Chapter 3
The Pattern of Gentrification in a Knowledge Economy: The Case of Bengaluru, India

Arindam Biswas⬤, Sukanya Koner⬤, and Jayant Singh

1 Introduction

Changing global order towards knowledge driven development has direct impact on the geographical connotations of cities (Cappellin 2007; Penco 2013). Today's knowledge clusters, example, "Silicon Valley" in San Jose, California (Saxenian 1983) and "BioRN" in Heidelberg, Germany (Krauss and Stahlecker 2001) draw attention to the sprawling urban formations and processes that transform intermediate settlement space (Isaksen 2006). Post Fordism, the neoliberal agendas facilitated economic transition towards knowledge economies based on technological innovations (Asian Development Bank 2007). Many scholars consider regional economy as geographical and economic base for production and, as a result, act as new gateways to generate new economic activities, commodities and services, jobs, and revenue streams (Den Hertog et al. 2001; Feldman et al. 2005; Florida 2003). In fact, geographic concentration of knowledge industries and associated institutions with strong government's strategic policy choices (Hariharan and Biswas 2020a, b) reinforces knowledge cities to become global magnets for foreign investments and human capital (Porter 2000).

Transition from traditional industrial district to innovative milieu, mainly due to technological advantages, is responsible for the changing spatial and social configurations of the region (Maillat 1998). Innovative milieu is a spatial set identified by

A. Biswas (✉)
Department of Architecture and Planning, Indian Institute of Technology, Roorkee, India
e-mail: arindam.biswas@ar.iitr.ac.in

S. Koner
Master of Science in Urban Studies, 4CITIES - Erasmus Mundus Scholarship Program, Vrije Universiteit Brussel, Ixelles, Belgium
e-mail: sukanya.koner@vub.be

J. Singh
Bachelor of Planning, Maulana Azad National Institute of Technology, Bhopal, India

a technical culture with innovative process and optimum location factors (skilled labour, research centres, airport, pleasant climate etc.) (Maillat 1995) Knowledge cities are hubs of such innovative milieus where interactions between interdependent firms and institutions promotes spatial proximity and high-level competitiveness (Trippl and Bergman 2014; Tallmann et al. 2004). They assimilate large pool of skilled labour, local entrepreneurship and globalised markets creating industry-institution-human capital nexus (Florida 2002; Ergazakis et al. 2006). The notion of these socio-economic networks mainly explains the stimulated flow of diversity and cross-fertilised ideas to build new business opportunities deteriorating the old dynamics of a society, termed as "creative destruction" (Schumpeter 1947).

Therefore, knowledge-based economy is highly criticised for creating spatial segregation and socio-economic polarisation in the urban milieu (Autor et al. 2003; Edlund et al. 2015; Stehlin 2015). The influx of inhabitants to the low-income neighbourhoods due to the employment opportunities (Kennedy and Leonard 2001), post-secondary institutions (Moos et al. 2018), government's investments supporting middle and upper class (Morisson and Bevilacqua 2019) accelerates gentrification processes. Movement of knowledge workers into the city transforms the urban neighbourhoods by communities' and accelerates cultural displacement with skyrocketing economic heft in housing and mobility costs (Richardson et al. 2019).

Bengaluru has been recognised as a knowledge city (Hariharan and Biswas 2020a, b), global outsourcing city (Sengupta 2010) and global hub of tech start-ups (Subrahmanya 2017). The decennial data of migration reveals a 141% increment in inmigration due to work or employment in Bengaluru (Census of India 2011). Moreover, the upsurge of 117% in knowledge workers during the same period (2001–2011) to the present count of over a million workers in the city (Hariharan and Biswas 2020a, b), acknowledges the inflow of diverse human capital transforming socio-economic structure of city's neighbourhoods.

The chapter aims to explore how the rapid urban growth in Bengaluru has influenced the pattern of gentrification. The study is based on a hypothesis that the emergence of knowledge-based industries in Bengaluru is the prime reason behind its accelerated urban growth. The objectives of this research are

i.   To assess the temporal growth of Bengaluru urban district;
ii.   To understand the dynamics of knowledge economy in Bengaluru; and
iii. To identify the patterns of gentrification in Bengaluru.

This book chapter consists of eight sections. Following the 'Introduction', Sect. 2 focuses on "knowledge economy, urban transformation and gentrification" by reviewing the contextual literature that offers the formation of a knowledge city and examines the relationship between the knowledge economy and different facets of urbanism. It also elucidates the concept of gentrification and its different forms to understand the shift in the demographic, socio-economic, and cultural fabric of neighbourhoods. Section 3 discusses "Urban growth in Bengaluru" by reviewing the Bengaluru Urban District (BUD) and emphasises the decadal spatial analysis of urban growth in BUD. Section 4 comprehends the "Industrial restructuring and Urban Transformation in Bengaluru" through regional socio-economic profile for a deep

understanding of the conducive ecosystem of the knowledge economy in Bengaluru. Section 5 details out the research methodology. Both qualitative and quantitative methods are applied in this research. Section 6 analyses the patterns of gentrification within the neighbourhoods of BUD using the patch-based Landscape Expansion Index. The section discusses the findings by explaining the extent of different types of gentrifications based on the classification of three urban growth patterns. The "Conclusion" in Sect. 7 elucidates the conceptualisation of the research. It reflects various insights gained by the novel pattern identification process for gentrification in a knowledge city.

