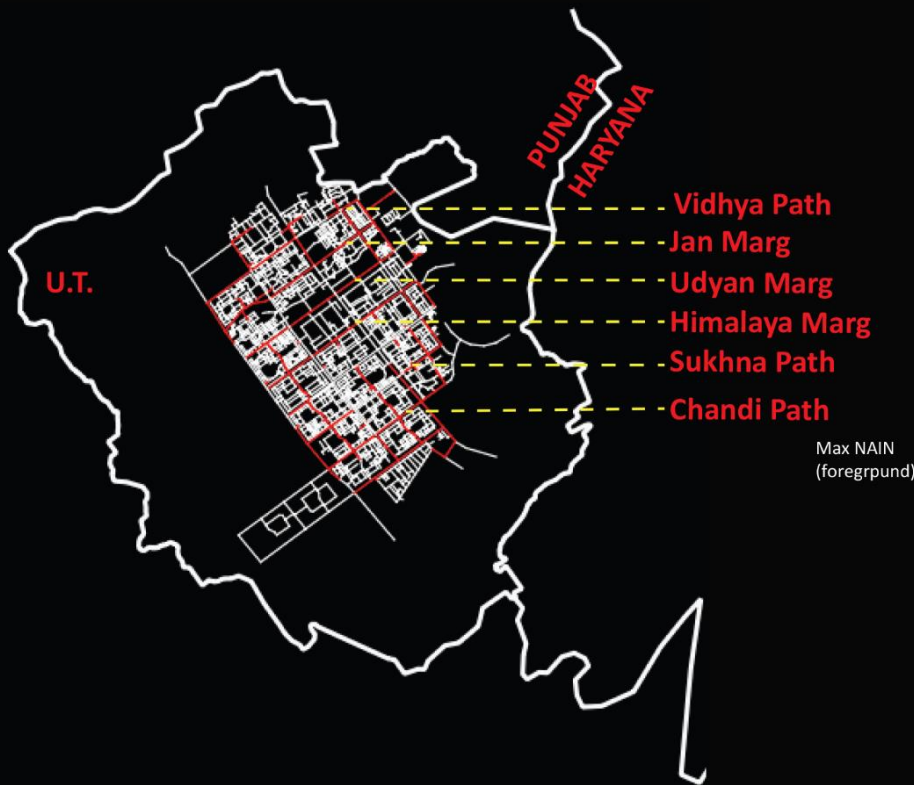


Figure 47: Chandigarh plan -1966.
Analysed: NACH Rn_1.4 Structure

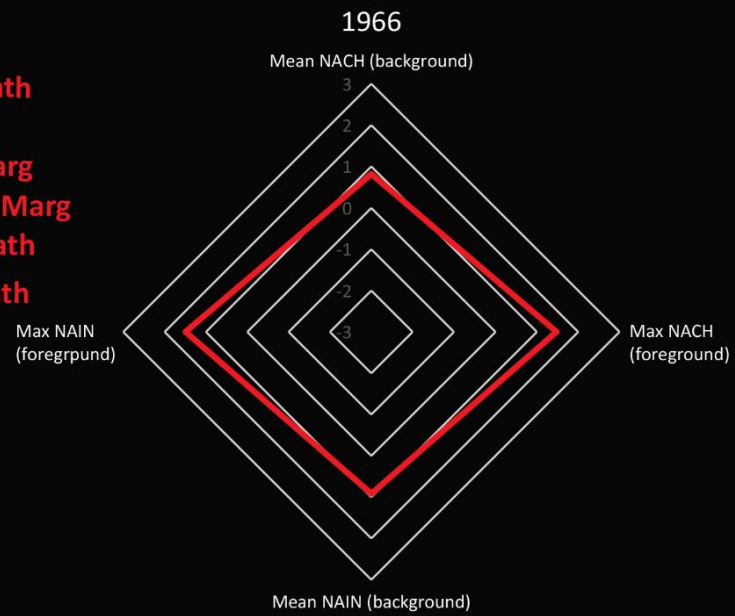


Figure 48: Chandigarh plan -1966.
Star Model

The Second phase of the city - 1986 (sector 31-47) _ Order and Structure

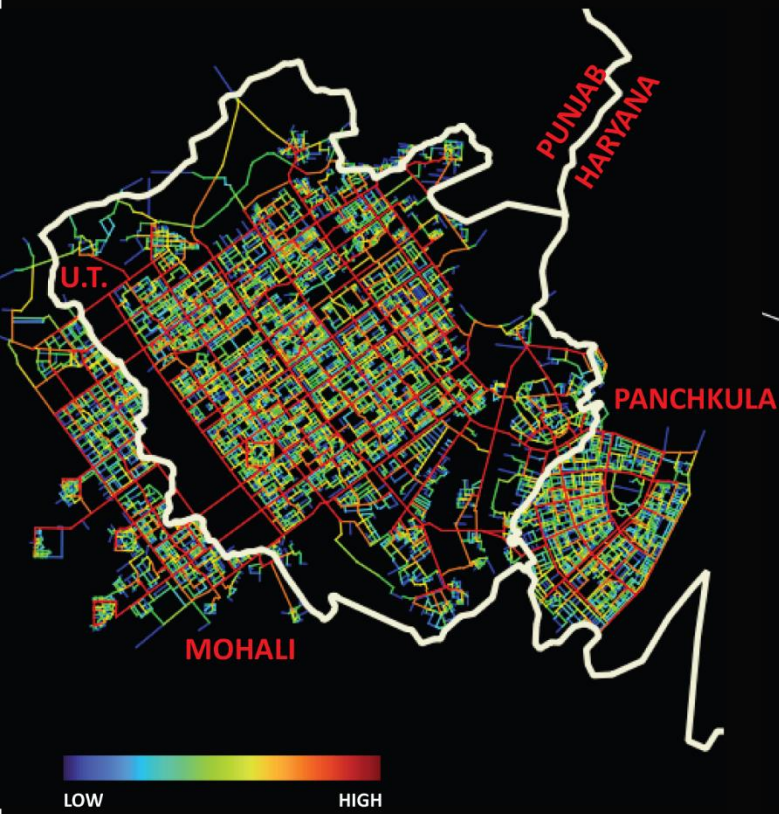


Figure 49: Chandigarh plan -1986.
Analysed: NACH Rn

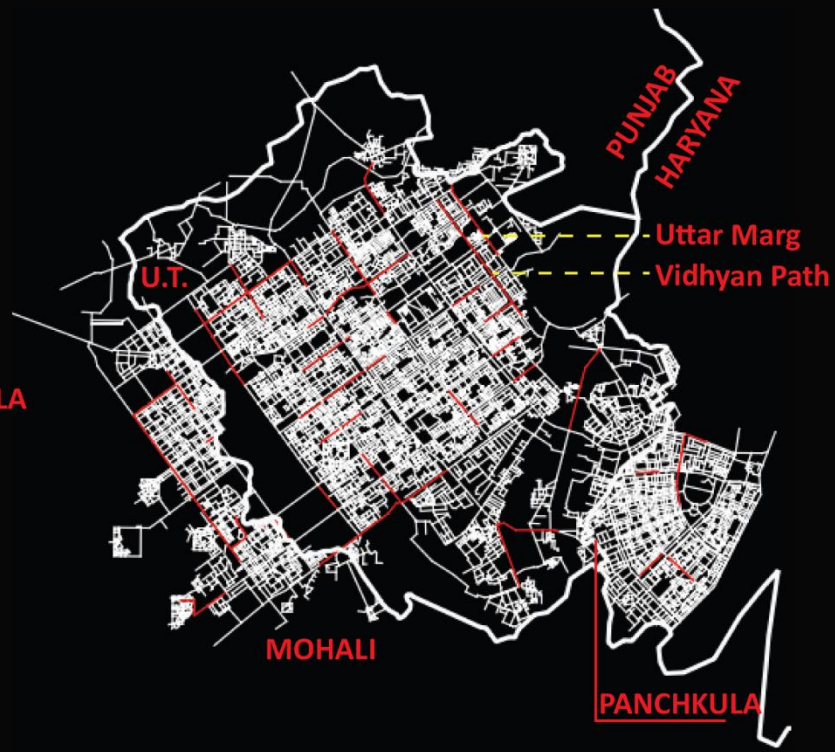


Figure 50: Chandigarh plan -1986.
Analysed: NACH Rn_1.3 Structure

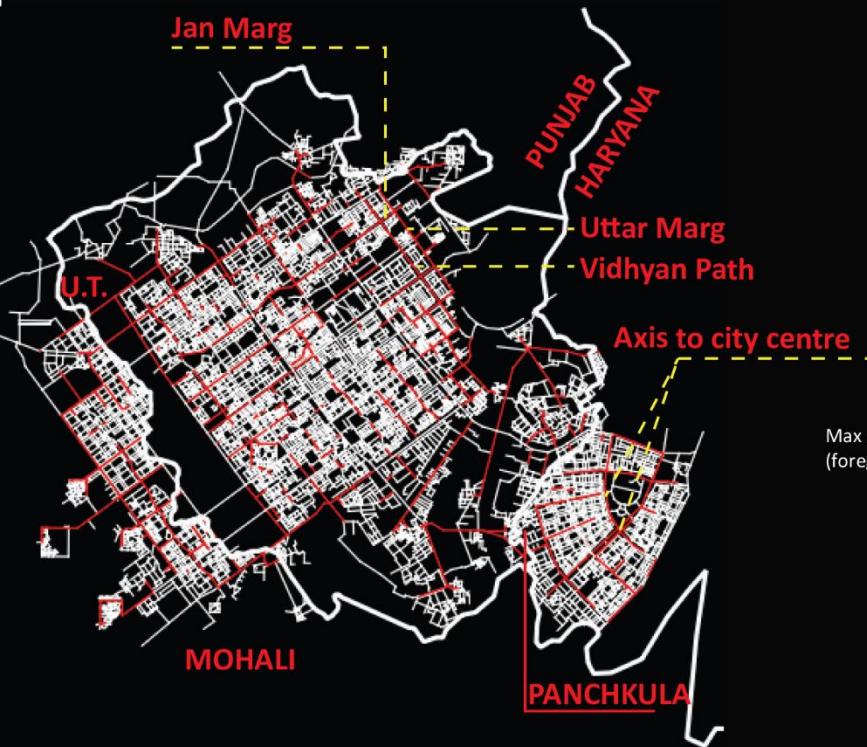


Figure 51: Chandigarh plan -1986.
Analysed: NACH Rn_1.4 Structure

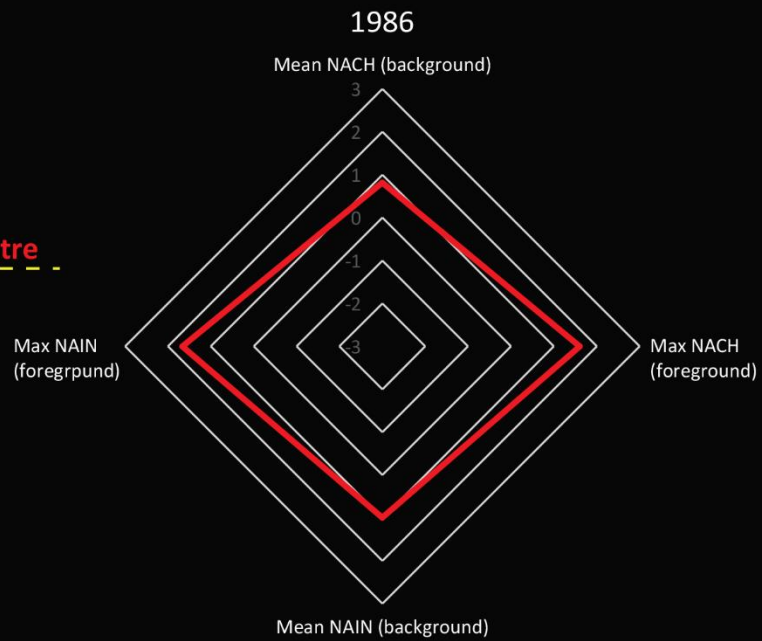


Figure 52: Chandigarh plan -1986.
Star Model

The Third phase of the city - 2006 (sector 48-63) _ Order and Structure

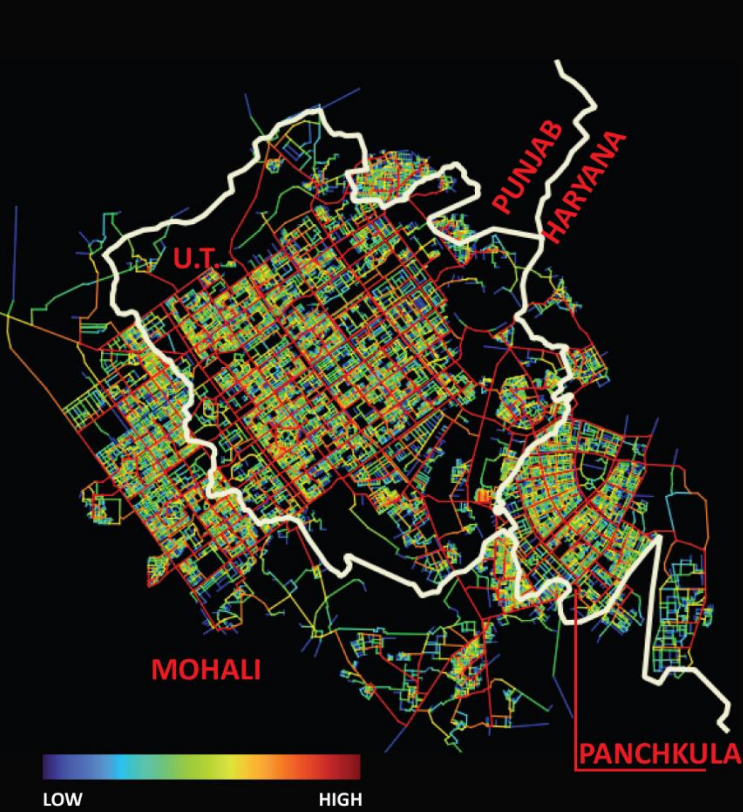


Figure 53: Chandigarh plan -2006.
Analysed: NACH Rn

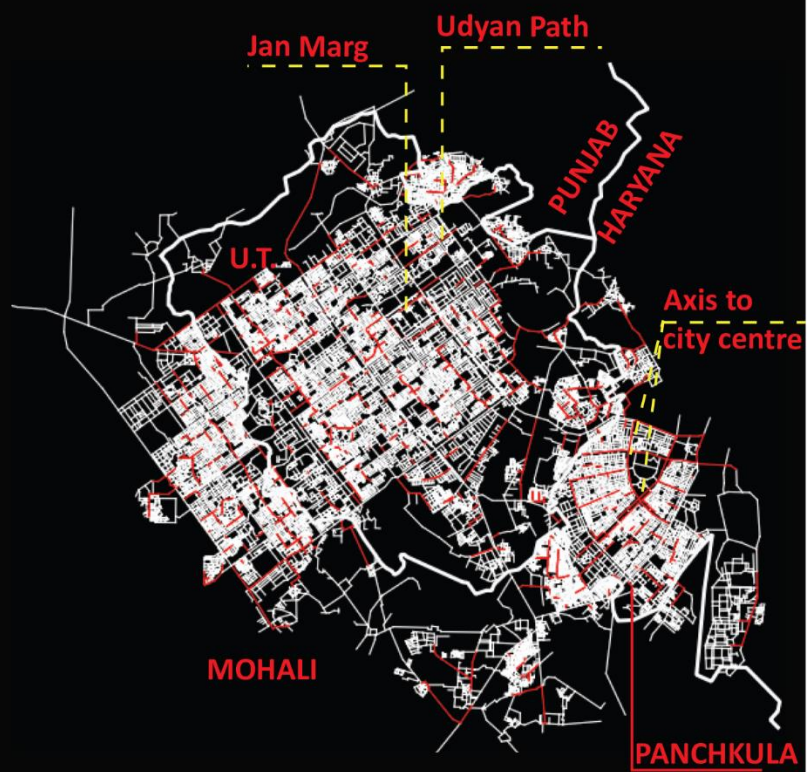


Figure 54: Chandigarh plan -2006.
Analysed: NACH Rn_1.3 Structure



Figure 55: Chandigarh plan -2006.
Analysed: NACH Rn_1.4 Structure

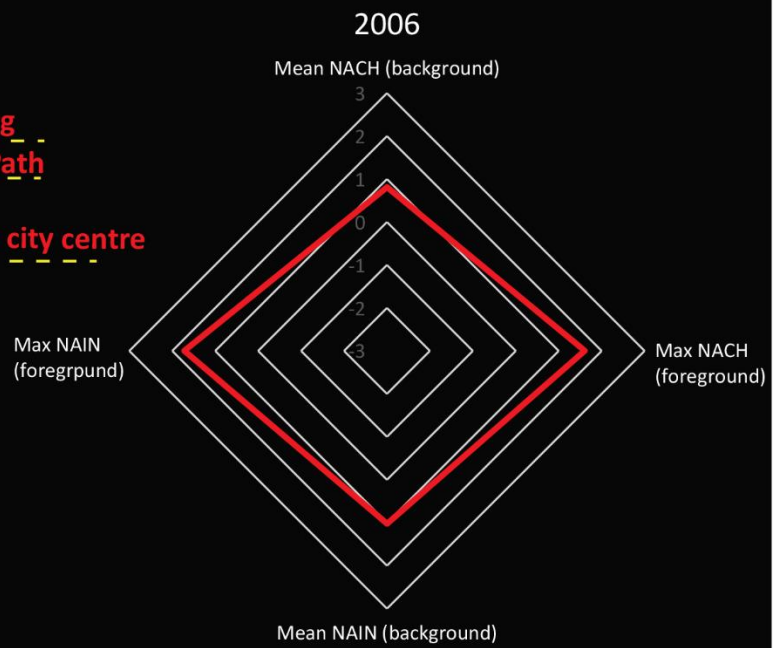


Figure 56: Chandigarh plan -2006.
Star Model

The city today – 2023 (75 years of Evolution)_ Order and Structure

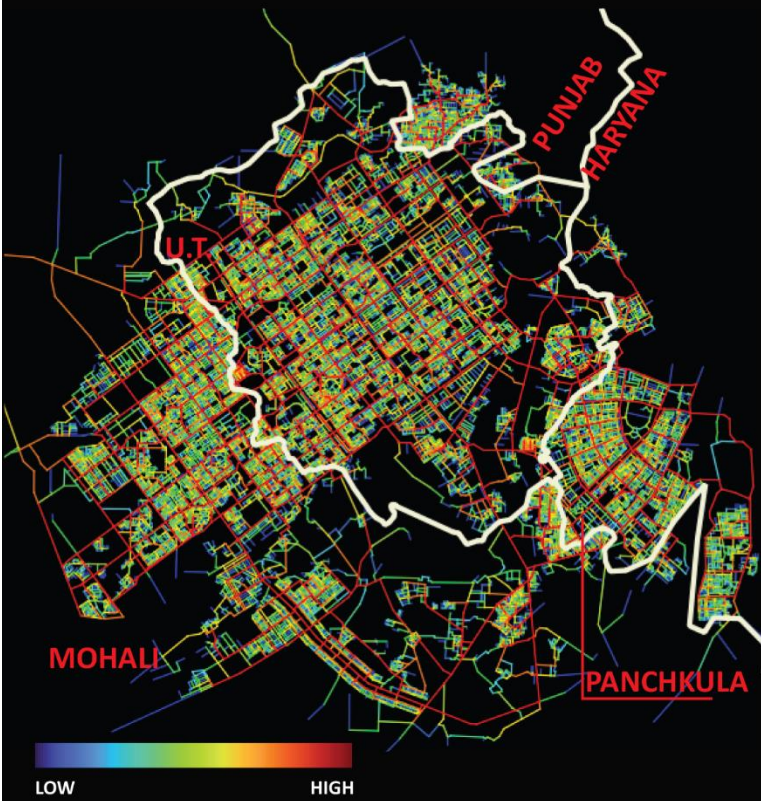


Figure 57: Chandigarh plan -2023.
Analysed: NACH Rn

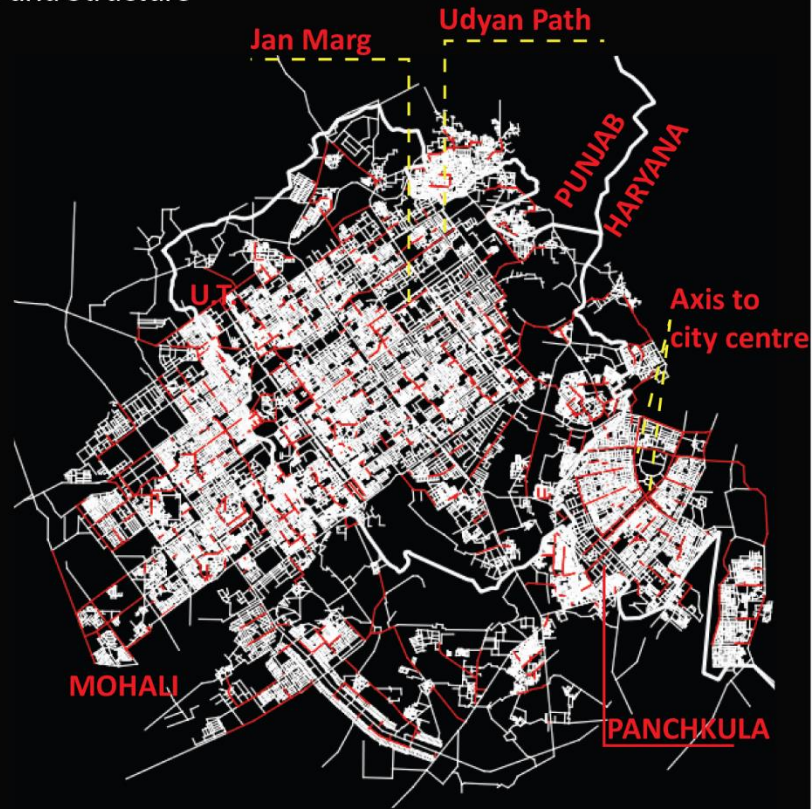


Figure 58: Chandigarh plan -2023.
Analysed: NACH Rn_1.3 Structure

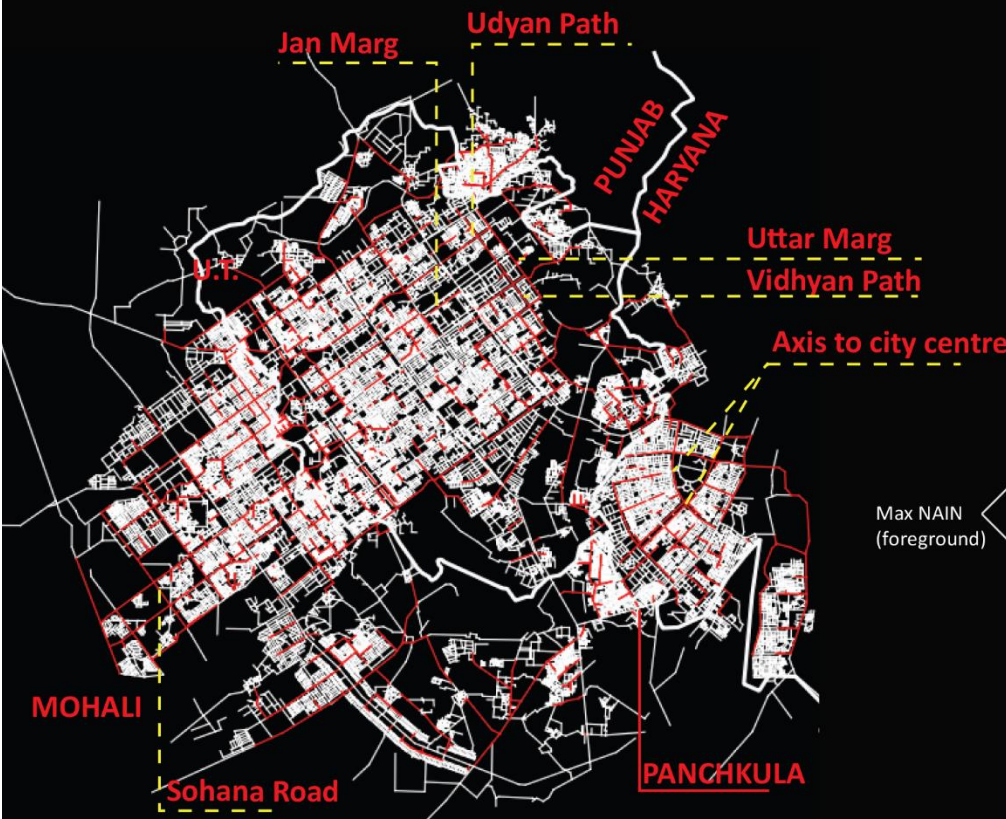


Figure 59: Chandigarh plan -2023.
Analysed: NACH Rn_1.4 Structure



Figure 60: Chandigarh plan -2023.
Star Model

6.2 The role of the symbolic axis with the city as it evolved.

As the city never lost its structure throughout its evolution, the symbolic axis (Jan Marg) leading to the Capitol complex and the parallel axis (Udyan Marg) leading to the secretariat always remained prominent while analysing choice¹⁸(See section 6.1.2). The integration¹⁹ analysis NAIN Radius (N) showing global centrality at all phases (Figure 63-66) of the city shows that the main axis running around the sectors remains highly integrated followed by the horizontal axis which divides the sectors into two parts. When integration is tested for the whole city today, the last segment that connects to the monumental core shows an integration value of 1.2 and does not correspond to higher value of 1.9 integration when tested at global scale making the monumental core segregated (Figure 