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Investigating the Linkages Between Migration and Image of the City

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ABSTRACT

This study explores the complex interplay between migration and the image of the city, with a focus on the Hadapsar-Magarpatta area of Pune, India. Using Kevin Lynch's theoretical framework of urban elements—districts, paths, nodes, landmarks, and edges—combined with Geographic Information System (GIS) analysis, the research investigates how migration reshapes urban form and identity. The study employs a decadal analysis of urban transformation, identifying key changes driven by migration patterns. Findings reveal that migration significantly influences the development of new urban nodes, alters paths, and affects the overall spatial structure, leading to evolving city identities. The influx of migrants is found to enhance the functional complexity of urban districts, impact the hierarchy of nodes, and reconfigure the prominence of paths within the city's spatial organization. This transformation contributes to socio-economic shifts, influencing local economies, labor markets, and resource distribution patterns. The study underscores the importance of integrating migration dynamics into sustainable urban planning, promoting the need for resilient infrastructure and inclusive policies to accommodate demographic changes. This research contributes to urban morphology literature by providing new insights into how migration drives urban transformation, reshaping the image and functionality of cities in a rapidly urbanizing world.

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Highlights:	Contribution to the field statement:
- Migration drives the evolution of urban districts along the Pune-Solapur Highway, altering Hadapsar's socio-economic landscape. - Kevin Lynch's framework reveals how migration reshapes urban nodes and paths, affecting city identity. - Road hierarchy mapping reduces vehicle-pedestrian conflicts, improving urban safety and accessibility. - GIS analysis offers a novel method for examining migration's impact on urban transformation. - Migration influences local economies by changing labor markets and resource distribution patterns.	This study contributes to urban morphology literature by analyzing the urban transformation of Hadapsar, Pune, through migration dynamics using Kevin Lynch's framework. It reveals how migration reshapes urban form and identity, highlighting new nodes and paths, thereby offering insights into sustainable urban planning and the socio-economic impacts of contemporary urbanization.

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1. Introduction

1.1 Background and Context

Cities are complex, dynamic entities that continuously evolve under the influence of social, economic, political, and environmental factors. This evolution shapes the unique image of each city, which emerges as an ever-changing expression of its material and immaterial conditions. As urban populations grow and migration patterns intensify, cities undergo significant transformations in their physical form and socio-cultural identity (United Nations, 2019). Migration, in particular, plays a critical role in shaping urban landscapes, often driving changes in land use, infrastructure, and social dynamics. Human activity is a primary driver of these landscape transformations, making demographic shifts closely linked to changes in the urban environment (Egidi et al., 2021). Globalization has accelerated these changes, leading to uneven development in many countries. Resources tend to concentrate in a few urban centers, exacerbating regional inequalities—an issue more pronounced in the Global South than in the Global North (Hassanzadehkermanshahi et al., 2022). Within this context, migration can reshape the image of the city by altering its spatial, social, and economic landscapes. The intention to migrate and residents' satisfaction levels are crucial indicators for predicting development trends in both expanding and shrinking cities (Fu & Zheng, 2021).

In many cities, especially in the Global South, rapid urbanization has pushed development beyond traditional urban boundaries, creating new peri-urban areas characterized by rapid physical, social, and economic changes (Woltjer, 2014). These dynamics are particularly evident in overpopulated cities where expansion into rural areas transforms the city-countryside relationship, creating a new kind of peri-urbanity (Ticau et al., 2023). Concurrently, the migration of urban residents from city centers to inner suburbs in search of improved living conditions contributes to further urban sprawl (Qin & Deng, n.d.).

Given these transformations, the integration of migrants presents significant challenges. Rapid and poorly managed migration can lead to social fragmentation, resource disparities, and economic inequalities, which undermine societal stability and hinder progress towards sustainable development goals (Zhang & Li, 2024). Shaw's (1975) definition of migration as "the comparatively permanent movement of individuals over a considerable distance" highlights both the spatial and temporal dimensions of this phenomenon. Migrants often settle in peripheral urban areas, addressing labor shortages and mitigating human capital deficits, thereby influencing the socio-economic fabric of their new localities (Kowalewska, 2024).

1.2 Problem Statement and Research Gap

Pune, a rapidly growing city in the state of Maharashtra, India, exemplifies the complex interplay between migration and urban development. Known as the "Oxford of the East" due to its educational institutions, Pune is also one of the largest IT hubs in India. The city offers a combination of economic opportunities, quality infrastructure, and a favorable living environment, making it a magnet for talent and business operations across the country. This concentration of resources has led to rapid population growth, driven by both in-migration from neighboring areas and the internal movement of residents within the city.

However, this growth has also exacerbated various urban challenges, including inadequate housing, traffic congestion, pollution, waste management, and the proliferation of informal settlements or slums (Kateja & Jha, 2021; Sorolla Edo, 2014). These issues make it difficult to maintain sustainable urban expansion and resilience in the face of ongoing growth pressures (Garcia-López & Muñiz, 2020). Migration-driven changes are particularly evident in areas like Hadapsar-Magarpatta, where the influx of new residents has reshaped urban form and functionality.

Despite the significant impact of migration on the city's development, there remains a limited understanding of how migration specifically influences the urban image and spatial structure of Pune. While studies have explored various aspects of urban transformation, there is a noticeable gap in research that integrates migration dynamics with urban morphology, particularly using frameworks like Kevin Lynch's urban elements theory combined with Geographic Information System (GIS) analysis. This study

seeks to fill this gap by examining the interplay between migration and the city's evolving image, providing new insights into sustainable urban planning and development.

By focusing on the Hadapsar-Magarpatta area of Pune, this research aims to analyze how migration reshapes urban nodes, paths, and overall spatial organization, influencing the city's identity and socio-economic landscape. Through a decadal analysis of urban transformation, this study offers a novel perspective on the role of migration in urban morphology and contributes to the broader discourse on urban development in rapidly urbanizing contexts.

2. Materials and Methods
2.1 Literature Review
2.1.1 Why People Migrate

People migrate for a multitude of reasons, driven by a combination of push and pull factors. Push factors, such as economic hardship, political instability, social discrimination, and environmental degradation, compel individuals to leave their current locations in search of better opportunities or safer environments. Conversely, pull factors like improved economic prospects, political stability, social acceptance, and favorable living conditions in potential destinations attract people to new areas. These motivations are often intertwined, with individuals weighing the challenges of their current circumstances against the perceived benefits of moving to a new place. Migration is not solely a response to adverse conditions; it is also a proactive choice driven by aspirations for a better life, access to education, healthcare, and social services, or the desire to reunite with family and friends.

The dynamics of migration are complex and influenced by both long-term trends and sudden events. For example, economic downturns, political upheavals, natural disasters, or social conflicts can create immediate pressures for migration. On the other hand, gradual changes, such as economic development in a destination country or demographic shifts, can encourage steady flows of migrants over time. Additionally, migration is often a multi-stage process where initial moves may lead to subsequent migrations as people adjust their strategies based on new experiences and information. Understanding why people migrate requires examining these diverse factors and recognizing the fluid and evolving nature of migration patterns.