2   Knowledge Economy, Urban Transformation, and Gentrification

The paradigm shift from "agriculture to knowledge" (Drucker 1992), the process of deindustrialisation (Penco 2013) and technology based information density (Raspe and Oort 2006) has developed the production processes creating "knowledge cities" (Carrillo 2011). The decline in natural resource driven economy, represented as global agriculture raw material exports in Fig. 1, with an upsurge in the knowledge-intensive economic activities reveals the transition in global pattern of economic growth. Figure 2 demonstrates the upscale production in "Information Technology" (IT) service in four major economies of the world. Thus, wealth creation through application of human knowledge and creativity is steadily outpacing wealth creation through extraction and processing of natural resources.
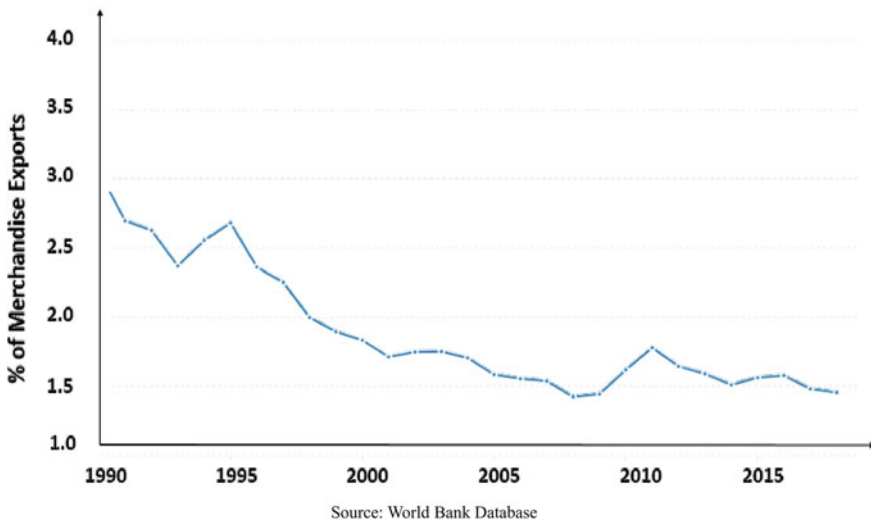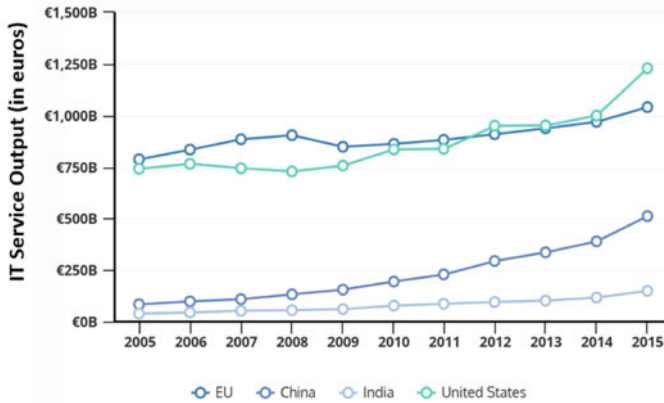

Fig. 1 Timeline for global agricultural raw materials exports

Source: Brookings Institutions, Joint Research Center and European Commission and Communications Networks, Content and Technology.

Fig. 2 IT sector production in 4 economies

The knowledge based economic development model was first introduced by Machlup and Drucker but surfaced in late 1990s as a "new growth theory" with knowledge as the key driver of productivity (OECD 1996). Four pillars of knowledge economy have been identified (Asian Development Bank 2007; World Bank 2007; ODI 2009). Firstly, an institutional regime that incentivises the knowledge creation and dissemination with policy based regulatory environment. Secondly, thriving educated and skilled workforce as human capital for effective knowledge creation. Thirdly, a vibrant innovation system of government, academia, private sector and civil society, which can channelize the global knowledge into products valued by local needs as well as the markets. Lastly, a dynamic information infrastructure that facilitates efficient flow and access to information and technology.

The contemporary research discussion raises fundamental concerns about conceptualisation and interpretation of functional urban hierarchy (Luthi et al. 2012). There is a need to examine at the interconnection of knowledge-intensive economic activities at various geographic scales, particularly, due to morphing of cities into networks of clusters, characterised by a new functional division of labour providing immense economic strength (Hall and Pain 2006; Hoyler 2011). Formation of knowledge clusters is the result of a spatial upscaling of agglomeration economies and a spatial concentration of global network of knowledge-based economies (Raspe and Oort 2006; Davoudi 2003). These are primarily driven by continual innovation enhancing productivity due to competitive advantages and fuelled by the supply and demand for high-quality urban attributes (Porter 1998; Oort 2003). On the supply side, advancements in transportation and telecommunication technology are propelling the growth of urban environments. On the demand side, spatial requirements of knowledge-intensive industries drive the concentration of global network economies in large-scale metropolitan environments. High-quality infrastructures, such as academic

institutions, large settlements of leading global companies, proximity to international gateway infrastructures like airports or high-speed train nodes, as well as the availability of specialised knowledge, the presence of competitors, business partners, and customers, are all important to knowledge-intensive firms (Porter 1990). The interaction of these forces produces a highly strategic location-based Knowledge city-region, reinforcing socio-economic transformations on a new spatial scale.