67). Hence, the political centre as a designed and lived experience throughout evolution is not embedded into the city's fabric. When analysed at a local radius of 1200 (Figure 67-70), the symbolic axis does not stand out as the more syntactic integrated core. Although, Le Corbusier defined the CBD to be at Sector 17 (Phase I) and the sub-CBD at Sector 34 (Phase II), the highly regular nature of the grid also makes it difficult to distinguish a clear centre for the city it lacks the distinctive compact 'spike potato' spatial configuration noticed by Hillier (1999).

The city as a whole today has retained its structure however when analysed at local centrality, with 2.1 values highlight new active centres (Figure 71). By overlaying this segment analysis onto the land use map (Figure 72), it becomes clear that the centrality in Chandigarh is not solely driven by the process of 'movement economy' (Hillier, 1996, p 111). The new active centres such as Sector 22, I.T. Park and the Industrial Area in Chandigarh have removed the focus from the CBD (Sector 17). The retail street for Panchkula along with the Industrial area and new commercial link in Mohali (Figure 73-78) are acting as emerging active centres in the satellites. It is important to note that these centres do not coincide with the monumental core or the symbolic axis. The city as a lived experience today has shifted the preconceived centres for the movement economy and these active commercial centres are thriving in the city today. This highlights the importance of grid adaptation and intensification to create 'live centres'

¹⁸ Choice measures how likely an axial line or street segment is to be passed through on all shortest routes from all spaces to all other spaces in the entire system or within a predicted distance (radius) from each segment. (Hillier et al, 1987, p 237)

¹⁹ Integration is a normalised measure of distance from any a space of origin to all others in a system. In general, it calculates how close the origin is to all other spaces. (Hillier and Hanson, 1984, p 108)

(Hillier, 1999); conversely to the 'static' nature of the monumental core, where the grid has remained constant over time. This presents as a sign of a bottom-up emergent commercial process that contradicts the designer's and the government's top-down impositions of socio-economic and socio-political planning principles for the city.