2.1.2 Migration Theories and Models

Over the past decades, researchers have developed various theories and models to explain migration. These theories highlight the complex interplay of multiple factors that influence migration decisions. Neoclassical migration theory, based on (Sjaastad, 1962) cost-benefit model and Lee's push-pull model (Lee, 1980) suggests that individuals migrate due to economic discrepancies between their current location and potential destinations. According to this theory, people tend to move if the expected benefits of migrating outweigh the costs. The decision to migrate is often linked to substantial differences in income or utility between places.

While Lee's push-pull model and the augmented gravity model explain overall migration flows relatively well, they have been criticized for not accounting for why the majority of people do not migrate despite significant income disparities. One reason for immobility is that migration decisions are influenced by individual agency and self-determination, rather than being solely driven by economic factors.

Critics of the neoclassical migration model argue that it suffers from methodological individualism, assuming that individuals are the main decision-makers. However, individuals are part of households and communities that influence, or even make, migration decisions. Scholars have therefore urged a reconsideration of migration decision-making, highlighting the role of households and families.

Two perspectives on the role of households have emerged. First, family structure and functions have both direct and indirect effects on migration decision-making, with the individual remaining the decision-maker. Second, the family is seen as the ultimate migration decision-making unit. Families transmit information, shape motivations, and influence migration norms, thereby directly and

indirectly affecting migration decisions. Structural and functional family characteristics also affect perceptions of the costs and benefits associated with migration.

2.1.3 New Economics of Labour Migration

The new economics of labour migration, proposed by (Bloom, 1985) places households at the center of migration decision-making. This theory argues that households can diversify income risks and control uncertainty by allocating members to different income sources, including migration. Family ties, representing social externalities, significantly impact migration decisions. Strong ties to the place of origin can decrease the likelihood of migration, while connections with family and friends elsewhere can provide valuable information that reduces migration-related uncertainty.

2.1.4 Modern Migration Models

More recent migration models combine individual factors with a focus on the family or household. These models consider the temporality, selectivity, and geography of migration drivers. Temporality refers to whether a driver is permanent or transitory. Selectivity acknowledges that broader social, economic, or political transformations affect societal groups differently. Geography considers the location and scope of migration drivers, from local to global levels. Migration is a multifaceted phenomenon driven by a complex interplay of push and pull factors. Economic disparities, political instability, environmental challenges, social inequalities, and lack of services push individuals to migrate, while better economic opportunities, political stability, higher quality of life, social networks, and cultural attractions pull them towards new destinations. Understanding the intricate dynamics of migration requires a holistic approach that considers individual, household, and broader structural factors.

2.1.5 Migration Driver Taxonomy: Driver Dimensions and Driving Factors

The motivations behind migration are varied and complex, influenced by an array of factors that can be both structural and event-driven. (Czaika & de Haas, 2022) categorizes these motivations into different dimensions and factors that drive migration. These include the quality of public infrastructure, educational opportunities, labor market conditions, and the interrelation of migration with spatial policy. Each of these factors can either encourage or deter migration, depending on their specific context and impact.

The impact of public infrastructure on migration is somewhat ambiguous. On one hand, a well-developed and efficient public infrastructure can lower transportation costs, thereby facilitating migration and increasing overall mobility. On the other hand, improved infrastructure can also reduce the propensity to migrate by enhancing local economic opportunities (Gachassin, 2013). For example, educational infrastructure, particularly the quality of higher education, plays a significant role in student mobility. Students are drawn to regions or countries with reputable universities, available scholarships, and manageable living costs (Beine et al., 2012; Findlay & King, 2011). Cities with good universities not only attract students but also retain graduates, partly due to job availability and strong employer-university relationships (Ciriaci, 2014). The lack of educational opportunities in one's home country can drive international migration for students, unaccompanied minors, and asylum seekers (McAuliffe & Ruhs, 2018). However, educational opportunities often rank secondary to factors like security, labor market prospects, and residency or citizenship opportunities (Dimitriadi, 2017). High-skilled migrants, such as health professionals (Awases et al., 2004) and academics, often migrate for professional training and career advancement (Bartolini et al., 2017).

2.1.6 Labour Migration

Labour migration is heavily influenced by economic factors. The neoclassical approach views migration in macroeconomic terms, as a means of redistributing the workforce from low productivity areas to high productivity ones (Lewis, 1954). This perspective sees migration as instrumental in

balancing economic disparities on regional, national, and global scales. At the micro level, neoclassical theory defines migration as the outcome of individual decisions based on a rational assessment of the costs and benefits of moving, aiming to achieve higher returns (Todaro, 1970) (Sjaastad, 1962);. This approach frames migration as an investment in human capital closely tied to labor market conditions. Push factors in the regions of origin, such as unemployment and low incomes, combined with pull factors in the destination areas, like job opportunities and higher wages, underscore the rational decision-making process of migrants (Lee, 1980).

2.1.7 Migration and Spatial Policy Interrelation

Migration patterns are also shaped by spatial policies and the distribution of urban and rural populations. Large-scale changes are occurring as households move away from rural areas plagued by poverty, unemployment, violence, and environmental collapse, towards new localities with better prospects. Survey data from the Development Bank of South Africa (DBSA) indicate that migration is now common among the rural population of South Africa's coastal provinces. Infrastructure development plays a significant role in these migration processes, prompting population movements when previous livelihoods become unsustainable despite the absence of jobs. This highlights the importance of spatial planning and infrastructure delivery in managing migration. Policies must account for population movements to ensure effective public spending, development delivery, and social justice. Infrastructure must be strategically placed to support these movements and ensure cost-effective, sustainable delivery that enhances livelihoods.

Migration flows generally move from overcrowded, economically depressed rural interiors to coastal areas with more economic activity. However, migrants tend to prefer shorter moves that maintain their social capital and support networks. These population flows are substantial enough to reshape rural economies and necessitate new paradigms for high-density rural settlement development. The affordability of infrastructure for these trends poses challenges, especially for smaller towns with deteriorating existing infrastructure. Even relatively prosperous urban centers like Cape Town struggle to accommodate high levels of rural inflow, demonstrating that transferring rural poor to cities does not solve housing and service delivery crises. The rural poor often do not see their future in urban areas, and the government faces challenges in providing housing and infrastructure within budget constraints.

Migration is driven by a multitude of factors that interact in complex ways. Public infrastructure can both facilitate and deter migration, depending on how it impacts local opportunities. Educational opportunities are a major driver for student mobility, but security, labor market prospects, and residency options are often more critical factors. Labour migration is influenced by economic disparities and labor market conditions, with individuals making rational decisions based on expected benefits. Spatial policies and infrastructure development also play crucial roles in shaping migration patterns, particularly in rural areas facing economic and environmental challenges. Effective management of migration requires a comprehensive understanding of these driving factors and strategic planning to support sustainable development and social equity.