The concept of a "knowledge city" is still in its nascent stage but there are several complementary perspectives to explain the formation of a knowledge city, such as urban capital systems (Carrillo 2004), regional intellectual capital (Bounfour and Edivinsson 2006), and Information Technology (IT) (Komninos 2002). Another interesting concept of integrating people, places, processes and purposes determined by "knowledge moments" that triggers, and enables the formation of a knowledge city (Dvir 2005). A "knowledge moment" is a planned or spontaneous human interaction in which knowledge is discovered, created, nourished, exchanged, and transformed into an intellectual material that any institution can use to create value (Dvir 2005). Multitude of escalated "knowledge moments" spurs the city-region into a "space of flows" highlighting the paramount role of knowledge intensive industries in shaping the urban growth of the city (Castells 1989). Such growth with high economic performance that concentrate wealth germinates social inequality (Glaeser et al. 2009) and stimulates urban transformations, both structural and spatial (Mattar et al. 2014). The structural transformations are propelled by the pool of specialised human capital, easy flow of technological externalities or knowledge spill-overs, increased access to global markets and conducive policy based regulatory environment (Krugman 1991; Spencer et al. 2010). However, spatial transformations intricate multi-scalar changes in urban morphologies due to reasonable urban services and high quality of living standards escalating cosmopolitan urbanism (Penco 2013; Moos et al. 2018). Figures 3 and 4 explain the formation of a knowledge city and associated urban transformations in the knowledge city, respectively.
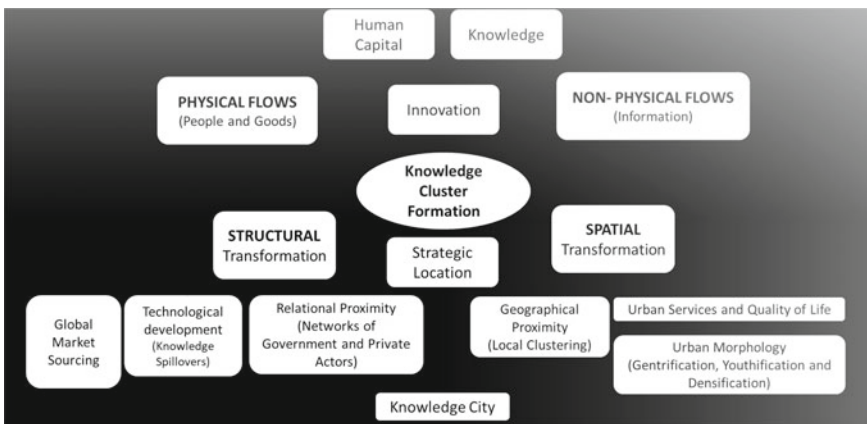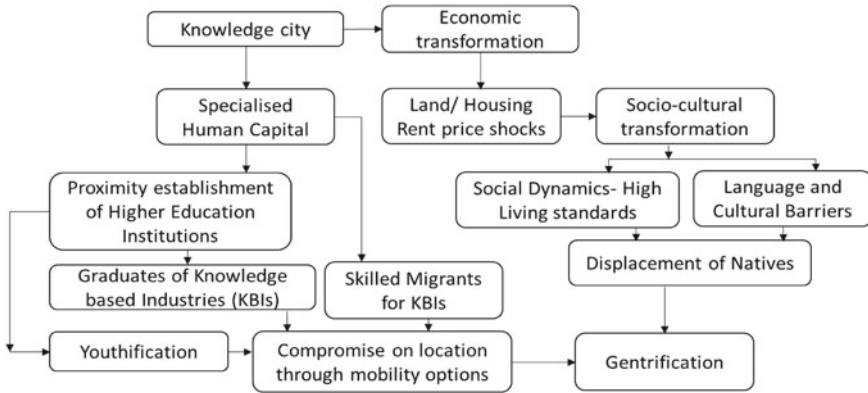

Fig. 3 Formation of a knowledge city

Source: Compiled by authors

Fig. 4 Economic and socio-cultural transformations in a knowledge city

Cities also highlight the importance of real estate development enterprises in meeting the high demand for urban transformations as a place-based strategy to promote the knowledge economy (Bevilacqua et al. 2017). Knowledge based industries price out city's neighbourhood character due to shocks of rising rent and cost of living. This leads to compromise on location through mobility options, social character transition of natives and conflict in social dynamics for living conditions. The incoming of the knowledgeable workforce and skilled migrants to accommodate as urban milieu automatically creates pressure on the well-functioning neighbourhoods through socio-economic restructuring of its character. The problem exacerbates with influx of new educational institutions that leads to "youthification" and further distorting the housing and rental markets (Moos et al. 2018). The knowledge-based development strategies accelerate the cognitive distances between different socio-economic groups in city regions, leaving negative externalities of gentrification as the outcome of development process. The negative impact of gentrifications assorts from 'displacement' to destruction of community due to the increased sparseness on housing availability and higher rents (Morisson and Bevilacqua 2019).

The concept of gentrification was first identified by Ruth Glass in 1964, as the transformation in housing pattern and ownership, changing the physical and socio-economic urban environments (Glass 1964; Seo 2002; McKinnish et al. 2010; Meltzar and Ghorbani 2017; Atuesta and Hewings 2019; Cho et al. 2020). This is a "classical gentrification" where middle class rehabilitates in city's neighbourhood displacing working class or indigenous communities (Lees 1994; Kosta 2019). Many researchers have focussed on the cause of this phenomenon in cities like New York City, San Francisco, Baltimore, Chicago, Washington D.C. etc. (London and Palen 1984; Cohen 1983; Smith 1996; Richardson et al. 2019). The rent-gap theory, which is based on the principles of the potential land value and capitalised land value, was

used by Smith to describe the cause of gentrification (Smith 1996). The term "potential land value" refers to the value of land that can be realised when it is used to its full potential. The capitalised land value is the value of the land's present use (Smith 1996). Smith claimed that, while the capitalised land value is low in older neighbourhoods, the potential land value increases with the prospect of redevelopment for profit maximisation. Thus, gentrification occurs because of the disparity between the two divergent land values. Researchers like Ley and Moos argued that the change in the workforce to young professionals increased the city's socio-cultural activities and fostered gentrification as there was a paradigm shift from manufacturing industries to knowledge industries (Ley 1986; Moos et al. 2018).

The definition of gentrification has evolved from Ruth Glass's conventional definition to a myriad of other definitions, such as rural gentrification and new-build gentrification (Lees et al. 2008). Gentrification can also be defined as "the transformation of a working-class or unoccupied core city neighbourhood into middle-class residential and/or commercial use" (Lees et al. 2008). For example, the city of San Francisco entailed a political-economic reconfiguration to adjust the urban environment to the knowledge economy's new demands. Direct displacement, indirect displacement, exclusionary displacement, displacement pressure, and social exclusion are all kinds of displacement identified due to the gentrification process (Morisson and Bevilacqua 2019). Different forms of gentrification based on their mechanism are synthesised from various literature and listed in Table 1.

3 Urban Growth in Bengaluru

Erstwhile Bangalore, and present Bengaluru, with an average economic growth rate of 8.5%, is one of the world's top ten fastest growing cities (Srinivas 1997; Paul et al. 2018). It grew out of a tiny settlement founded by a chieftain of Yelahanka Nada Prabhu dynasty named Kempe Gowda in 1537 A.D. (Kamath 1990; Nagendra et al. 2014). Bengaluru grew from a small 18-square-kilometer town to 737-square-kilometer metropolis in 2016, and it is continuously expanding (Annaswamy 2003; Bengaluru Development Authority 2017). Bengaluru is India's fifth largest urban agglomeration (Registrar General and Census Commissioner of India 2011). It is known as a high-tech industry centre and the home of India's highest number of IT firms and thus earning the designation of "India's Silicon Valley" (Britton 2017). The increasing worldwide recognition as the most dynamic city has made Bengaluru home to citizens from every state and diverse nationalities (Kelly 2017).