NAIN Rn - Global Centrality- 75 years of evolution

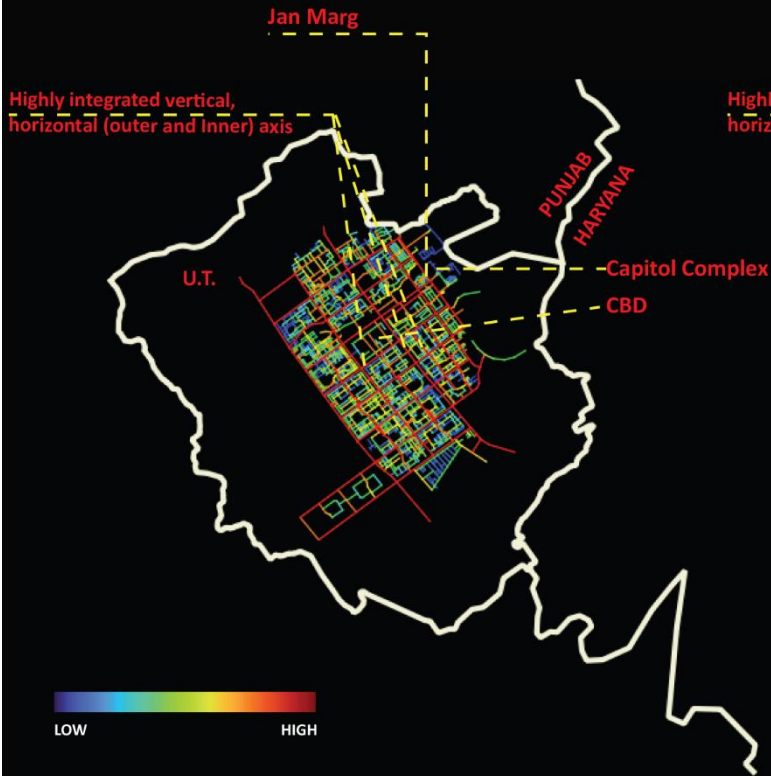


Figure 63: Chandigarh plan -1966.
Analysed: NAIN Rn

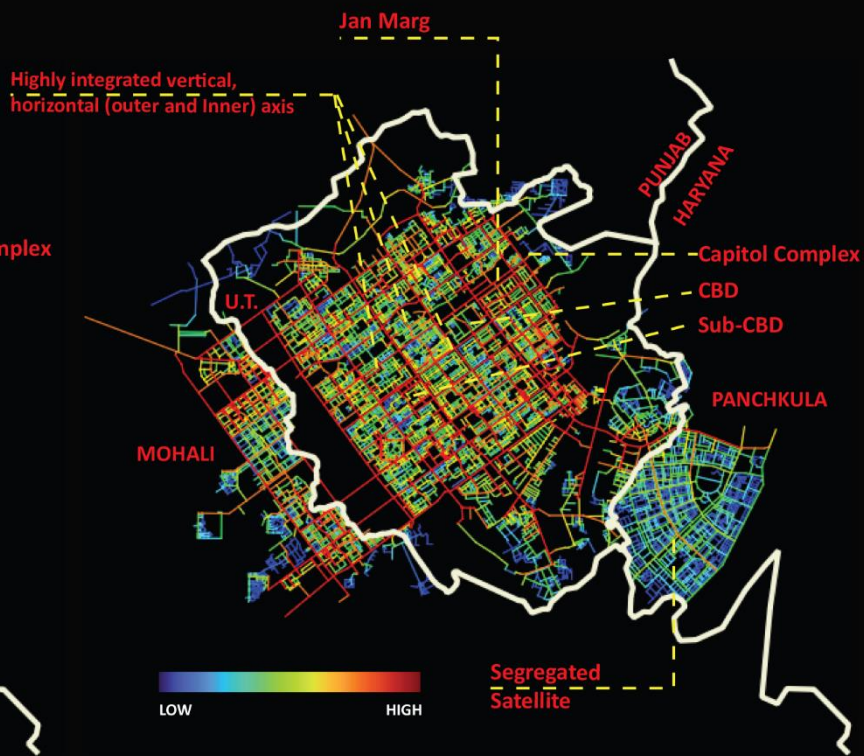


Figure 64: Chandigarh plan -1986.
Analysed: NAIN Rn

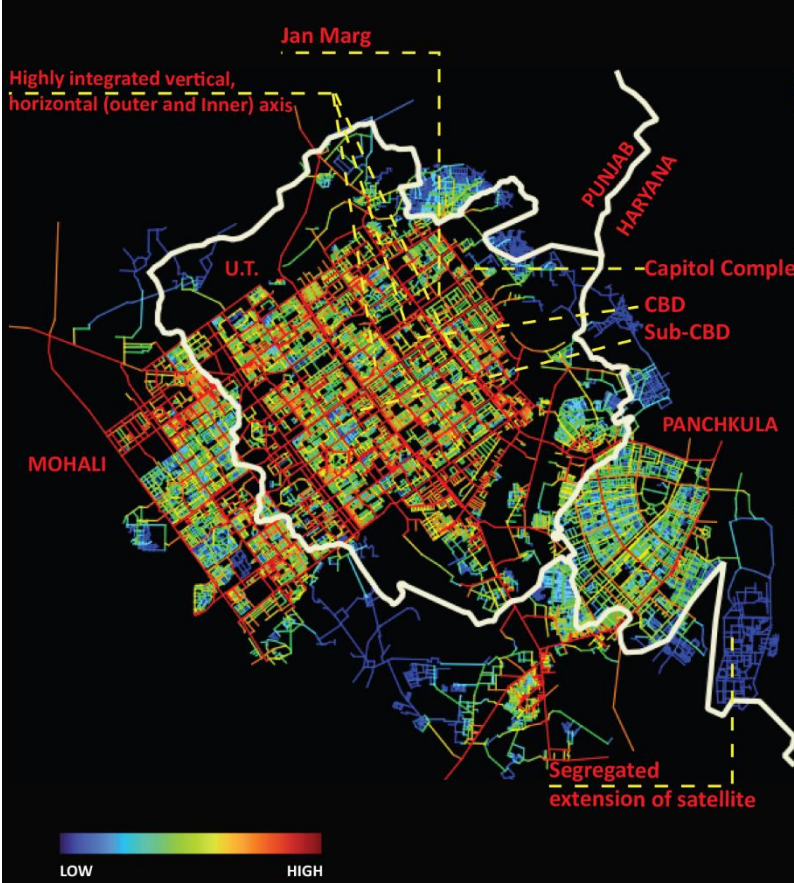


Figure 65: Chandigarh plan -2006.
Analysed: NAIN Rn



Figure 66: Chandigarh plan -2023.
Analysed: NAIN Rn

NAIN R1200 - Local Centrality- 75 years of evolution

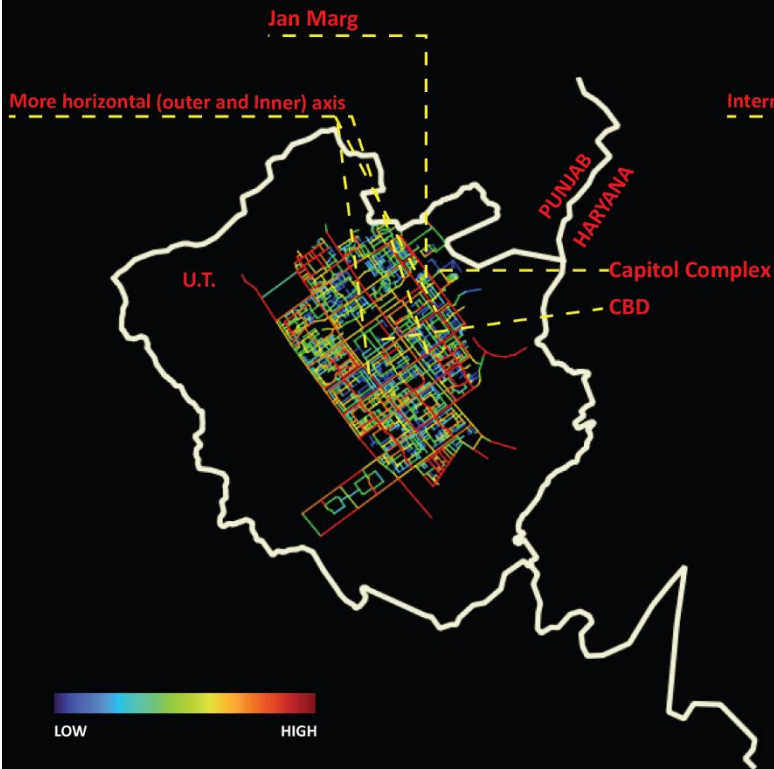


Figure 67: Chandigarh plan -1966.
Analysed: NAIN R1200

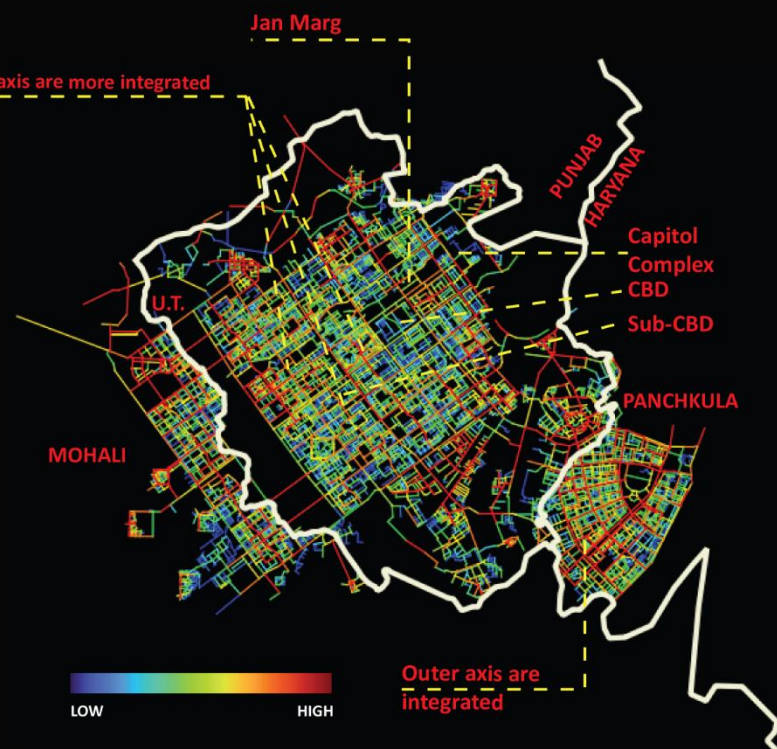


Figure 68: Chandigarh plan -1986.
Analysed: NAIN R1200

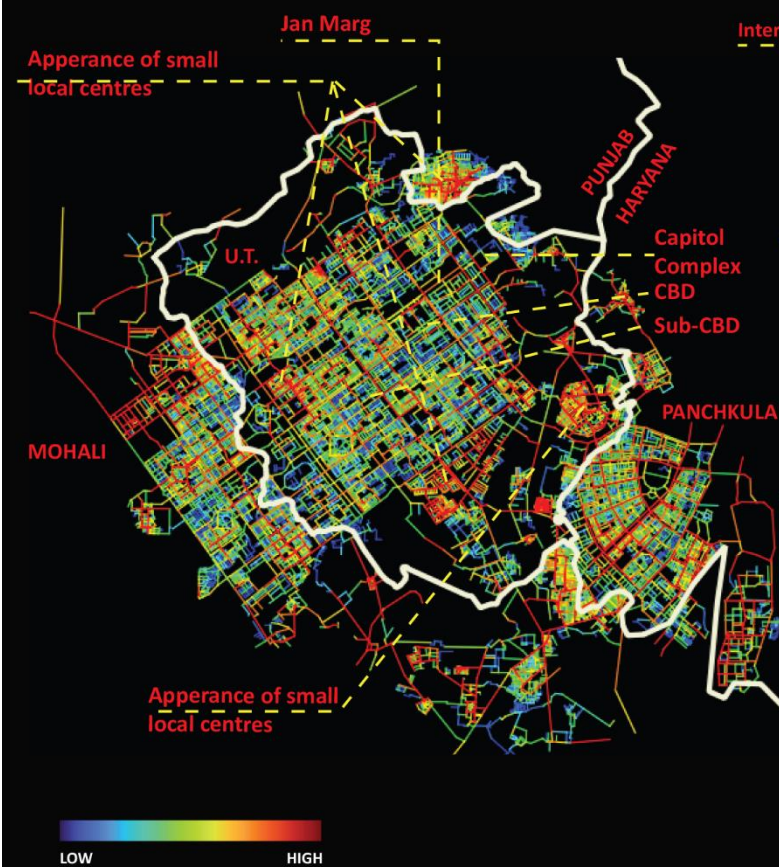


Figure 69: Chandigarh plan -2006.
Analysed: NAIN R1200

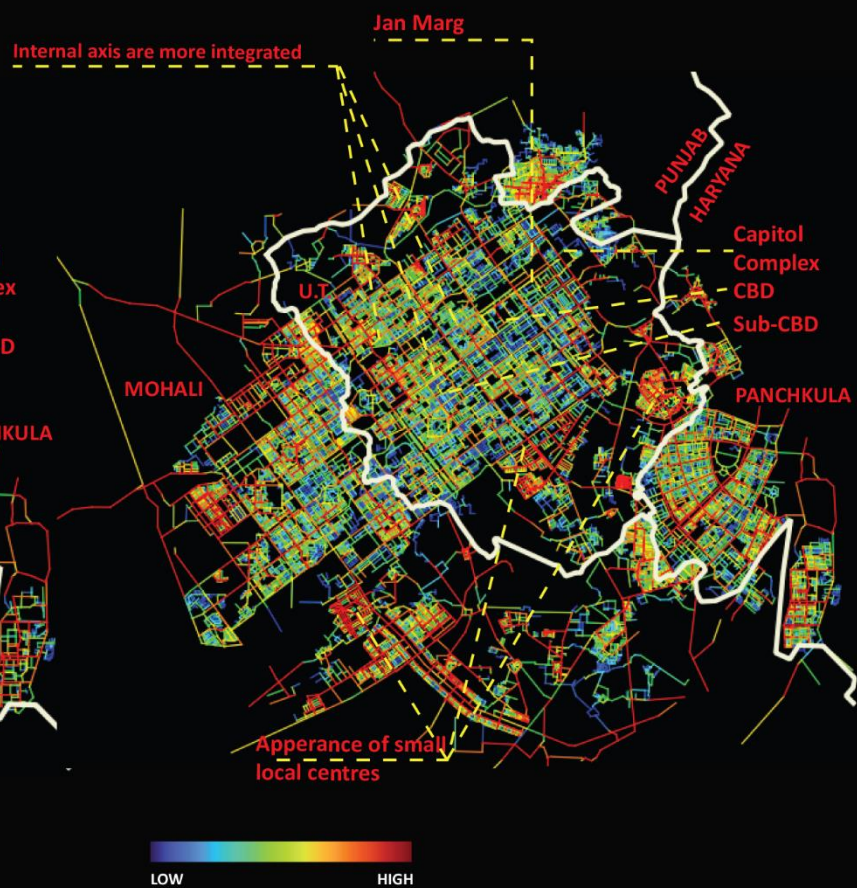


Figure 70: Chandigarh plan -2023.
Analysed: NAIN R1200

NAIN R1200 - Local Centrality- Today

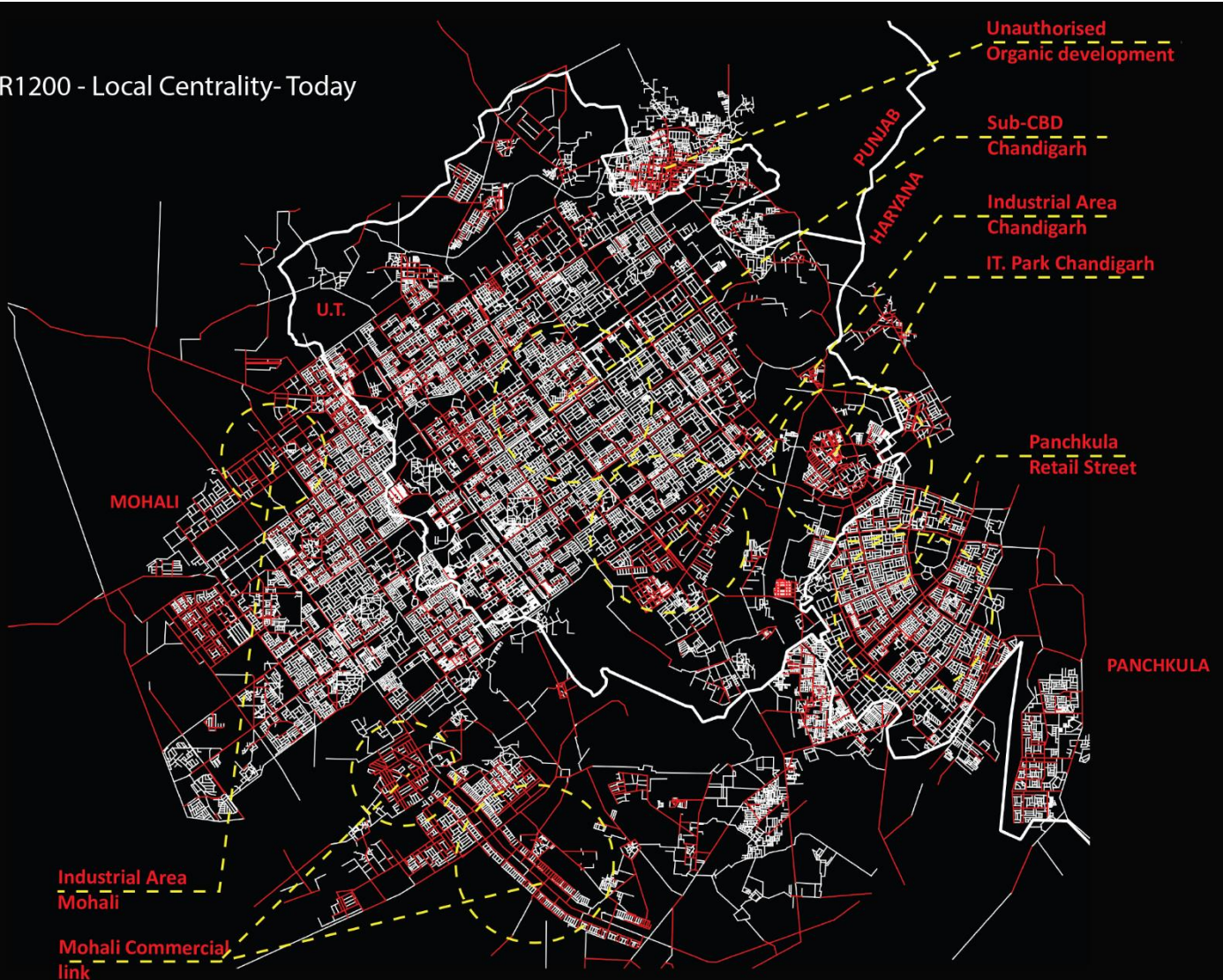


Figure 71: Chandigarh plan -2023.
Analysed: NAIN R1200_ 2.1 Values



Figure 72: Chandigarh plan -2023.
Analysed: NAIN R1200_ 2.1 Values
with Land use

Industrial Area
Mohali
52
Mohali Commercial
link



Figure 73: Sector 22 (Chandigarh-Local Centre)



Figure 74: Industrial Area (Chandigarh-Local Centre)



Figure 75: Retail Street (Panchkula-Local Centre)



Figure 76: I.T. park (Chandigarh-Local Centre)