2.2 Method
2.2.1 Districts

Figure 1 denotes the Built-Unbuilt Ratio for the city of Pune. A district's physical characteristics include texture, space, form, detail, symbol, building type, use, activity, inhabitants, degree of maintenance and topography. They are elements that define districts as the primary components of large urban areas. Each element contributes to the district's identity and plays a key role in shaping the character of the place; together they create a unique sense of place which is easily identifiable. The spatial patterns that emerge from these elements influence how people move and interact with the district: form (which closely relates

to space) determines the shape while building type and use define function and activity within the area. Figure 2 includes the Building Height Mapping done using QGIS Software.
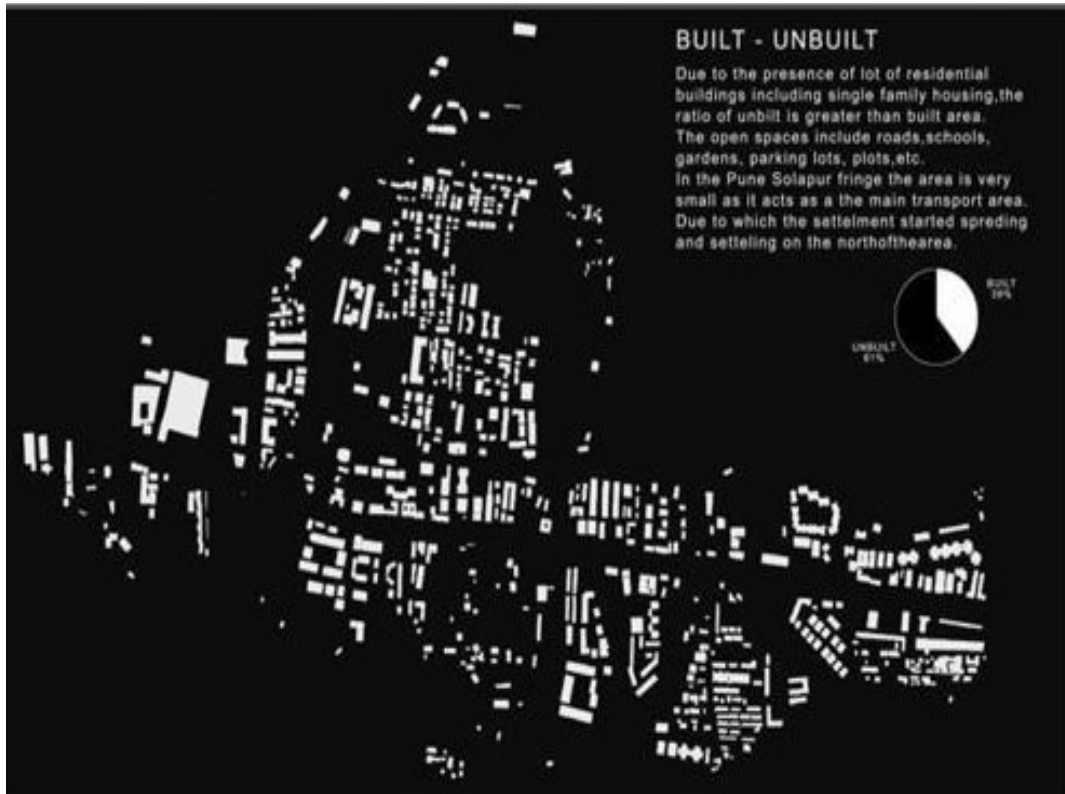

Figure 1. Figure Ground showing Built-Unbuilt Ratio.

Figure 2. Number of floors Mapping on QGIS.

Form is closely related to space; it refers to the shape and configuration of the buildings and structures within the district. It encompasses scale, height, massing of buildings, public spaces' layout and other urban elements that constitute it. Type of building closely relates with functional activity in the district: different types like residential or commercial have different roles which lead them into different patterns of use in the district area. The people living in a district are key players in defining its character— they infuse cultural and social aspects into it which further develop its identity. The population's demography, their ways of life, and cultural rituals that portray the people in the district are what give the place its unique character and dynamics of activities. The degree of maintenance is an indicator showing how well the district is taken care of in terms of keeping the built environment. The upkeep on public spaces plus

buildings besides other urban materials significantly contributes to establishing a safe, friendly, and attractive district. Figure 3 maps the Building Age within the selected District consisting of four spans.

Figure 3. Building Age Mapping on QGIS.

Ultimately, land topography is pivotal in defining physical characteristics for any district including building arrangements intertwined with streetscapes; it also dictates what should be incorporated into the landscape design due to natural features within an area. Districts may have different kinds of boundaries, including hard, definite, and precise boundaries that create clear edges, or soft, uncertain boundaries that gradually fade away into surrounding areas. Some districts may stand alone, while others are connected to each other, creating a complex network of interconnected urban areas. In conclusion, districts are complex and multifaceted urban areas defined by a range of physical characteristics that create a unique and recognizable sense of place. These features are shaped by the built environment, the people who live and work within the district, and the cultural and social practices that define the community. Understanding these elements is essential for creating vibrant and sustainable urban areas that meet the needs of residents and visitors alike.

2.2.2 Path
Paths play a significant role in urban design by influencing how people move through the city and interact with its built environment. As Kevin Lynch suggests, paths are channels along which the observer moves either customarily, occasionally, or potentially. In Hadapsar, certain paths have gained importance due to the concentration of special use or activity along them, which gives them prominence for observers. The development of the IT hub of Magarpatta in Hadapsar has been a driving factor for the area's population growth over the last two decades, leading to changes in the urban environment and the paths people use to move through it. As the population has grown, the paths people take have become more diverse and complex. In some cases, customary travel patterns have emerged along certain paths, while in others, potential paths have been created to accommodate new developments. Figure 4 highlights the identifiable Paths according to Kevin Lynch's theory within the Hadapsar-Magarpatta area.

Figure 4. Paths Mapping on QGIS.