India is a popular Global Capability Center (GCC) location, with 25–30% of Fortune 500 companies establishing GCCs in the country (Pabari et al. 2021). Bengaluru is India's leading GCC destination, accommodating 34% of India's GCCs. Bengaluru accommodates 33% of India's tech expertise. Almost 44% of the migrants moving to the city have tech skills, compared to only 12% in Delhi and 11% in Mumbai (Dharma et al. 2020). The ratio of engineering colleges to the population

Table 1 Types of contemporary gentrification

Type of gentrification	Definition	Features
New-build gentrification	The process of demolition/reconstruction activities, as well as new developments of infill housing or corporate developments (Davidson and Loretta 2005; Rerat et al. 2010)	• Reinvestment in capital • Social upgrading of neighbourhood by higher income groups • Occurs near or within existing communities, a higher potential for conflict between long-term residents and newcomers • Direct or indirect displacement of low-income groups • Landscape change
Retail upscaling	The process that changes area's retail composition by 'boutiquing' of streetscapes (Zukin et al. 2009) and supermarkets that appeal to high income group consumers (Sullivan 2014)	• Development of selective product-based consumerism • Inequitable distribution to retail access due to high prices • Unable to serve low-income residents
Tourism gentrification	The phenomenon of changing area's historical ethnicity by commercialising ethnic cultures to promote tourism-based consumerism (Gotham 2005; Hackworth and Rekers 2005; Burnett 2014)	• Use of business improvement techniques to package ethnicity of neighbourhoods • Escalated housing prices due to changes in residential and commercial real estate • Transition in focus from ethnic population to tourist population, creating a sense of exclusion and alienation in ethnic residents
Peripheral gentrification	Process of gentrification promoting restructured housing on the peripheral locations (Uitermark and Duyvendak 2007; Bridge et al. 2012)	• Affluent social housing in a low-income neighbourhood • Increased population density due to multi-storeyed buildings • Varying socio-economic mix of residents
Transit oriented gentrification	The gentrification aided by the characteristics of transit proximate neighbourhoods (Ong et al. 2014; Chapple et al. 2017)	• Changes in employment profile of the neighbourhood due to accessibility • Increase in commercial and residential property values • High risks to pedestrians and bicyclists as these areas attract major vehicular traffic
Residential-commercial gentrification	The phenomenon of conversion of residential housing to cafés, restaurants, big retail outlets, and apparel stores (Yoon and Park 2018; Cho et al. 2020)	• Mounted rent and property value • Transformation in composition of residents and character of place • Large chain stores may disrupt social bonds and cohesiveness • High competitiveness in the area

(continued)

in Bengaluru is five times that of Delhi and 1.7 times that of Mumbai (Accel Partners 2019). Bengaluru Innovation Report 2019 highlights that the state capital of Karnataka is India's most millennial-friendly city, with strong employability rates and even being the best choice for women, and 37% of the population belongs to the age group of 15–35 years (Accel Partners 2019). Bengaluru's comparative advantage

Table 1 (continued)

Type of gentrification	Definition	Features
Rural gentrification	The transformation of former agricultural areas and other greenfield into new developments and the "subsequent displacement" of working-class rural residents because of rising local land and housing process (Philips 1993; Hackworth and Rekers 2005)	• Change towards peri-urbanisation • Growth of "marginal gentrifiers" • Asymmetries in class positions of householders • Change in role of workforce and lifestyles

Source Compiled by authors

in India's IT industry stems from crucial determinants, including favourable government policies, a high-quality workforce, and the availability of research laboratories (Subrahmanya 2019). The report further emphasised that the city has recorded more tech start-ups establishment since 2016 than Delhi and Mumbai combined. It has about 800 colleges, with over 100 of them being engineering colleges. The Indian Institute of Science (IISc), Indian Institute of Management Bangalore (IIM-B) and other important academic institutions are also located here. Every year, these educational institutions produce more than 90,000 engineering graduates (The Hindu 2018).

The Bangalore Urban Agglomeration (BUA) has more than doubled its share in the urban population of Karnataka, rising from 17.66 to 35.96% during 1951 to 2011. Since 1951, the population of the Bangalore Urban Agglomeration (BUA) has expanded by 11 times, with a 4.05% Compound Annual Growth Rate (CAGR) (Sudhira et al. 2007). The population growth for BUD and BMR reflects this rise. According to a comparative analysis of 25 global cities, Bengaluru is on a fast-growth trajectory. Compared to cities in the United States, where urbanisation is constrained in the core, significant spatial expansion in Bengaluru is seen in the city periphery (Schneider and Woodcock 2008). It is transforming from a mononucleated to a polycentric growth pattern, with rapid growth occurring in multiple periphery areas (Shaw and Satish 2007; Taubenböck et al. 2009). The BMR's growth pattern is characterised by Bengaluru City as the urban core. Four growth events have contributed to Bengaluru's transformation from a town to a metropolis. Firstly, the State Capital was relocated to Bengaluru from Mysore after India's independence (Raman 1994). Secondly, integration of the Cantonment with the city in 1949 (Verma et al. 2017). Thirdly, establishment of major Public Sector Undertakings/Higher Education Institutions (Subrahmanya 2017; Manimala 2017); and fourthly, development of IT/ITES/Biotech based Knowledge industries (since 1980s) (Hariharan and Biswas 2020a, b). The continual flow of immigrants from surrounding areas and other regions to Bengaluru has resulted in the region's urban growth. According to Census 2001, almost half of the population (45%) was classified as immigrants (Bengaluru Development Authority 2005).