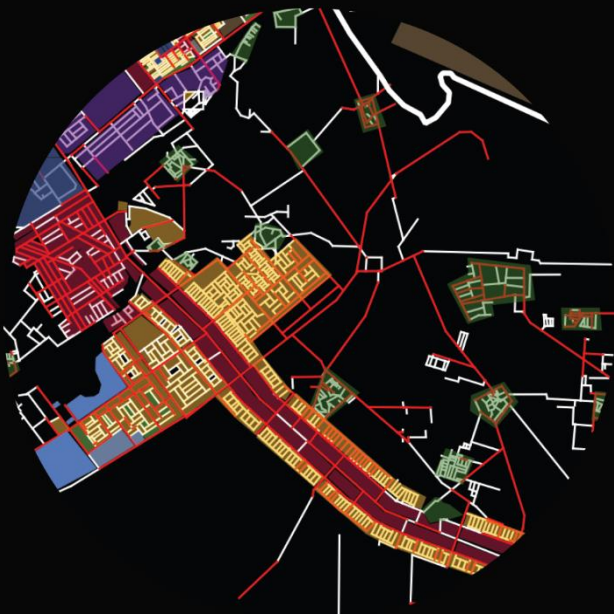


Figure 77: Commercial Link (Mohali-Local Centre)



Figure 78: Industrial Area (Mohali-Local Centre)

- Police Stations
- Residential
- Waterbody
- Greenarea
- Educational
- Healthcare
- Important Land (Administrative)
- Commercial
- Industrial
- Village
- No Land use information

6.3 Demographic and socio-economic changes as per spatial model

The analysis of demographics and social categorisation to integration, when targeted using geo-processing with a polygon to sector pin code with average R_n , shows a low correlation of $R^2 = 0.009$ for the city today. When looking at the areas close to the linear regression line, it can be seen that the areas with higher populations are in more segregated areas especially when there is organic development in relation to areas that have low populations and higher integration values (Figure 82, 86, 90) (See Appendix 2). These areas house the Elite, Government officials of the city. In the first phase of the city (1966), $R^2 = 0.306$ shows that the population is higher in the areas with high integration, but it should be noted that the city only housed Elites, Government officials, and Institutional accommodation. There are areas where there was a very low to nihil population making the correlation better than in other years (Figure 79, 83, 87) (See Appendix 2).