In Hadapsar, paths leading to the IT hub of Magarpatta have become more important due to the concentration of technology-related businesses in the area. Similarly, paths leading to parks, schools, or other amenities can gain increased importance due to their proximity. Paths with clear and well-known origins and destinations tend to have stronger identities. In Hadapsar, paths leading to major landmarks or transportation hubs such as bus stops or train stations tend to have more defined identities, while other paths that lead to more generic destinations may be less well-defined. Overall, the growth of the population in Hadapsar has had a significant impact on the city's paths and urban environment. Figure 5 highlights customary travel paths identified after interviewing the residents of Hadapsar.
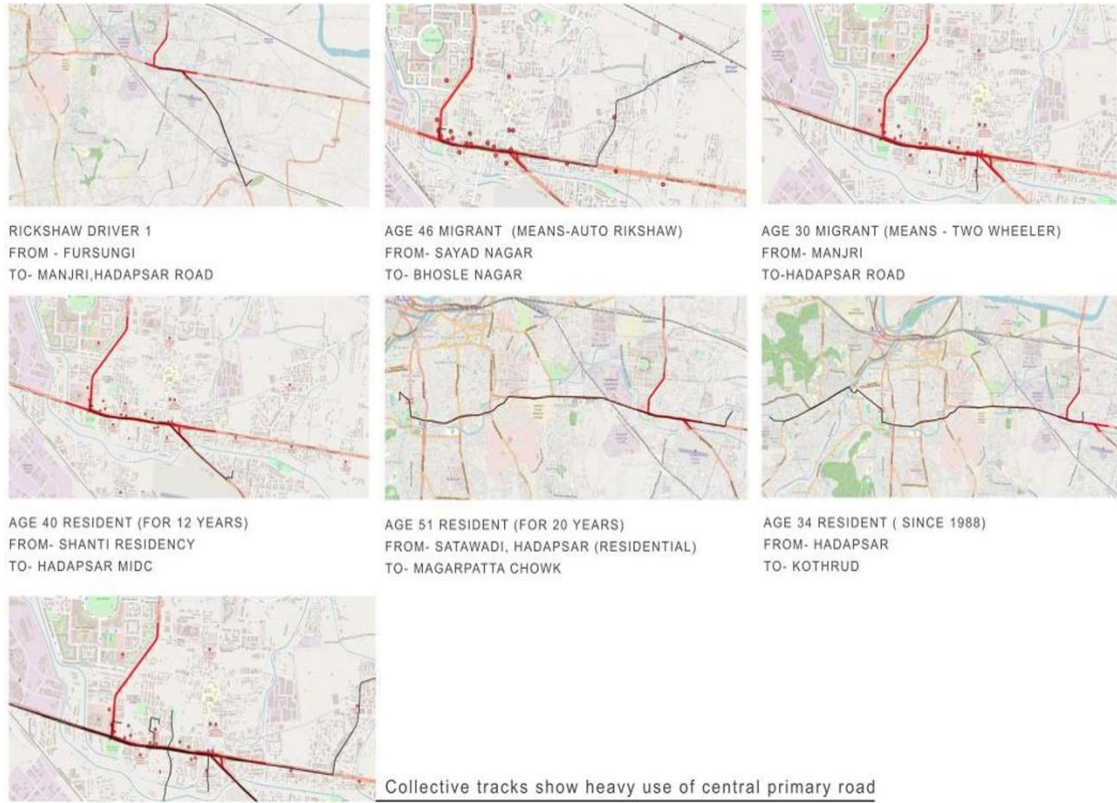
Figure 5. Interviews with Residents regarding paths.

As the city continues to evolve, it will be important for urban designers and planners to consider the role of paths in shaping the city's character and identity, and to ensure that the paths people take are safe, accessible, and well-connected to the rest of the urban fabric. Figure 6 highlights actively used paths by the immigrants of Hadapsar city.

Figure 6. Activity path used by Immigrants.

2.2.3 Nodes

Understanding the hierarchy of nodes and the order in which they occur is important for architects and planners when creating a functional and visually appealing space. Different nodes will have different levels of importance and their design will vary depending on their functions and the density of people using them. For example, bus stops may require a different design than residential or commercial areas. In order to create a space that meets the needs of its users, the type, importance and hierarchy of the nodes were taken into account and their effects on local behaviour and the physical characteristics of the area were determined. Figure 7 highlights identifiable Nodes according to Kevin Lynch's theory within the Hadapsar-Magarpatta area.

Figure 7. Nodes Mapping on QGIS.

To do this, designers need to consider important factors such as mobility and infrastructure, hierarchical and cross-sectional structures, the influence of the surrounding environment, and model work and operation. A variety of tools, including Google Maps and QGIS, as well as interviews and questions with local residents and immigrants of varying ages, can help map and understand walkable and walkable communities. By identifying and analyzing important and unimportant areas and their impact on society, designers can make informed decisions about their design and development. Street classes are an important part of city planning that separates streets according to their functions and capacities. Generally, it divides the road into three classes according to its width: primary, secondary and secondary. Figure 8 highlights changes in local nodes over the time span of the last two decades.

2002 – 2005

2006 - 2010

2011 – 2015

2016 - 2020

Figure 8. Distinction of Nodes.

2.2.4 Edge

In Hadapsar, the edge can be seen as the riverside and expressway which mark the urban boundary from a macro perspective. From a micro perspective, the edge space refers to the transition space between buildings, and between buildings and roads. Edge space is a crucial component of urban public space as it serves as an intermediate space for various social activities. Over time, the nature of the edges has gradually transitioned due to the upcoming developments and modifications. Magarpatta is a unique project in India, where farmers pooled their land to build a township instead of selling it to a developer. It is located in the eastern part of the city and is characterized by a prominent bus route.

The proximity to businesses in Magarpatta is the main factor driving the expansion of the residential sector. Magarpatta is well known for its IT park and connectivity to other major areas in Pune, such as Kharadi IT Park and Koregaon Park, within a radius of 2 km only. The edges in Magarpatta are characterized by buildings (shops) on the plinth level and a pedestrian walkway with trees, food stalls, and parking on the side. The area under the bridge is also used for parking. Due to the limited space of land and increasing land prices, there are also shops below ground level. Figure 9 denotes the condition of edges according to the number of people using it and in correlation their street sections.

LEGEND

▮ 25-50 People per 100 sq.m

▮ 10-25 People per 100 sq.m

▮ 0-10 People per 100 sq.m

▮ Edges

STREET SECTION - MAGARPATTA ROAD

STREET SECTION - GADITAL BUS STOP

Figure 9. Edge Condition Mapping on GIS and Corresponding Street Sections.

2.2.5 Landmarks

Over the past few decades, the area of Hadapsar has undergone significant developments. Before 1985, there were only a few main landmarks in Hadapsar, such as Hadapsar Gaon Tal, Hadapsar Post Office, and Hadapsar Vegetable Market. During this time, religious structures, including Dutta Mandir and Vittal Mandir, were also built. Between 1985 and 2002, new landmarks emerged in the area, such as hospitals, shopping centres, and schools. These landmarks played a vital role in the development of the region and made it more attractive for residents and visitors. This period marked a significant shift in the urbanization of Hadapsar. Between 2002 and 2012, several other significant landmarks were established in Hadapsar, including hospitals, institutes, malls, and the Magarpatta chowk.