The Bengaluru Metropolitan Region (BMR) is composed of three districts in Karnataka's Bangalore Revenue Division: Bengaluru Urban District (BUD), Bengaluru Rural District (BUR), and Ramanagara. BMR is 8005 square kilometres
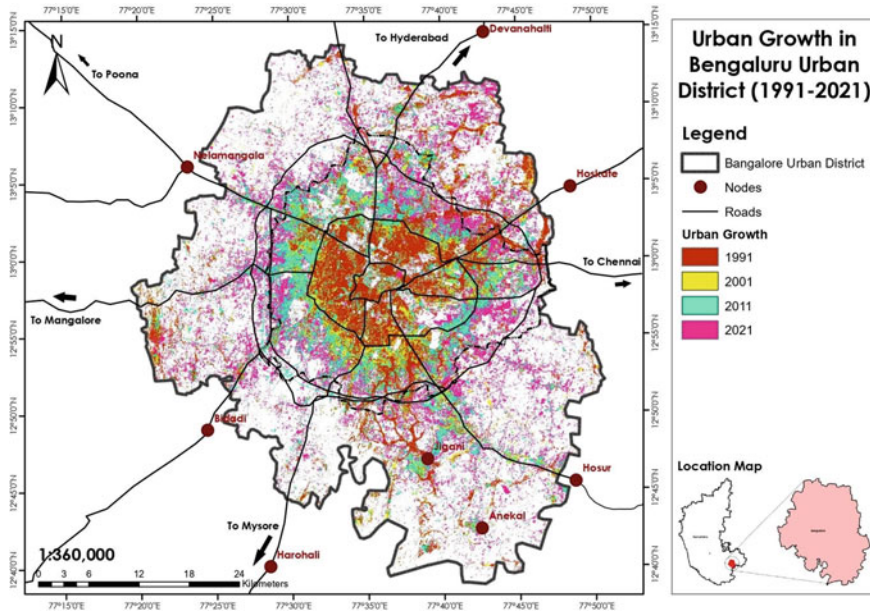
Fig. 5 Urban growth in Bengaluru urban district and major nodes in the area

in size (Bengaluru Development Authority 2017). The study area for the research is Bengaluru Urban District (BUD). Talukas in the BUD comprises North, South, East and Anekal. Figure 5 represents urban growth in BUD from 1991 to 2021. It has been analysed by assessing Remote Sensing (RS) data[1] in the geospatial software tool of ArcGIS. The method used for determining the urban growth is a pixel-based analysis using supervised classification. The total area of BUD is 2236 square kilometres. The urban area in BUD has significantly increased from 13.06 to 38.55%. The direction of growth is towards North-Eastern side in 2021, but it was towards South-Eastern side in 2001 and 2011. Figure 6 highlights all the satellite towns that have been engulfed by the core like Jigani, Kengerim Yeshwanthpur and Yelanhanka and even the small urban nodes have developed forming a radial network, including Anekal on Hosur Road, Bidadi & Ramanagara on Mysuru Road, Hoskote on Old Madras Road, Devenahlli on Bellary Road, Neelmangala and Dobaspete on Tumukuru Road (Sen 2013).

---

[1] Satellite images used for 1991 and 2001 are Landsat 5 (30 m), for 2011 and 2021 is Landsat 8 (30 m).

Fig. 6 Location of Bengaluru metropolitan area and satellite towns in the area

4 Industrial Restructuring and Urban Transformations in Bengaluru

Bengaluru has been recognised as the fastest growing urban regions within the country. The growth is attributed to the knowledge based industrial structure, an influx of specialised human resources, establishments of public sector companies and research and development (R&D) units (Subrahmanya 2017; Hariharan and Biswas 2020a, b). The network of "100 higher educational institutions" and conducive industrial environment promoting "small-scale and large-scale non-polluting industries" has favoured the city to become the hub of knowledge and innovation (Srinivas 1997; Manimala 2017).

Bengaluru's economy diversified from trading during the British period to Public Sector Undertaking (PSU) enabled manufacturing to the recent shift to IT/ITES industry. Bengaluru began as a trading centre from the Petta region in 1537, and in the 1800s, it developed after being designated as a British cantonment and administrative headquarters (Pani et al. 2010). Before 1940, the major industries contributing to Bengaluru's economic growth were Binny Mills, United Breweries, Tata Silk Farm (Basavangudi), Government Soap Factory (now Yeshwanthpur), Minerva Mills, Indian Tobacco Company (Cox Town) and Government Porcelain Factory (Bengaluru Development Authority 2017). The government extensively invested in big public sector enterprises such as Hindustan Machine Tools (HMT), Bharat Electronics Limited (BEL), Bharat Heavy Electricals Limited (BHEL) and Hindustan Aeronautics Limited (HAL) between 1940 and 1960 (Sen 2013). Rajajinagar and Dyavasandra industrial areas were established around the 1960s. Electronic City was founded in 1978 to encourage the development of electronic companies, and it has since grown one of the leading IT hubs in the world (Basant 2006).

Termed as the "Silicon Valley of India", Bengaluru metropolitan region has witnessed its regional development since the 1980s. The offshore development centre of Texas Instrument, established in 1985, strongly enabled the local software firms to serve as an IT interface between Indian knowledge and global technological developments (Plechero et al. 2020). Liberalisation strategies of the government for the knowledge-based sector in the 1990s increased the organisational network and capitalised on the growing outsourcing business from the West, especially Silicon Valley (Chatterji 2014). Globally, Bengaluru is among the most favoured knowledge cities and accommodates India's 40% IT based knowledge industries (Dezan Shira & Associates 2019). Population increased from 0.22 million in 1901 to 9.59 million in 2011 because of the evolution due to knowledge-based industries (KBIs) (Hariharan and Biswas 2020a, b). Immigration of skilled and unskilled labour into the industrial estates amplified the sectorial specialisation and thickened the multi-cultural environment (Sudhira et al. 2007). Nascent evolution of Bengaluru as the hub of an entrepreneurial ecosystem has embarked geographic concentration of human capital and many knowledge-based industries (Subrahmanya 2017). The elements involved in determining the formation of Bangalore as a Knowledge city is described in Fig. 7.