In the second phase of the city (1986), $R^2 = 0.004$, looking at the areas close to the linear regression line, it can be seen that the third phase with higher populations is in more segregated areas especially when there is organic development such as the urban villages in relation to areas that have low populations and higher integration values, (Figure 80, 84, 88) (See Appendix 2) this is due to the satellites. The lower correlation value is also evident in the third phase with $R^2 = 0.021$ (Figure 81, 85, 89) (See Appendix 2). This continues to be the trend when the city as a whole is observed today.

The lower correlation values show that there is a bigger factor other than integration responsible (See sections 3.1 and 4.6). Therefore, the areas with high integration show a low population but when considering the social groups residing in these low correlation areas, it shows the top-down imposition of social categorisation done by the designer and the government in terms of planning principles for the city.

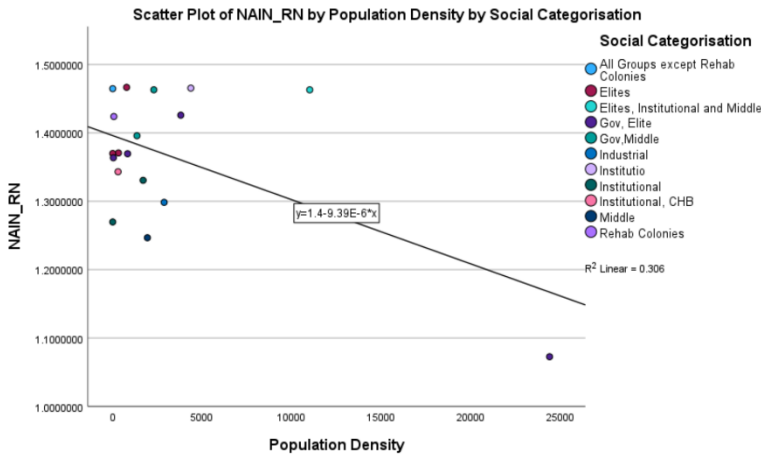


Figure 79: Correlation between population density and NAIN_Rn based on Social Categorisation-1966 (see Appendix 2)

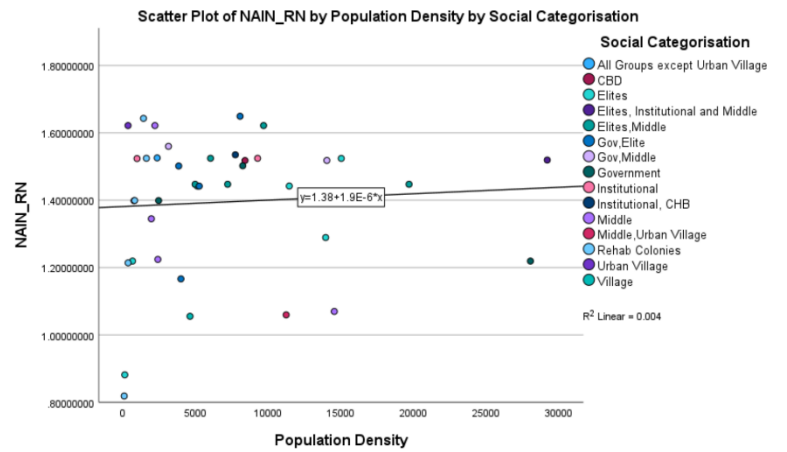


Figure 80: Correlation between population density and NAIN_Rn based on Social Categorisation-1986 (See Appendix 2)

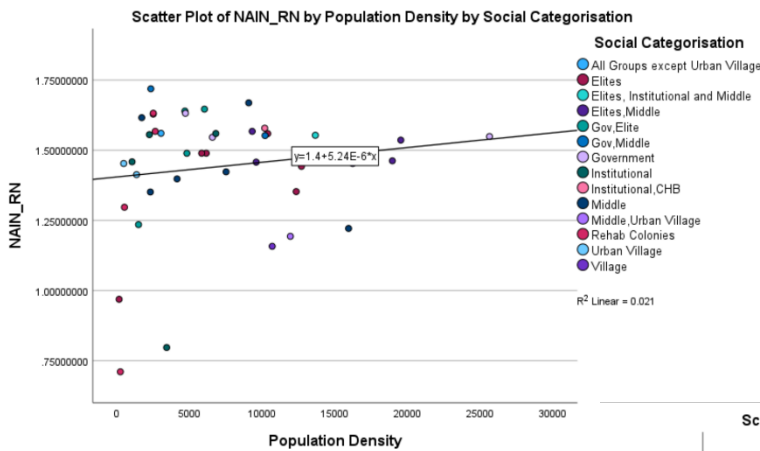


Figure 81: Correlation between population density and NAIN_Rn based on Social Categorisation-2006 (See Appendix 2)

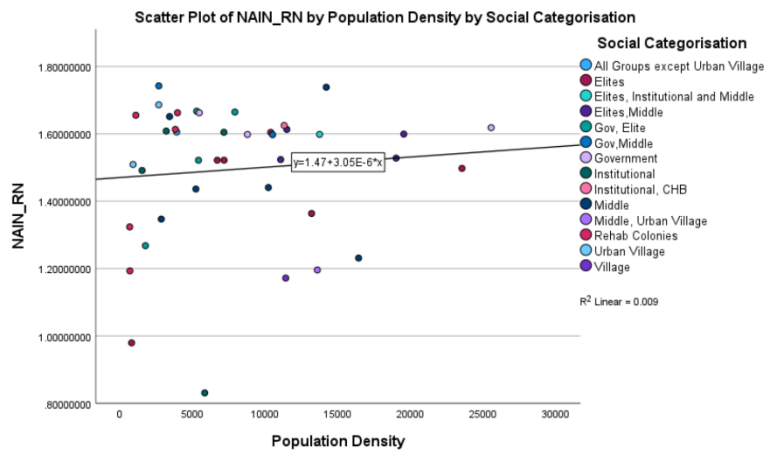


Figure 82: Correlation between population density and NAIN_Rn based on Social Categorisation-2023 (See Appendix 2)

Demographic Analysis - Change in Population density -75 years of evolution

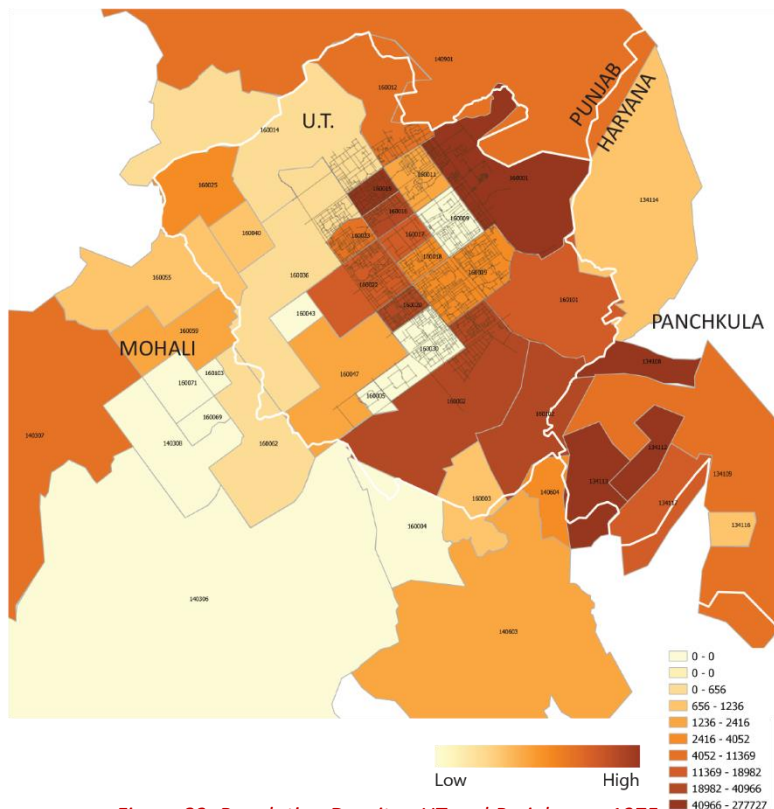


Figure 83: Population Density - UT and Periphery – 1975
 Source: European Commission, Joint Research Centre;
 digitised by Author

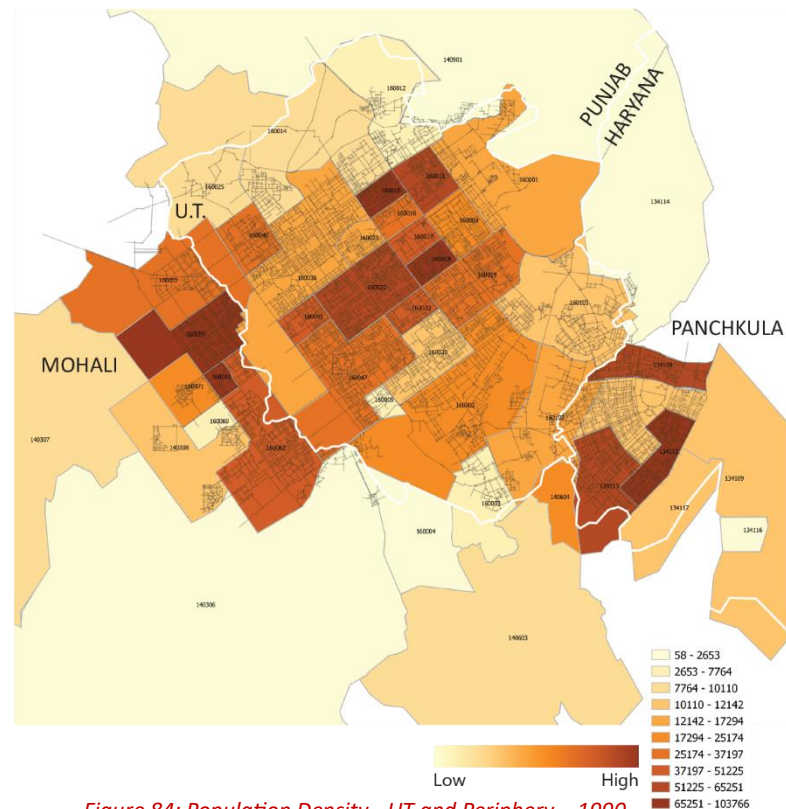


Figure 84: Population Density - UT and Periphery – 1990
 Source: European Commission, Joint Research Centre;
 digitised by Author