The Magarpatta chowk is a bustling area in the locality that is home to several commercial establishments, such as shops and restaurants. In the past ten years, i.e., between 2012 and 2022, there have been further developments in Hadapsar, with the establishment of more hospitals, institutes, and amenity places. These developments have made Hadapsar an attractive destination for both residents and visitors. Overall, the development of Hadapsar has been significant over the past few decades. The area has transformed from a quiet, residential locality to a bustling commercial centre. The establishment of new landmarks has contributed to the growth of the area and has attracted more people to the locality. The timeline of landmark development in Hadapsar reflects the changes and development of the locality over the years. Figure 10 highlights different landmarks which are segregated by the typology of the buildings.
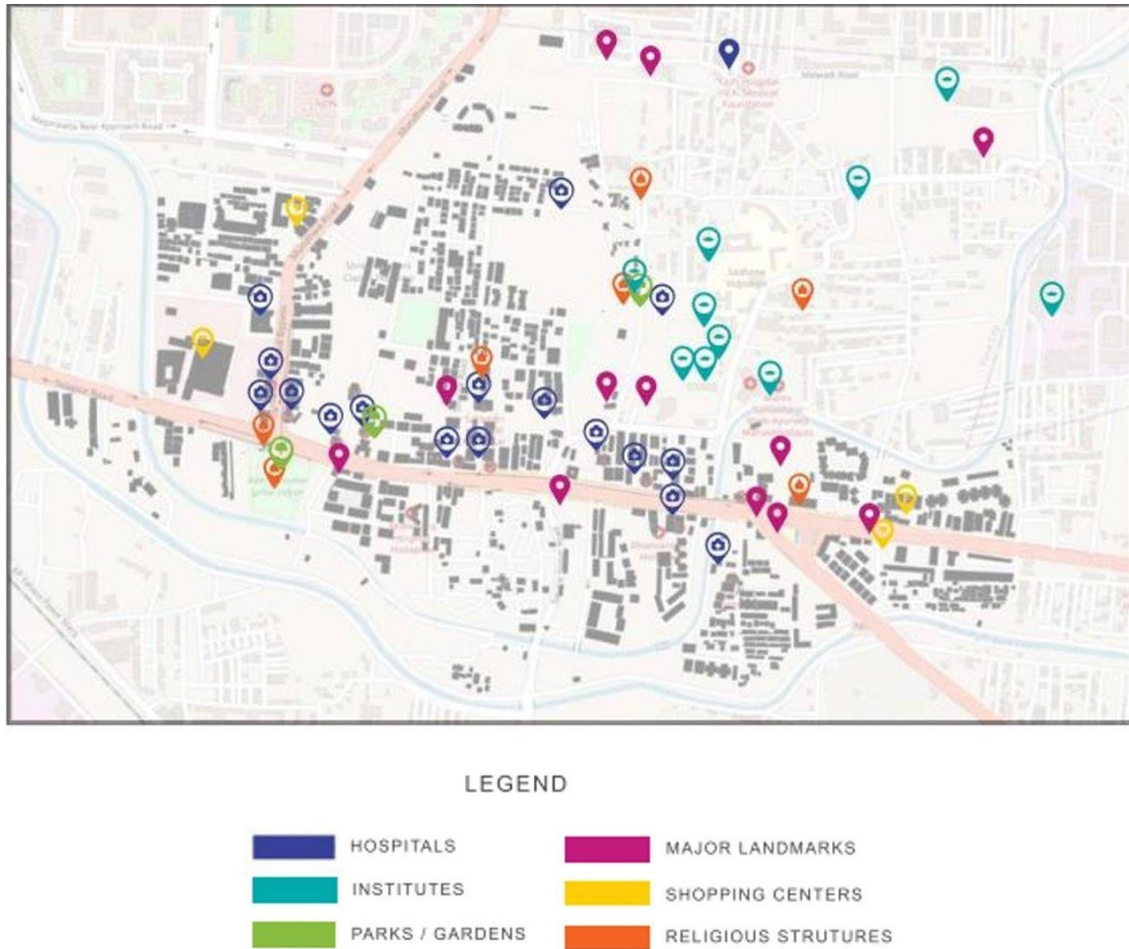
**Figure 10.** Landmarks Identification and Segregation.

3. Results
3.1 Districts
The Pune-Solapur Road region has undergone significant architectural development over the past few decades. In the 1980s, there was limited development on the outskirts of the road and a surplus of agricultural land away from it. However, since the arrival of IT industries in 2002, there has been intensified settlement on both sides of the road. The construction of Magarpatta city in 2003 acted as a catalyst for the growth of Hadapsar, leading to the emergence of many townships, IT industries, and commercial spaces. This trend has continued, with several proposed residential and commercial developments planned for the future.

The architectural development of the region emphasises sustainability and eco-friendliness, with many new developments incorporating green spaces, solar panels, and other environmentally friendly features. The focus is also on creating vibrant and liveable communities, with new townships featuring parks, recreational facilities, and shopping centres. This creates a sense of community and enhances the quality of life for residents.

The building use plan of the Pune-Solapur Road region includes a mix of residential and commercial structures. Commercial buildings along the main road are designed to be functional and efficient, with multi-story structures, modern facades, and ample parking facilities. They house a range of businesses, from small shops to large corporate offices. Residential buildings are designed to provide comfortable and safe living spaces, ranging from high-rise apartments to spacious bungalows. Landscaped gardens, parks, and other amenities are designed to enhance the quality of life for residents.

The region also includes several amenities, such as educational institutions, hospitals, and health centres. Educational institutions are located among residential settlements, while hospitals and health centres are situated near commercial and residential zones to provide easy access to medical care when needed. The architectural language of the buildings in the region reflects a blend of modernity and functionality, with a focus on creating efficient and comfortable living and working spaces. The buildings along the main road feature sleek, modern facades, while the residential buildings in the interior are designed to be more traditional and comfortable, with spacious balconies and open living spaces. Figure 11 highlights the two different districts identified according to its image.
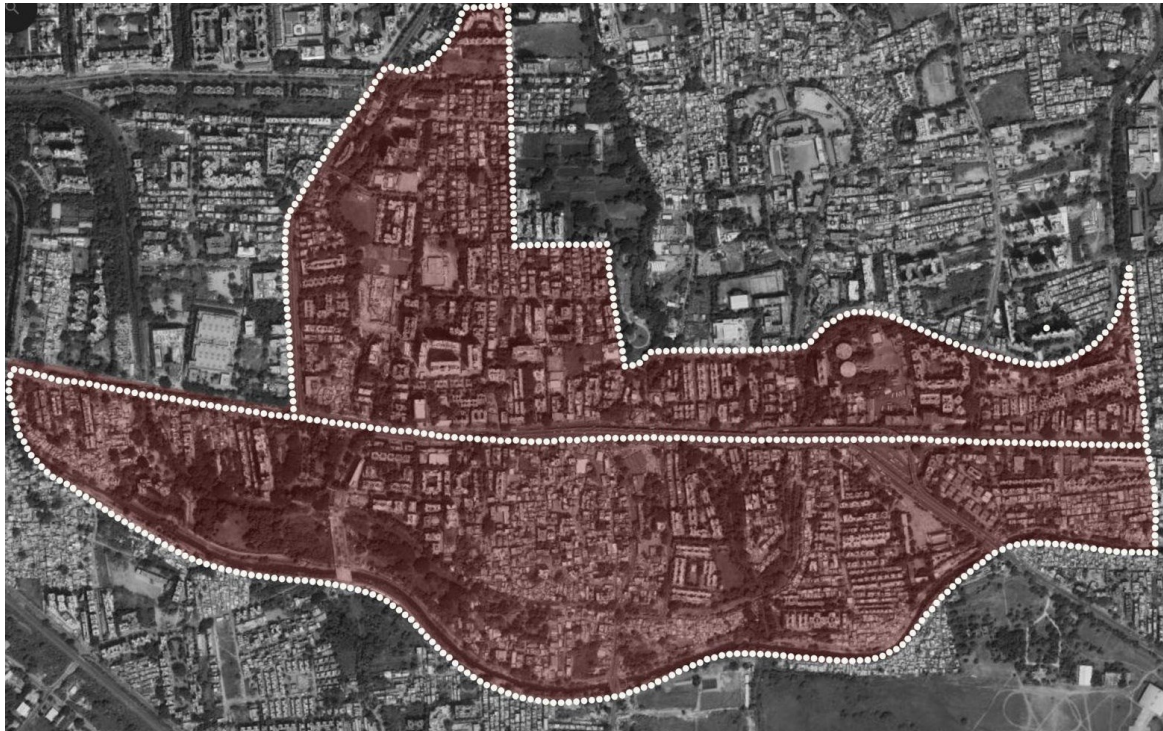

Figure 11. Difference in development pattern within the identified district.