The economic development of Bengaluru as a knowledge city can be stated through its knowledge-based structures, the efficiency of institutions, the density of public and private organisations and the level of networks among these agents. The Bengaluru Urban District (BUD) accounts for the majority of Karnataka's "gross state domestic product" (GSDP). BUD alone contributed 1.73% to India's GDP and 34.36% to Karnataka's GSDP in 2014–2015 (Bengaluru Development Authority 2017). 14.97% of the employment share is dedicated to knowledge-based industries (KBIs). The areas with the highest concentrations of KBIs include Peenya, Whitefield, Electronic City, and areas of Bommasandra and Jigani (Bengaluru Development Authority 2017). The Electronic City in Bangalore is a key attraction that has prompted companies to congregate in the vicinity. Industries may be found throughout the entire stretch of NH-7 from Electronic City to Attibele and beyond, all the way to Hosur in Tamil Nadu. Manimala (2006) observes from the cluster
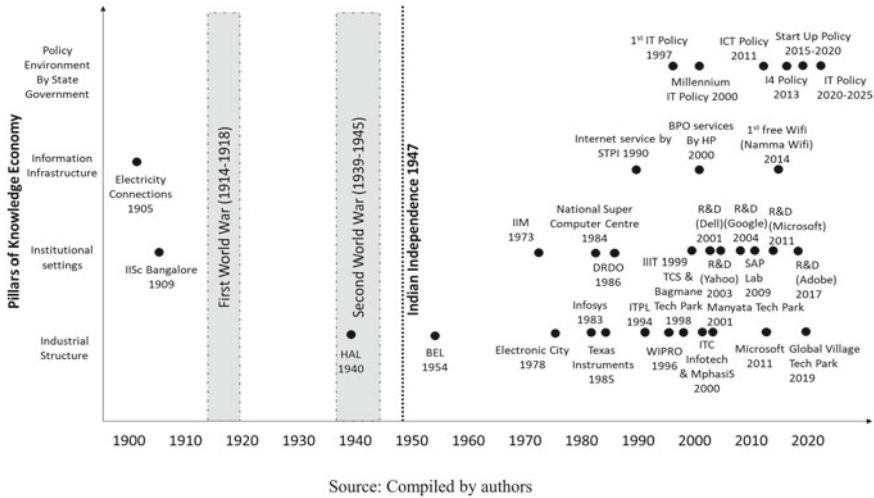
Source: Compiled by authors

Fig. 7 Elements of knowledge economy in Bengaluru

classification that the city's expansion may be segmented into four distinct periods of spatial development (Manimala 2006; Hariharan and Biswas 2020a, b). The four phases of spatial development of Bengaluru's knowledge city have been detailed out in Table 2.

Domestic start-ups and multinational corporations established offices in their own houses and commercial premises within the Central Business District (CBD) or surrounding locations, dependent on the firm's affordability during the first incubation period. The gradual shift of concentration of KBIs from CBDs towards the Electronic city situated on the Southern side of the city was witnessed in the Nucleation phase. The development of ITPL was one of the prime reasons for peripheral growth during the Y2K boom and dot com phase. Due to the low cost of real estate, many technology parks were established between the Electronic city and ITPL, which led to peripheral agglomeration. The establishment of the new international airport in 2008 shifted the direction of developmental activities of KBIs to the Northern direction of the city. IT/ITeS sector of KBIs accounts for 55% of the total demand of Bengaluru's real estate market and the average price increase in Bengaluru's residential areas. The approximate price increase is 23% from 2016 to 2020, which is greater than the average price growth in all other major cities, including Delhi NCR (18%), Mumbai (22%) and Pune (17%) (Ghosh and M 2020). The Southern side of Bengaluru includes Kanakapura, Bannergatta, Electronic city, Jigani, and Eastern area comprising Hoodi, Marathalli, Old Madras Road, Whitefield, Mahadevpura are most preferred by IT professionals (Sheikh et al. 2017).

The influx of huge human capital due to KBIs in new and old residential areas has resulted in various types of gentrifications. The present study has identified three types of gentrifications in the Eastern and Southern sides of the Bengaluru Urban District.

Table 2 Phases of spatial development of Bengaluru

Phase of development	Time period	Major events
Initial phase	1980–1991	• Establishment of Texas instrument in Bengaluru as the 1st MNC of India in 1985 (Kar 2016); • Central and regional governmental favourable liberalisation policies from 1991, for example, setting of Software Technology Park of India in Bengaluru in 1991 (Srinivas 1997; Saxenian 2001)
Nucleation phase	1991–1996	• High speed data connection links (Kumar 2014); • MNCs of US and Europe setting up their different units of operations in Bengaluru (Balasubramanyam and Balasubramanyam 2002); • Establishment of Information Technology Park Limited (ITPL) in Bengaluru through a collaboration between India and Singapore (YEOH and David 2005)
Y2K boom and dot com bust phase	1996–1999	• Growth of comprehensive gamut of services, especially outsourcing services offered by IT companies in Bengaluru across the world (Saini 2019)
Peripheral agglomeration phase I	2000 -2008	• Investment in infrastructural facilities like peripheral ring road boosted the growth of the high-tech knowledge-based development between Electronic city and ITPL (Kalra 2006)
Peripheral agglomeration phase II	2008 - Present	• Decongestion strategy through development of new international airport to mobilise the concentration of companies (Hariharan and Biswas 2020a, b)

Source Compiled by authors from (Hariharan and Biswas 2020a, b)

5 Research Methodology

The study takes the help of temporal and consequential policy evaluation methodology to build the foundation of the research (Haralambos et al. 2013). It follows an integrated approach of qualitative and quantitative methods. The qualitative method allows gathering in-depth insights through participant observation, literature reviews and experiencing social reality, whereas the quantitative method enables analysing spatial data (Brannen 1992; Duffy and Chenail 2011). These study areas/clusters are
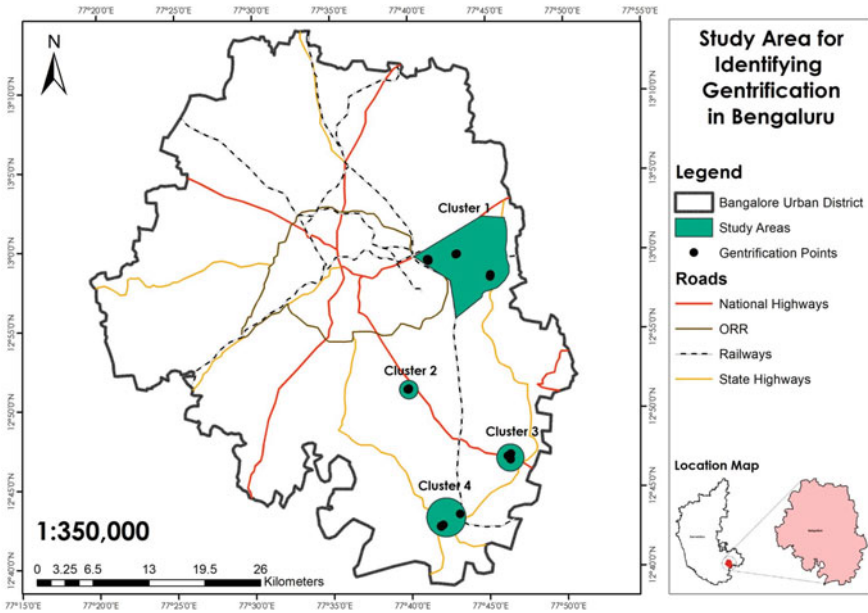
Fig. 8 Representation of Identified clusters in the study area

delineated based on three basic methods—reconnaissance survey, major transportation networks and direction of urban growth. Figure 8 exhibits these clusters in the BUD study area.