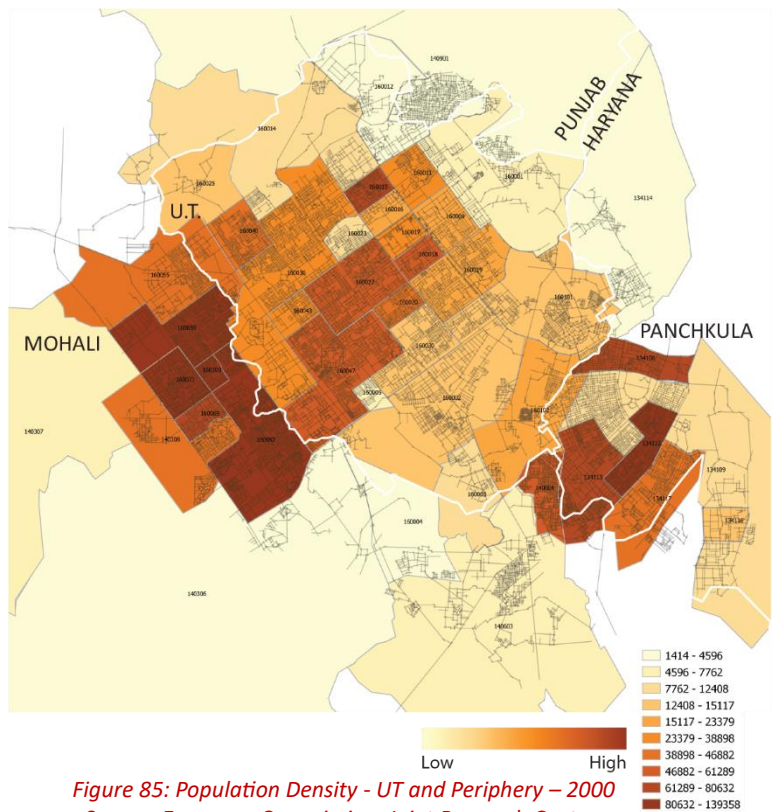


Figure 85: Population Density - UT and Periphery – 2000
 Source: European Commission, Joint Research Centre;
 digitised by Author

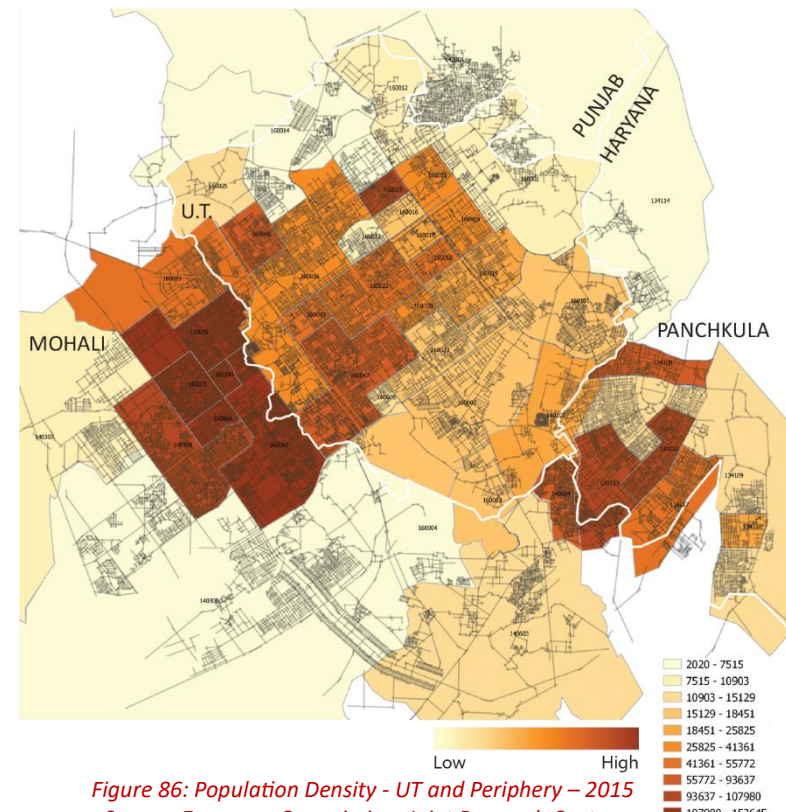


Figure 86: Population Density - UT and Periphery – 2015
 Source: European Commission, Joint Research Centre;
 digitised by Author

Socio-Economic categorisation based on housing type.

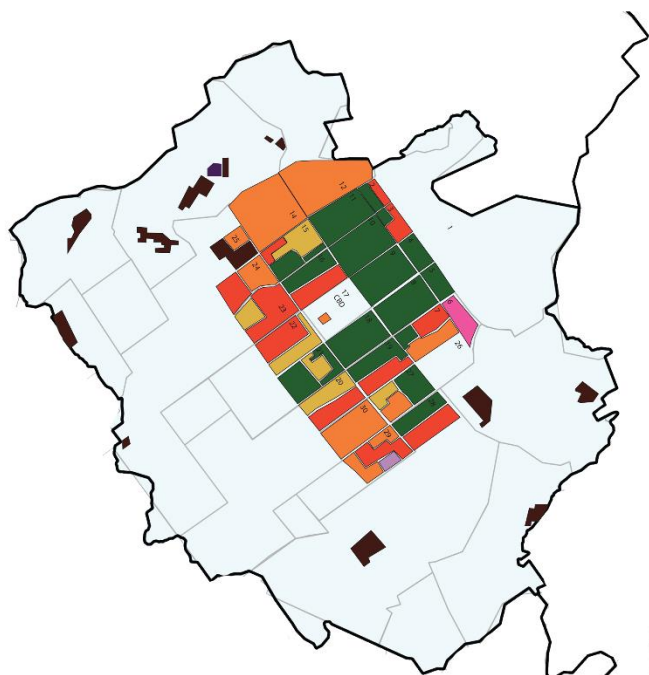


Figure 87: Socio-economic distribution based upon type of housing-1966
Source: Chandigarh master plan-2031; digitised by Author

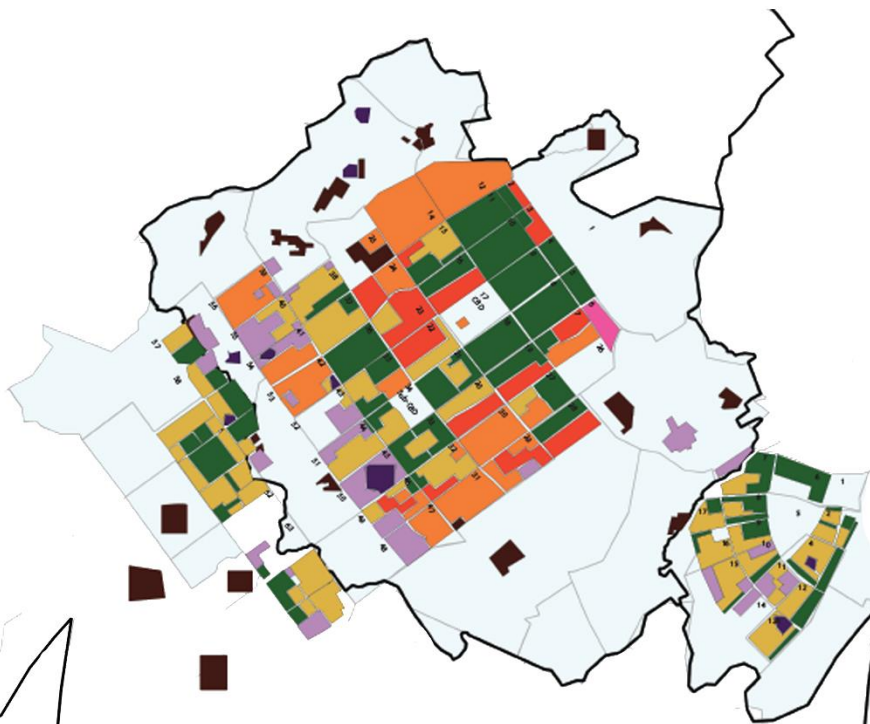


Figure 88: Socio-economic distribution based upon type of housing-1986
Source: Master plans of tri-city area; digitised by Author

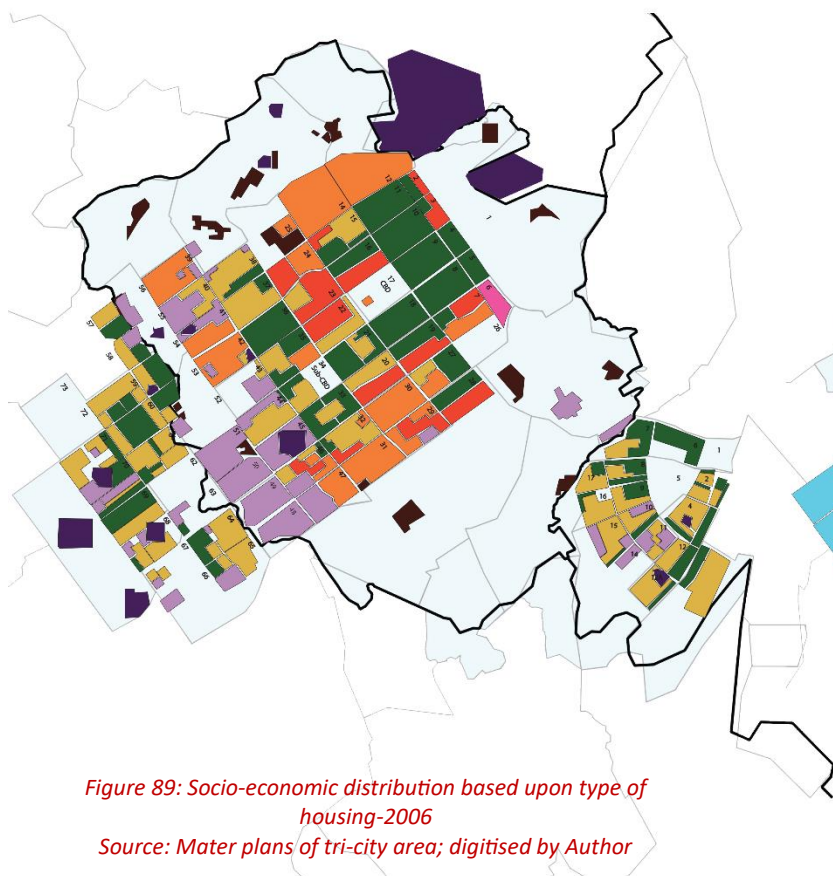


Figure 89: Socio-economic distribution based upon type of housing-2006
Source: Mater plans of tri-city area; digitised by Author



Figure 90: Socio-economic distribution based upon type of housing-2023
Source: Mater plans of tri-city area; digitised by Author

- Social- economic categrisation
- A. The Elite
 - Living in private house built on plots of at least 1 Kanal (418 sq.m.) in size. ■
 - B. A Hierarchical Middle Class
 - Living in :
 - a. Government accommodation ■
 - b. Institutional accommodation ■
 - c. houses built on private plots smaller than one kanal in size ■
 - d. flats built by Chandigarh housing board ■
 - C. Residents of Urban Villages ■
 - D. Dwellers of Slums and Rehabilitation Colonies ■
 - E. Sectors sold to private builders for mixed-use development ■

7. Discussion and Conclusion

This chapter joins the findings of the analyses with the research questions and the theoretical background.

The first research question aims to understand how order and structure are intertwined in Chandigarh's original design and how it has evolved over time in the actual physical construct. As the analysis shows that the city was designed to have a high order in terms of its planning principles with the hierarchy of roads and distribution of socio groups by using the principles of repetition, symmetry and so on. However, the low value of mean NACH present in the original design shows that the city will eventually move to a generic structure over time which was Alber Mayer's original design intention as opposed to Le Corbusier's. With emergent development within and beyond the original design boundaries shows that the city has adapted over time to accommodate the growing needs. The analysis shows that the process of spatial adaptability consolidated with the original plan and the satellites resulted in the maintenance of the structure of the city with a higher value of max NACH. The extension of the same grid toward the southern satellite of Mohali resulted in retaining to a greater extent the initial structure for 75 years.