3.2. Paths

An activity mapping exercise was conducted in Hadapsar to better understand the behaviour patterns of migrants. This exercise involved tracking and locating frequently visited buildings and spaces such as commercial spaces, eateries, and hospitals, which were mainly concentrated along the primary routes. Consequently, these areas experienced heavy traffic and high pedestrian footprints. On the other hand, the secondary and tertiary routes were mostly residential spaces interconnected in smaller groups and accessed through smaller roads and pathways. By understanding the migration pattern of residents and visitors, architects and urban planners can design and plan the city better to accommodate their needs. The heavy influx of migrants in Hadapsar has led to the development of a dense road network, including flyovers and the widening of roads to reduce the increasing vehicular density. However, the lack of a distinguishable road hierarchy and pedestrian paths has created heavy traffic and high pedestrian footprints.

During peak hours, the central road experiences significant traffic congestion, while the flyovers provide parking spaces near commercial spaces, reducing traffic congestion. The higher frequency of permanent and temporary migrants settled nearby has reduced travel distances, resulting in higher use of the main road and causing traffic congestion at the Hadapsar Saswad junction. The visible traffic and pedestrian congestion on the main road is due to the segregation of residential and commercial spaces, leaving emptier branched paths. Figure 12 highlights major and minor paths within the district.
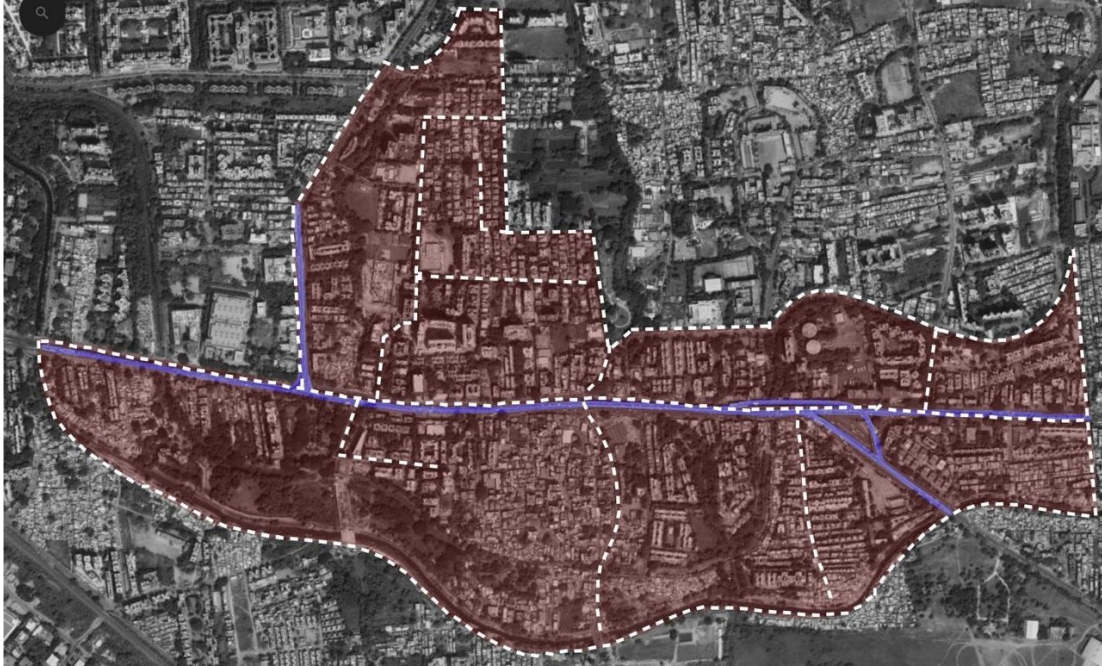
Figure 12. Major and minor paths affecting the district.

3.3. Nodes

During the mapping and analysis of the nodes in the study area, several types of nodal activities were observed. Small public squares and community facilities were identified as vital nodes for pedestrian movement and social interaction. These places provide opportunities for people to meet and interact, contributing to the social fabric of the community. Bus transit junctions and depots were also identified as significant nodes for pedestrian and transit-oriented communities. These nodes allow for easy movement between different parts of the city and provide access to public transportation. As a result, they are essential for improving the overall mobility of the area. Another important nodal activity observed was the Mantri Market, which is a hub for commercial and retail activity. This node attracts people from all over the area and offers a diverse range of goods and services, contributing to the local economy. The combination of community facilities and local vendors is another important nodal activity observed in the study area. These nodes offer a mix of community services and local vendors, including small shops and food stalls. Figure 13 highlights the nodes identified within the studied district.

Figure 13. Nodes identified according to QGIS mapping.

The road hierarchy was observed as a nodal activity for reducing vehicle-pedestrian conflicts. This nodal activity is essential for ensuring the safety of pedestrians and cyclists and improving the overall quality of life in the area. The road hierarchy includes measures such as traffic calming, pedestrian crossings, and bike lanes to encourage non-motorized forms of transportation. The observations made during the mapping of nodes revealed several inferences about the surrounding areas. The streets were found to be dominated by vehicles, indicating that the pedestrian infrastructure is inadequate. The neighboring areas are a mix of commercial, residential, and mainly transit activity, highlighting the need for transit-oriented communities. The population has increased, and as a result, the neighborhood has evolved. This can be seen in the diverse range of activities and facilities available at the nodes. The study also revealed that there has been migration to the area due to inadequate or limited urban services and infrastructure such as healthcare, education, utilities, and transport.

This has resulted in an increase in the population and the need for better facilities and services. The streets were widened to accommodate vehicles, which has negatively impacted the pedestrian movement. The study highlighted the need to reduce vehicle-pedestrian conflicts by redesigning the road hierarchy. Overall, the inferences suggest that the area is in need of better pedestrian infrastructure and transit-oriented communities. The study recommends that urban services and infrastructure be improved to meet the needs of the growing population, and the road hierarchy be redesigned to prioritize pedestrian movement. After studying the nodes in detail, their types were further analyzed, including cross T-junctions, Y-junctions, L-junctions, and four-way junctions. Among these, T-junctions were found to be the most common type on internal roads and near the main road, while L-junctions were the least common. Four-way junctions were identified as playing a crucial role in the minor node category. This information can aid architects and urban planners in understanding the spatial configuration of the area and its potential for future development.

3.4. Edges
Figure 14 highlights the edges developed in the study area according to the landmarks identified.

The population density of edges in this area has been categorized. The edges located along the primary road, from Noble Hospital in the north to Magarpatta Chowk in the south, and from Hadapsar Gadital in the east to Karnabadhir Vidyalaya in the west, have the highest population density. This is because they have easy access to transportation, major landmarks, infrastructure, and amenities such as bus and rickshaw stands, food stalls, temples, and streetlights. Due to the increased density caused by migration, street vendors can be observed sitting along the edges and under the Inder bridge. As the width and length of roads decrease towards the interior, the density also decreases. The edges along the canal are unoccupied due to the unhygienic environment caused by the disposal of waste by pedestrians.