Many diverse fields, such as urban planning, landscape ecology, and urban modelling, have examined urban growth and development patterns extensively (Reis et al. 2015). Urban transformation such as gentrification can be described through analysing the spatial patterns of urban growth for a specific period (O'Sullivan 2002). The research uses pattern identification of different types of gentrifications through a patch based Cellular Automata model. Three patterns of gentrification are identified in the study area: new build, peripheral and rural. These patterns can be categorised according to their respective features, as mentioned in Table 1. New build gentrification is depicted by infilling type of pattern where new urban areas fill in the gaps between existing urban areas (Liu et al. 2010). The pattern of peripheral gentrification is demonstrated as an expansion of new urban areas towards the urban edge of existing urban areas as urban fringe development (Forman 1995; Liu, et al. 2012). Rural gentrification reflects the pattern of outlying character referring to minimum spatial connection with existing urban areas (Xu et al. 2007; Liu et al. 2010). The landuse/landcover data is procured from the USGS Earth explorer.[2] The temporal

---

[2] The United States Geological Survey (USGS) developed the EarthExplorer (EE) user interface, which allows users to search, browse, export metadata, and download data from satellite, aeroplane, and other remote sensing inventories online.

assessment of the remote sensing data for 2001, 2011 and 2021 are procured from the Landsat imageries.[3]

The major prospect of the study lies in the method of quantifying the pattern identification of urban growth. The study has adopted a patch-based method over a pixel-based method an many pixel-based analysis methods like Landuse-Landcover (LULC) classification examine each pixel's spectral characteristics of within a region of interest without taking into account any spatial or contextual information (Weih and Riggan 2010). The fast pace of urbanisation requires a method of analysis that can help identify the accurate pattern of urban growth (Lei et al. 2021). Many scholars have preferred patch-based analysis because of the growing number of clustered urban patches in a metropolitan area (Meentemeyer et al. 2013; Moghadam et al. 2018; Lei et al. 2021). A patch is a group of neighbouring cells representing a single land-use unit, but their attributes may differ (Wang and Marceau 2013). Landscape Expansion Index (LEI) has been utilised as a tool for patch-based analysis. It is critical to determine the neighbourhood rule that should be used to integrate pixels into patches. The study follows 8-cell neighbourhood or Moore neighbourhood rule that shares an edge or corner (Lei et al. 2021). LEI was proposed by Liu et al. (2010) where the classification process is based on the LEI in a buffer area around the new gentrified urban patches. The equation is as follows:

$$LEI = 100 \times A_0/(A_0 + A_v) \tag{1}$$

– LEI refers to Landscape Expansion Index of a new gentrified urban patch;
– A_0 is the intersection of existing urban patches and new gentrified urban patch's buffer area;
– A_v is the intersection of buffer area of the new gentrified patch and vacant land.

The following three rules have been followed for pattern identification of gentrified area.
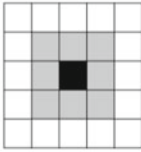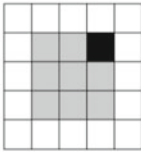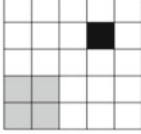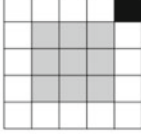
(1) When LEI is larger than 50, the buffer zone of a new urban patch intersects with an existing urban patch; thus, the new urban patch is classified with the infilling property. This has been categorised as newly-build gentrification.
(2) When the LEI ranges between 0 and 50, the buffer zone of the new urban patch intersects with vacant land and the existing urban patch. This intersecting pattern signifies the characteristics of an urban area's expansion and is categorised as peripheral gentrification.
(3) When the value of LEI equals to 0, the buffer zone of a new urban patch is only composed of vacant lands. In this case, the vacant land is assumed as agricultural land. The new urban patch is determined to have an outlying property and is categorised as rural gentrification.

Figure 9 visualises types of gentrification patterns identified in the study area as per the LEI-8 neighbourhood cell method. The study has deployed the "LEI tool"

[3] Satellite images used for 2001 is Landsat 5 (30 m), for 2011 and 2021 is Landsat 8 (30 m).

Fig. 9 Patterns of classification and gentrification identified in the study area

integrated with ArcGIS software and is available through the following website http:// www.geosimulation.cn/LEI.html. The spatio-temporal assessment of four identified clusters based on LEI is for two decadal periods i.e., from 2001–2011 to 2011–2021. Figure 10 summarises the detailed methodology and helps to understand the overall framework of the research.

6 Analysing the Pattern of Gentrification in Bengaluru and Findings

The major contribution of this research to quantify the spatial pattern of urban growth and integrating the growth with the gentrification process through LEI. The LEI assessment has been carried out in the identified four clusters. Total LEI counts for the decade 2001–2011 are 776, and 2011–2021 are 1412. Table 3 shows the number of counts for both decades. Figures 11, 12, 13 and 14 are the GIS-based visualisation of LEI in the identified four clusters for both decades.