The second research question is related to the socio-political performance of the city by analysing the role of 'symbolic axis' with respect to other functional centres today. As the centrality is applied in a top-down manner through geometry, the global syntactic analysis shows that the end of the symbolic axis where the capitol sits is highly segregated however, the symbolic axis remains highly integrated. It, however, does not act as a live centre when analysed at a local scale with Land use. The finer scale analysis captures some emergent commercial centres, along with industrial spaces showing that although they are mainly centres of social reproduction, these places evolve and adapt over time through grid-intensification. These centres have moved further away from the monumental core as well as the symbolic axis showing a bottom-up process of development. However, the distribution of land uses is still influenced by the presence of a symbolic axis and strict planning control imposed from a top-down perspective. Even though the CBD (Sector 17) and sub-CBD (Sector 34) are located on a symbolic axis they are not presented as the most integrated location when

tested locally. The city was designed to have a top-down imposition of social categorisation with maximum convenience to be given to the elites, government officials and professors of the institution. The areas closer to the Capitol complex have a lower population density and higher integration into the functions of the city. However, due to the rise in population and liberalisation, the areas with dense populations have moved further away from the city centre and established new areas showcasing the bottom-up process of development both for residential and commercial areas. The retention of order in the city in place of the structure was the designer's intention but could not be implicated because of the socio-economic as well as socio-political realities of today.

The study raises questions about post-colonial planned cities in an Indian context where there was no character, and the city was raised from scratch to justify a political agenda. The growth of the city was essentially due to socio-economic or socio-political requirements of the government and hence the characteristics deriving the city's growth failed to explain the spatial impact. The city as a lived experience today, through analysis shows that the shift from a period of state-sponsored planning and urban development to wider market forces caused a disruption in the reconciliation of the legacies of the previous period with the socio-economic realities of the present.

To conclude, this study has examined how Chandigarh has evolved from a highly planned modernist artefact to an organic lived city over 75 years, using space syntax techniques. The analyses revealed that while Chandigarh was designed with a strong spatial order, it gradually lost order but maintained its spatial structure due to emergent development processes. Its symbolic axis remain integrated but new centres have emerged, showing a shift from top-down planning ideas to bottom-up lived realities. Specifically, the order and structure analysis demonstrated that the city's foreground network and spatial hierarchy have persisted over time, even as the geometric order was adopted. However, shifting local integration centres highlight new nodes of commerce and activity that have organically emerged apart from the originally planned CBDs.

The study also reflected on Chandigarh's socio-political performance and demographic changes. The segregated political core and dispersed population distribution reflect

unintended transformations, as affluent groups have concentrated near integrated axes while dense informal settlements developed in segregated areas. This unintended socio-spatial outcome challenges modernist planning ideas of order and control. By situating Chandigarh in its unique historical circumstances, the research provided context on the social and political exigencies that shaped its establishment and growth. The trajectories of Chandigarh and its satellites illustrated the interplay between top-down planning and bottom-up evolution across the region. It is important to note that developing countries such as India, lack open-source GIS data for research and documentation of events.

The research reflected on how conceptual urban ideas are translated into lived space patterns in contexts where social complexity is rapidly built. It highlighted the need to balance strong planning visions with organic adaptations in cities. Through the use of 'space syntax' analysis and establishment of the theoretical background of the city, the research developed a methodology and suitable theory to address the research questions which understands space not only as a single variable but also takes into account social, political and economic which have evolved with time. The cities are subjected to emergent spatial processes from the moment of their creation; gradually blurring the strict geometry of their original arrangements. This produces a shift of the city structure towards spatial forms comparable to those of the so-called organic cities, showing how the natural processes of spatial adjustment overcome the imposed spatial and social forces of top-down design in cities. The significance of the study is to help planners and conservation architects of cities, that bear the legacy of modernity and planned capitals, to better understand the tensions and complexities in the transformation of cities from planned artefacts to evolving urban settings. For Chandigarh, the modernist vision significantly shaped its urban form and socio-spatial policies, but practical exigencies led to organic adaptations over time.

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Appendix 1: Database containing Hillier’s et al. (2012) analysed cities and Tania Oramas’s (2012) dissertation study modified data values and values for the city being analysed in the present research.

Cities	orderMaxNACH	orderMeanNACH	orderMaxNAI	orderMeanNAI
manhattan	31	2	1	1
D1. Washington Planned	5	1	3	2
Chicago_	9	19	2	3
mexicocity	15	8	5	4
hollywood	13	3	8	5
chicago centre	46	4	11	6
denver	14	10	6	7
Barcelona	1	11	4	8
santiago	2	21	7	9
D1. Washington Today_Planned	7	17	12	10
las vegas	16	36	9	11
new orleans	8	12	10	12
tokyo	4	32	13	13
charleston	40	9	19	14
Xangai	33	5	24	15
atlanta	34	16	15	16
athens	6	15	17	17
D1. Washington Today_All	12	24	14	18
uberlandia	26	13	20	19
City1676	11	45	18	20
D2. Brasilia Planned	51	6	26	21
antwerp	27	18	25	22
londonallsing	10	29	16	23
beijing	20	43	23	24
D3. Abuja Planned	36	7	21	25
jeddah-H	3	28	22	26
Beijing_Inner	23	27	28	27
kyoto	18	40	27	28
D4. Astana Planned	45	14	32	29
shanghai	38	33	31	30
amsterdam	21	25	29	31
madrid	28	31	30	32
munich	24	34	34	33
rectife	35	39	36	34
mytilene	30	23	35	35
nicosia in walls	56	20	44	36
ahmenabad	32	54	33	37
teotihuacan	22	26	38	38
canterbury	29	41	37	39
D2. Brasilia Today_All	17	56	39	40
bath	54	48	46	41
D4. Astana Today_All	39	30	42	42
hong kong	25	22	41	43
istanbul	19	42	40	44
nicosia	48	47	45	45
silkmaar	37	38	43	46
auckland	53	37	50	47
konya	47	35	48	48
D2. Brasilia Today_Planned	44	57	47	49
rome	43	44	51	50
gouda	41	53	49	51
D3. Abuja Today_Planned	49	55	52	52
sao paulo	50	46	53	53
rio de janeiro	42	50	54	54
D3. Abuja Today_All	55	58	55	55
shiraz2	52	59	56	56
hamedan2	60	52	58	57
petropolis	57	51	57	58
venice	59	60	60	59
ouro preto	58	49	59	60
Chandigarh_Mayer	55	4	18	9
Chandigarh Corbusier_1951	66	17	36	30
Chandigarh Corbusier_1966	61	55	43	44
Chandigarh Corbusier_1986	21	50	37	38
Chandigarh Corbusier_2006	20	59	35	36
Chandigarh Corbusier_2023	29	57	34	35
AVERAGE				
STDEV				

Cities	NACH_n_Mean	SS_NACH_n_Mean	NACH_n_Max	SS_NACH_n_Max
manhattan	1.187389723	2.549689575	1.5819960	0.2577700
01. Washington Planned	1.19986	2.667411925	1.65099	1.2885696
Chicago_	0.965338790	0.453476511	1.6442304	1.1875783
mexicocity	1.061611920	1.362317515	1.6093719	0.6667775
hollywood	1.146121830	2.160110954	1.6169945	0.7806624
chicago centre	1.131927360	2.026111816	1.5210780	-0.6523707
denver	1.017655120	0.947354978	1.6106993	0.6866094
Barcelona	1.011134670	0.885800396	1.6839447	1.7809267
santiago	0.940792690	0.221755550	1.6630344	1.4685180
01. Washington Today_Planned	0.967827	0.476965799	1.64591	1.2126722
las vegas	0.879945830	-0.352653128	1.6078752	0.6444162
new orleans	0.998611650	0.767580140	1.6444626	1.1910474
tokyo	0.893542430	-0.224298024	1.6565077	1.3710063
charleston	1.031155890	1.074805424	1.5515585	-0.1969792
Xangai	1.089900920	1.629372332	1.5699847	0.0783161
atlanta	0.972434440	0.520461117	1.5659418	0.0179134
athens	0.982488440	0.615373243	1.6478853	1.2421840
01. Washington Today_All	0.909512	-0.073541525	1.63079	0.9867730
uberlandia	0.997637310	0.758382141	1.5890373	0.3629700
City1676	0.849632101	-0.638821864	1.6371708	1.0821049
02. Brasilia Planned	1.08279	1.562243574	1.50733	-0.8577717
antwerp	0.967552430	0.474373793	1.5864753	0.3246926
londonallising	0.900013520	-0.163209412	1.6395510	1.1176660
beijing	0.853330790	-0.603905369	1.6011226	0.5435295
03. Abuja Planned	1.06829	1.425360162	1.56209	-0.0396341
Jeddah-H	0.900859500	-0.155223161	1.6621563	1.4553988
Beijing_Inner	0.903697450	-0.128432245	1.5913959	0.3982085
kyoto	0.859678480	-0.543981682	1.6066544	0.6261769
04. Astana Planned	0.990726	0.693137748	1.52333	-0.6187249
shanghai	0.890268100	-0.255208470	1.5582976	-0.0962942
amsterdam	0.909469070	-0.073946794	1.5955451	0.4601993
madrid	0.897063940	-0.191054141	1.5842010	0.2907136
munich	0.887795510	-0.278550301	1.5895703	0.3709332
recife	0.862145810	-0.520689506	1.5643107	-0.0064559
mytilene	0.917815340	0.004843959	1.5823081	0.2624329
nicosia in walls	0.952149680	0.328968208	1.4802134	-1.2629052
ahmenabad	0.808360930	-1.028431431	1.5811018	0.2444103
teotihuacan	0.906926420	-0.097950009	1.5915244	0.4001283
canterbury	0.859470000	-0.545949782	1.5831757	0.2753952
02. Brasilia Today_All	0.798627	-1.120322021	1.60751	0.6389599
bath	0.843279680	-0.698790213	1.4918031	-1.0897501
04. Astana Today_All	0.899285	-0.170086812	1.55449	-0.1531813
hong kong	0.924374760	0.066766427	1.5891237	0.3642608
Istanbul	0.859135700	-0.549105652	1.6058285	0.6138376
nicosia	0.844337020	-0.688808674	1.5180765	-0.6972144
alkmaar	0.864328880	-0.500080811	1.5607588	-0.0595228
auckland	0.878341090	-0.367802251	1.4929068	-1.0732604
konya	0.880816480	-0.344433987	1.5188625	-0.6854712
02. Brasilia Today_Planned	0.78068	-1.289745924	1.53131	-0.4995003
rome	0.850072440	-0.634664960	1.5334818	-0.4670527
gouda	0.813784790	-0.977228916	1.5458868	-0.2817168
03. Abuja Today_Planned	0.799298	-1.113987623	1.5175	-0.7058276
sao paulo	0.845643400	-0.676476140	1.5117947	-0.7910672
rio de janeiro	0.834588970	-0.780832560	1.5403726	-0.3641012
03. Abuja Today_All	0.779185	-1.303859076	1.48569	-1.1810824
shiraz2	0.766506750	-1.423544740	1.5052831	-0.8883532
hamedan2	0.826738890	-0.854939163	1.4034919	-2.4091569
petropolis	0.833119650	-0.794703287	1.4494977	-1.7218107
venice	0.757385910	-1.509647616	1.4051933	-2.3837372
ouro preto	0.836512130	-0.762677477	1.4330549	-1.9674731
Chandigarh_Mayer	1.136042000	2.064954986	1.5067030	-0.8671393
Chandigarh Corbusier_1951	0.973228000	0.527952510	1.3776360	-2.7954550
Chandigarh Corbusier_1966	0.820961000	-0.909483804	1.4743600	-1.3503574
Chandigarh Corbusier_1986	0.814889000	-0.966804913	1.6019700	0.5561900
Chandigarh Corbusier_2006	0.813002000	-0.984618638	1.6030630	0.5725199
Chandigarh Corbusier_2023	0.814860000	-0.96707868	1.5875600	0.340898494
AVERAGE	0.917302222		1.5647428	
STDEV	0.105929563		0.06693251	