Figure 14. Edges developed according to the Landmarks identified.

3.5. Landmarks

A study was conducted on the site to classify landmarks based on their function. The major landmarks such as the gaditol, vegetable market, post office, and cremation ground create nodes in the area and are considered important landmarks. These landmarks were present in the area before 1985 and have become essential for people to navigate and conduct daily activities. Hospitals and clinics are mostly located on the main roadside, indicating that the area is well-equipped with medical facilities for the residents. Educational institutions, on the other hand, are primarily located along the inner roads, indicating that the area has a good education system in place for the locals. This suggests that the area has a robust educational infrastructure. There are only a few parks located on the main road and one on the internal road, indicating that the area has limited open spaces for recreational activities. This can affect the well-being of the locals. Shopping centers are mostly located on the main road and have developed in the area in the past few years, indicating that the area has experienced commercial development, and the residents have access to shopping centers for their daily needs. Religious buildings such as temples are old structures located in the area before 1985.

These religious buildings serve as important landmarks in the area and contribute to the cultural and religious practices of the locals. In conclusion, the study conducted on the site revealed that the landmarks in the area are primarily focused on meeting the basic needs of the residents, such as medical facilities, educational institutes, and shopping centers. The lack of open spaces for recreational activities and the presence of religious buildings contribute to the cultural and social practices of the locals.

4. Discussion

4.1 Interpretation of Key Findings

Addressing rural infrastructure bottlenecks from the standpoint of migration directs attention to the process by which households move, where they are trying to go and what resources and expectations they have to work with. Migration flows respond rapidly to incentives. Extreme unemployment rates are creating a context of migration to second-best or default incentives where jobs are not available and infrastructure access is pivotal to household migration decisions. At the same time, migration also flows to areas with higher cash incomes and more economic options. Infrastructure delivery promotes the informal sector, carrying potential multiplier effects. Households dismissed or expelled from farms or elsewhere are often forced into the migration stream with only the default option of the nearest farm town. This concentrates on poverty and need around failing small towns. Urban and rural income sources can probably no longer be brought into balance for most of the rural poor: it appears that urban planners can no longer rely on the rural sector to absorb urban unemployment, as rural communities can no longer count on wage work in the urban areas to support families unable to live off the land economy. Migration to advantaged areas or at a minimum to centres that offer access to services and mass transport may not provide an optimum income, but it allows the household to cut its transport costs and its labour time loss so as to put more resources into cash earning.

Planning for spatial development in a context of high migration levels and an unstable population needs to build livelihood priorities actively into delivery, and cannot concentrate narrowly on housing and infrastructure. Migration findings suggest that the infrastructure delivery problematic has two axes: first, how to formulate spatial policy and structure delivery of infrastructure in relation to rural-to-rural migration, and particularly for the dense destination areas; and second, how to look at re-establishing rural/urban linkages through policies that will minimise rural exclusion if not immediately increase access to jobs. An ancillary question is how to increase developmental response from the grass roots, by enlisting the individual mobile household's capacity to invest and to generate income for its own members. Rural exclusion exacerbates both poverty and out-migration. Migration characteristically flows along transport corridors connecting source areas as catchments to destinations, and can be expected to orient quickly toward any areas that begin to receive infrastructure on scale. This approach to spatial policy would move infrastructure delivery out of the reactive category as far as possible. Better rural/urban linkages could reduce the exclusion effect of high urban unemployment on rural migration patterns, by encouraging rural households to maintain urban access and information flows. The social capital needed to overcome rural exclusion is maintained by people travelling back and forth regularly.

The Pune-Solapur Road region has gone through significant architectural development over the past few decades. In 1985, there was limited and scattered development on the outskirts of the road, with agricultural land located away from it. However, the region underwent a transformation in 2002 with the emergence of IT industries, which led to intensified settlements on both sides of the road. The construction of Magarpatta city in 2003 acted as a catalyst for the general growth of Hadapsar, leading to the emergence of a large number of townships, IT industries, and other commercial spaces in the area. The building use plan of the Pune-Solapur Road region reflects a mix of residential and commercial structures, with a focus on creating liveable and vibrant communities. Commercial buildings along the main road are multi-story structures with sleek, modern facades and ample parking facilities. They house a wide range of businesses, from small shops and cafes to large corporate offices and commercial centers. Residential buildings in the area range from high-rise apartments to spacious bungalows, each designed to meet the unique needs and preferences of different residents.

The interior residential settlements are designed to create a sense of community, with landscaped gardens, parks, and other amenities designed to enhance the quality of life for residents. Educational institutions, hospitals, and health centers are also situated in the area, providing easy access to amenities such as education, healthcare, and recreational facilities. The architectural language of the buildings in the area reflects a blend of modernity and functionality, with a focus on creating efficient and comfortable living and working spaces. Buildings along the main road feature sleek, modern facades with ample glass and

metal detailing, while the residential buildings in the interior are designed to be more traditional and comfortable, with spacious balconies and open living spaces.

Due to the heavy influx of migrants, the area has developed a dense road network, with the construction of flyovers and the widening of roads to reduce the increasing vehicular density. The lack of a distinguishable road hierarchy and pedestrian paths has created heavy traffic and high pedestrian footprints, with the central road experiencing significant traffic congestion at peak hours. However, the flyovers provide parking spaces underneath and near commercial spaces, reducing traffic congestion. Understanding the activity patterns of migrants in the area can help architects and urban planners better design and plan the city to accommodate the needs of its residents and visitors.

5. Conclusion

Hadapsar, a suburb in Pune, has undergone significant transformation over the years. In 2003, the settlements primarily ran along the periphery of the Pune-Solapur Road, with very little development of Magarpatta city. The major and a few minor connecting roads were visible throughout the area, with little to no riverside construction. In 2010, the scenario started to change as settlements began to run along and beyond the periphery of the Pune-Solapur Road. Magarpatta city's development progressed to about 60%, and there was a noticeable improvement in connectivity. There was also an increase in built spaces along both sides of the river. However, the area was still predominantly residential, with limited commercial development. In 2022 Hadapsar transformed into a bustling commercial and residential hub, with settlements and commercial spaces consuming most of the available land. The construction of Magarpatta city is now fully proposed with expansion and redevelopment plans. The riverside, which was once devoid of any construction, is now flooded with settlements and commercial development with structured landscaping, and limited agricultural land.

The development of an urban road network is a complex process that is heavily influenced by socio-economic and environmental factors. These factors have varying degrees of impact on different districts, which should be considered during the planning and implementation stages to create a sustainable and equitable urban environment. The development of roads and urban areas are crucial elements in the process of urbanization, as they influence the patterns of growth and level of economic activity. The creation of accessible transportation systems allows for the mobility of people and goods, which in turn encourages development and settlement patterns. In Hadapsar, the presence of major townships like Magarpatta city, with their IT and banking firms, has contributed to the development of the area. These findings of this paper exemplify the excess pressure exerted on urbanised cities due to migration from neighbouring peri-urban areas as a result of contemporary urbanisation.