Cities	NAInt_n_Mean	SS_NAIN_n_Mean	NAInt_n_Max	SS_NAIN_n_Max
manhattan	2.76391690	2.97821019	3.70597930	2.48177159
01. Washington Planned	2.48534	2.43897972	3.3083	1.94398247
Chicago_	2.24563214	1.97498653	3.61996220	2.36544906
mexicocity	2.13879956	1.76819486	2.98742840	1.51006184
hollywood	2.00859318	1.51615944	2.86124370	1.33941993
chicago centre	1.95607442	1.41450091	2.61196040	1.00230948
denver	1.95455839	1.41156639	2.98458860	1.50622153
Barcelona	1.91877376	1.34229948	3.22126960	1.82628965
santiago	1.79301549	1.09887408	2.88460230	1.37100820
01. Washington Today_Planned	1.70054	0.91987287	2.57501	0.95234077
las vegas	1.67238336	0.86537116	2.72088930	1.14961606
new orleans	1.64038218	0.80342772	2.61828800	1.01086642
tokyo	1.63627273	0.79547322	2.46987100	0.81015935
charleston	1.59554773	0.71664342	2.25375720	0.51790464
Xangai	1.57807391	0.68282003	2.16160540	0.39328604
atlanta	1.55316933	0.63461320	2.38656310	0.69750052
athens	1.53855311	0.60632115	2.30879160	0.59232868
01. Washington Today_All	1.51747	0.56551139	2.44681	0.77897353
uberlandia	1.48798569	0.50843976	2.24546960	0.50669716
City1676	1.46470336	0.46337306	2.25496980	0.51954446
02. Brasilia Planned	1.4306	0.39736051	2.14733	0.37398115
antwerp	1.41782347	0.37262948	2.15404420	0.38306089
londonallsing	1.41105559	0.35952916	2.31381030	0.59911556
beijing	1.34927636	0.23994551	2.19351220	0.43643420
03. Abuja Planned	1.34162	0.22512539	2.23834	0.49705567
jeddah-H	1.34094866	0.22382590	2.22947430	0.48506642
Beijing_Inner	1.30243171	0.14927014	2.01065110	0.18914774
kyoto	1.29832788	0.14132651	2.10100290	0.31133216
04. Astana Planned	1.21951	-0.01123819	1.76819	-0.13873692
shanghai	1.21321185	-0.02342927	1.84739860	-0.03162165
amsterdam	1.19239751	-0.06371878	1.88755510	0.02268273
madrid	1.17438382	-0.09858718	1.85315590	-0.02383595
munich	1.01453419	-0.40800190	1.61573390	-0.34490614
recife	0.98655575	-0.46215867	1.54555500	-0.43981037
mytilene	0.98349000	-0.46809293	1.60582850	-0.35830139
nicosia in walls	0.96032915	-0.51292448	1.31545130	-0.75098388
ahmenabad	0.96012932	-0.51331129	1.63069740	-0.32467072
teotihuacan	0.93271819	-0.56636994	1.47742630	-0.53194208
canterbury	0.91581518	-0.59908844	1.51306090	-0.48375274
02. Brasilia Today_All	0.880831	-0.66680596	1.47476	-0.53554776
bath	0.87904816	-0.67025693	1.28885010	-0.78695718
04. Astana Today_All	0.871313	-0.68522958	1.34051	-0.71709653
hong kong	0.86699101	-0.69359549	1.37000220	-0.67721368
istanbul	0.84937180	-0.72770031	1.37896240	-0.66509664
nicosia	0.84729504	-0.73172021	1.29812010	-0.77442118
alkmaar	0.84340528	-0.73924947	1.32141210	-0.74292298
auckland	0.83838624	-0.74896463	1.19042280	-0.92006225
konya	0.82066035	-0.78327595	1.27869680	-0.80068767
02. Brasilia Today_Planned	0.786547	-0.84930783	1.28085	-0.79777586
rome	0.77477772	-0.87208917	1.16075550	-0.96018189
gouda	0.74772094	-0.92446193	1.20635130	-0.89852184
03. Abuja Today_Planned	0.684376	-1.04707626	1.08535	-1.06215415
sao paulo	0.67692333	-1.06150211	1.05781960	-1.09938402
rio de janeiro	0.61997030	-1.17174387	0.96870238	-1.21989889
03. Abuja Today_All	0.602164	-1.20621084	0.914045	-1.29381308
shiraz2	0.50915773	-1.38623946	0.79701227	-1.45207862
hamedan2	0.46574653	-1.47026883	0.65040064	-1.65034425
petropolis	0.43833428	-1.52332965	0.67700034	-1.61437298
venice	0.37463466	-1.64663053	0.52615464	-1.81836443
ouro preto	0.36117897	-1.67267619	0.55080301	-1.78503198
Chandigarh_Mayer	1.79597100	1.10459495	2.26197300	0.52901502
Chandigrah Corbusier_1951	1.26297100	0.07288758	1.68829600	-0.24677906
Chandigrah Corbusier_1966	0.91595200	-0.59882361	1.49274200	-0.51123037
Chandigrah Corbusier_1986	0.99461100	-0.44656644	1.66461400	-0.27880467
Chandigrah Corbusier_2006	1.02403500	-0.38961155	1.72181100	-0.20145610
Chandigrah Corbusier_2023	1.04353000	-0.351875833	1.74961000	-0.16386300
AVERAGE	1.22531587		1.87078189	
STDEV	0.516619357		0.739470717	

Appendix 2: Dataset showing population density and NAIN_Rn to demonstrate socio-economic categorisation in a particular area by pincode.

Dataset for 1966

PinCode	Social Categorisation	Population Density	NAIN_RN
160001	Gov, Elite	24390	1.072599
160012	Institutional	1697	1.330629
160011	Elites	320	1.370671
160009	Elites	0	1.36985
160019	Gov, Elite	831	1.369491
160101	Middle	1936	1.246594
160016	Gov, Elite	3800	1.425883
160014	Rehab Colonies	63	1.423923
160002	Industrial	2871	1.29839
160015	Elites, Institutional and Middle	11000	1.462962
160022	Gov,Middle	2295	1.463032
160018	Elites	777	1.466614
160020	Institutio	4361	1.465482
160030	All Groups except Rehab Colonies	0	1.464675
160036	Gov, Elite	36	1.363582
160023	Gov,Middle	1353	1.395837
160005	Institutional	0	1.26971
160047	Institutional, CHB	298	1.343144

 Chandigarh

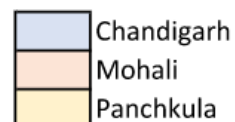
Dataset for 1986

PinCode	Social Categorisation	Population Density	NAIN_RN
160001	Gov,Elite	3980	1.166337
160012	Institutional	751	1.398324
160011	Elites	11432	1.441967
160009	Elites	5106	1.441878
160019	Gov,Elite	5238	1.441704
160101	Middle	1942	1.344768
160016	Gov,Elite	8046	1.649255
160014	Rehab Colonies	1403	1.642981
160015	Elites, Institutional and Middle	29181	1.519193
160017	CBD	8389	1.517842
160022	Gov,Middle	14020	1.518065
160018	Elites	15011	1.524019
160020	Institutional	9256	1.524359
160030	All Groups except Urban Village	2343	1.525592
160036	Gov,Elite	3826	1.501535
160023	Gov,Middle	3123	1.559874
160102	Government	2444	1.398913
160003	Rehab Colonies	797	1.399132
160040	Elites,Middle	6018	1.524373
160025	Rehab Colonies	1605	1.524373
160047	Institutional, CHB	7723	1.534848
160005	Institutional	959	1.523609
160043	Government	8232	1.502194
160062	Elites,Middle	9667	1.62171
140308	Middle	2190	1.62171
140306	Urban Village	341	1.62171
140901	Rehab Colonies	345	1.213903
160069	Elites	649	1.219195
160055	Elites,Middle	7193	1.447209
160059	Elites,Middle	19674	1.447194
160071	Elites,Middle	4957	1.447159
160103	Government	28025	1.219182
140604	Village	4603	1.055246
160004	Rehab Colonies	77	0.818433
134108	Elites	13937	1.289097
134114	Elites	117	0.881441
134109	Middle	2391	1.224149
134112	Middle	14532	1.069603
134113	Middle,Urban Village	11220	1.05947

	Chandigarh
	Mohali
	Panchkula

Dataset for 2006

PinCode	Social Categorisation	Population Density	NAIN_RN
160001	Gov,Elite	1475	1.234888
160012	Institutional	1030	1.458677
160011	Elites	6134	1.48924
160009	Elites	5820	1.489161
160019	Gov,Elite	4801	1.489013
160101	Middle	4125	1.397689
160016	Gov,Elite	4665	1.639426
160014	Rehab Colonies	2486	1.628781
160015	Elites, Institutional and Middle	13641	1.553216
160022	Gov,Middle	10181	1.552268
160018	Elites	10362	1.559082
160020	Institutional	6792	1.559463
160030	All Groups except Urban Village	3021	1.560201
160036	Gov,Elite	6012	1.646349
160023	Gov,Middle	2319	1.718813
160102	Government	4702	1.631606
160003	Rehab Colonies	2492	1.631717
160040	Elites,Middle	9296	1.567151
160025	Rehab Colonies	2627	1.567151
160047	Institutional,CHB	10158	1.578525
160005	Institutional	2222	1.555543
160043	Government	6558	1.546027
160062	Elites,Middle	16209	1.452592
140306	Urban Village	454	1.452563
160055	Elites,Middle	9568	1.457459
160059	Elites,Middle	18939	1.462227
140308	Middle	9055	1.668832
140901	Rehab Colonies	506	1.296674
160069	Elites	12686	1.44244
160071	Elites,Middle	19519	1.535974
160103	Government	25621	1.548633
140307	Urban Village	1339	1.412901
140603	Middle	1697	1.615901
140604	Village	10672	1.157489
160004	Rehab Colonies	226	0.710336
134108	Elites	12323	1.352517
134114	Elites	139	0.968682
134109	Middle	2289	1.351084
134112	Middle	15927	1.221139
134113	Middle,Urban Village	11921	1.193045
134117	Middle	7498	1.422876
134116	Institutional	3411	0.796859



Dataset for 2023

PinCode	Social Categorisation	Population Density	NAIN_RN
160001	Gov, Elite	1745	1.267907
160012	Institutional	1512	1.491286
160011	Elites	7153	1.521721
160009	Elites	6686	1.521661
160019	Gov, Elite	5394	1.521596
160101	Middle	5215	1.436142
160016	Gov, Elite	5269	1.667234
160014	Rehab Colonies	1082	1.655135
160015	Elites, Institutional and Middle	13725	1.598297
160022	Gov,Middle	10492	1.597413
160018	Elites	10363	1.604409
160020	Institutional	7141	1.604745
160030	All Groups except Urban Village	3896	1.605443
160036	Gov, Elite	7899	1.66481
160023	Gov,Middle	2663	1.742472
160102	Government	5447	1.662549
160003	Rehab Colonies	3952	1.662633
140603	Middle	3405	1.651327
160040	Elites,Middle	11472	1.613127
160025	Rehab Colonies	3799	1.613127
160047	Institutional, CHB	11289	1.624929
160005	Institutional	3174	1.608263
160043	Government	8762	1.598087
160062	Elites,Middle	16550	1.509351
140901	Rehab Colonies	661	1.323631
140306	Urban Village	893	1.509066
160055	Elites,Middle	11048	1.523513
160059	Elites,Middle	18990	1.52785
140308	Middle	14184	1.738432
160069	Elites	23521	1.49755
160071	Elites,Middle	19519	1.599258
160103	Government	25530	1.618349
140604	Village	11395	1.171683
160004	Rehab Colonies	674	1.193033
140307	Urban Village	2659	1.686258
134108	Elites	13176	1.363505
134114	Elites	792	0.979261
134109	Middle	2833	1.346882
134112	Middle	16409	1.231081
134113	Middle, Urban Village	13571	1.195741
134117	Middle	10201	1.440556
134116	Institutional	5823	0.830684

	Chandigarh
	Mohali
	Panchkula