As Hadapsar developed over the years, urban planners and architects played a crucial role in shaping the area's growth. They designed and implemented plans that focused on improving connectivity, increasing green spaces, and creating better infrastructure to support the growing population. The transformation from a predominantly residential area to a commercial and residential hub was due to the efforts of these planners and architects. The architectural style in Hadapsar has also undergone significant changes over the years. In 2003, the buildings were relatively simple and functional, with little emphasis on aesthetics. However, currently, the area boasts modern, state-of-the-art buildings that feature innovative designs, materials, and technology. The buildings are not just functional but are also visually appealing and sustainable. In conclusion, Hadapsar's transformation over the years is an example of the impact of urbanization on an area's development. With the right vision, planning, and execution, architects and planners can create vibrant, sustainable communities that meet the needs of the growing population while preserving the area's natural resources.

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The author(s) declare(s) no conflicts of interest.

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The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

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References

Awases, M., Gbary, A., Nyoni, J., & Chatora, R. (2004). *Migration of health professionals in six countries: A synthesis report*. World Health Organization Regional Office for Africa.

Bartolini, S., Sarracino, F., & Mikucka, M. (2017). Money, trust, and happiness in transition countries: Evidence from time series. *Social Indicators Research, 130*(1), 87-106. https://doi.org/10.1007/s11205-015-1130-3

Bayona-i-Carrasco, J., & Gil-Alonso, F. (2011). Intra mobility of foreigners in Barcelona. *Architecture, City and Environment, 6*(17), 129-156. https://doi.org/10.5821/ace.v6i17.2532

Beine, M., Noël, R., & Ragot, L. (2014). The determinants of international mobility of students. *Economics of Education Review, 41*, 40-54. https://doi.org/10.1016/j.econedurev.2014.03.003

Bloom, O. S. (1985). The new economics of labor migration. *The American Economic Review, 75*(2), 173-178.

Bogue, D. J. (1977). A migrant's-eye view of the costs and benefits of migration to a metropolis. In *Internal Migration* (pp. 177-192). https://doi.org/10.1016/B978-0-12-137350-4.50016-0

Ciriaci, D. (2014). Does university quality influence the interregional mobility of students and graduates? The case of Italy. *Regional Studies, 48*(10), 1592-1608. https://doi.org/10.1080/00343404.2013.821569

Czaika, M., & de Haas, H. (2022). Migration drivers: Why do people migrate? In *Introduction to migration studies* (pp. 45-63). Springer. https://doi.org/10.1007/978-3-030-92377-8_3

Dimitriadi, A. (2017). Governing irregular migration at the margins of Europe: The case of hotspots on the Greek islands. *Journal of Borderlands Studies, 32*(3), 1-15. http://dx.doi.org/10.3240/86888

Egidi, G., Salvati, L., & Vinci, S. (2021). Re-framing the latent nexus between land-use change, urbanization, and demographic transitions in advanced economies. *Sustainability, 13*(2), 533. https://doi.org/10.3390/su13020533

Findlay, A. M., & King, R. (2011). World class? An investigation of globalisation, difference, and international student mobility. *Transactions of the Institute of British Geographers, 36*(1), 118-131. https://doi.org/10.1111/j.1475-5661.2011.00454.x

Fu, H., & Zheng, G. (2021). Life satisfaction and migration intention of residents in shrinking cities: Case of Yichun City in China. *Journal of Urban Planning and Development, 147*(4), 04021050. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000791

Gachassin, M. (2013). Should I stay or should I go? The role of roads in migration decisions. *Journal of African Economies, 22*(5), 796-826. https://doi.org/10.1093/jae/ejt004

Garcia-López, M. À., & Muñiz, I. (2020). Urban spatial structure in Barcelona: Immigration, spatial segregation, and new centrality governance. *Applied Spatial Analysis and Policy, 14*(2), 333-354. https://doi.org/10.1007/s12061-020-09365-0

Habibi, S., & Asadi, N. (2011). Causes, results, and methods of controlling urban sprawl. *Procedia Engineering, 21*, 133-141. https://doi.org/10.1016/j.proeng.2011.11.1996

Hassanzadehkermanshahi, K., Sharifi, S. S., Mosavi, A., & Shamshirband, S. (2022). Measuring urban sustainability over time at national and regional scale for addressing United Nations Sustainable Development Goal (SDG) 11: Iran and Tehran as case studies. *Sustainability, 14*(12), 7402. https://doi.org/10.3390/su14127402

Kateja, A., & Jha, M. K. (2021). Migration pattern and the emerging trends of migration in India. In M. Sharma, A. K. Singh, & S. S. Thakur (Eds.), *Urban growth and environmental issues in India* (pp. 143-160). Springer. https://doi.org/10.1007/978-981-16-4273-9_8

Kowalewska, I. Z. (2024). Employment of migrants as a response to the needs of entrepreneurs in rural border regions—Examples from Poland. *Sustainability, 16*(13), 5614. https://doi.org/10.3390/su16135614

Lee, E. S. (1980). A theory of migration. *Demography, 3*(1), 47-57. https://doi.org/10.2307/2060063

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *The Manchester School, 22*(2), 139-191. https://doi.org/10.1111/j.1467-9957.1954.tb00021.x

McAuliffe, M., & Ruhs, M. (2018). Report overview: Making sense of migration in an increasingly interconnected world. *World Migration Report*. https://doi.org/10.1002/wom3.1

Ni, J., & Sun, S. (2013). The drivers of land use change in the migration area, Three Gorges Project, China: Advances and prospects. *Earth Science Frontiers, 20*(3), 1-8. https://doi.org/10.1007/s12583-013-0306-5

OECD. (n.d.). Steering urban development to more sustainable pathways. In *Rethinking urban sprawl*. https://doi.org/10.1787/9789264189881-7-en

Qin, X., & Deng, Y. (n.d.). Urbanization, suburbanization, and population redistribution in urban China: A case study of Nanjing. *Journal of Urban Planning and Development*. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000882

Shi, Y., & Li, H. (2023). The multidimensional measurement method of urban sprawl and its empirical analysis in Shanghai metropolitan area. *Sustainability, 15*(2), 1020. https://doi.org/10.3390/su15021020

Sjaastad, L. A. (1962). The costs and returns of human migration. *Journal of Political Economy, 70*(5), 80-93. https://doi.org/10.1086/258726

Sorolla Edo, A. (2014). Housing policy, beyond building: The fourth pillar of the welfare state. *ACE: Architecture, City and Environment, 9*(26), 223-236. https://doi.org/10.5821/ace.9.26.3691

Ticau, I. R., Drăgoi, M. C., & Mihăilescu, D. L. (2023). Sustainable development in peri-urban regions: A triangulation analysis. *Sustainability, 15*(20), 14837. https://doi.org/10.3390/su152014837

Todaro, M. P. (1970). Migration, unemployment and development: A two-sector analysis. *The American Economic Review, 60*(1), 126-142.

Woltjer, J. (2014). A global review on peri-urban development and planning. *Journal of Regional and City Planning, 25*(1), 1-16. https://doi.org/10.5614/jpwk.2014.25.1.1

Zhang, X., & Li, X. (2024). The impact of social capital on migrants' social integration: Evidence from China. *Sustainability, 16*(13), 5564. https://doi.org/10.3390/su16135564

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