Figure 15 represents the types of LEI classification for both decades. The assessment highlights a rapid incremental phenomenon of peripheral gentrification in
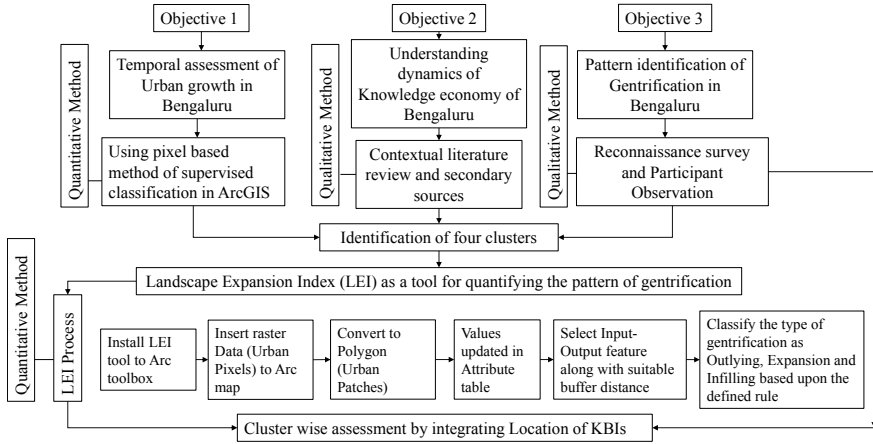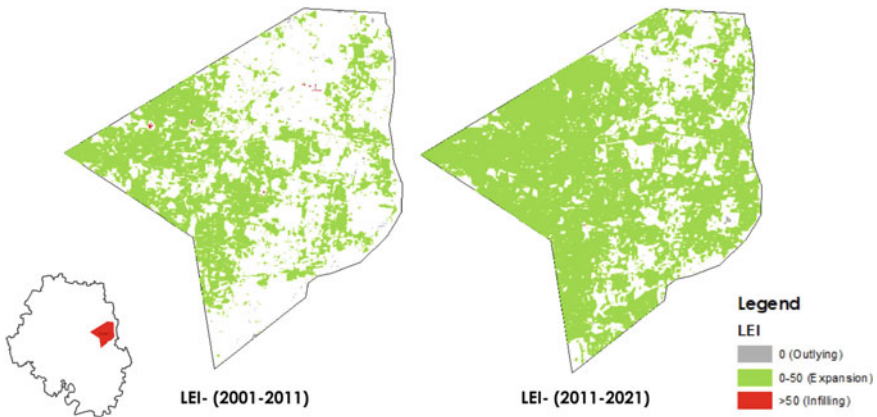
Fig. 10 Detailed research methodology

Table 3 Numbers of counts for LEI for different type of classification

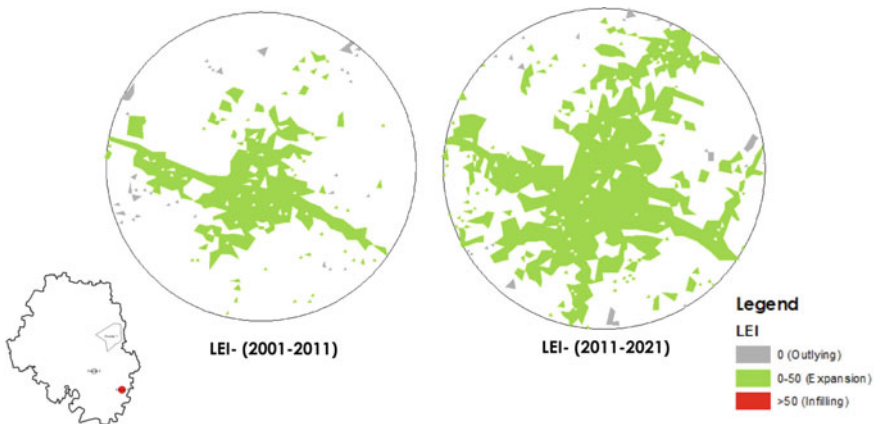| Clusters	Outlying		Expansion		Infilling	
	2001–2011	2011–2021	2001–2011	2011–2021	2001–2011	2011–2021
Cluster 1	16	106	359	964	19	22
Cluster 2	0	0	12	27	1	9
Cluster 3	21	33	85	52	0	0
Cluster 4	37	64	225	135	1	0
Total	74	203	681	1178	21	31

Source Compiled by authors

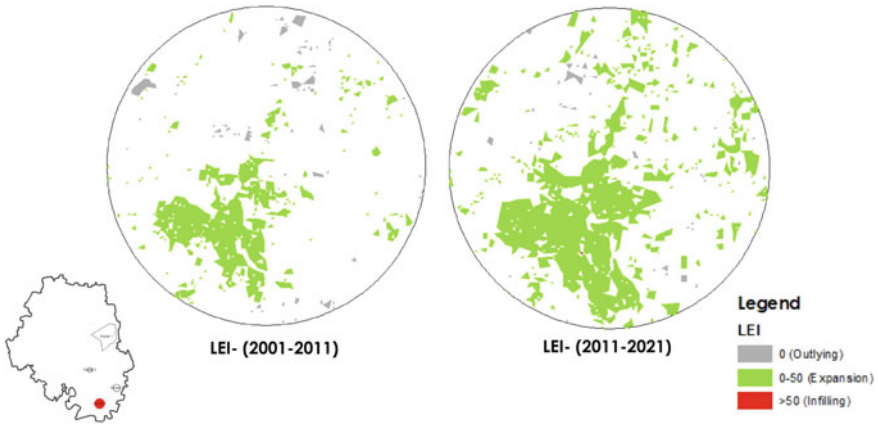**Fig. 11** Landscape expansion index (LEI) assessment in Cluster 1

**Fig. 12** Landscape expansion index (LEI) assessment in Cluster 2

Fig. 13 Landscape expansion index (LEI) assessment in Cluster 3

cluster 1 and cluster 2. The infilling type of classification is least in all the clusters and insignificant in clusters 3 and 4. The majority of new urban patches intersecting with existing urban patches are present in clusters 1 and 2. The outlying classification is observed highest in cluster 1 and none in cluster 2. In clusters 3 and 4, the outlying classification is increasing, and the expansion classification is decreasing.

The interpretative approach through social survey and participant observation has helped to identify the gentrification locations. Table 4 demonstrates the gentrification locations in the identified clusters located in the Eastern and Southern areas of BUD. These clusters accommodate most of Bengaluru's Knowledge based industries (KBIs). Figure 16 demonstrates the temporal evolution for the year (1994–1995, 2003–2004 and 2014–2015) of major KBIs in all the four clusters. The detailed cluster wise map is presented in Fig. 17a, b. 64% of KBIs in the selected clusters

Fig. 14 Landscape expansion index (LEI) assessment in Cluster 4
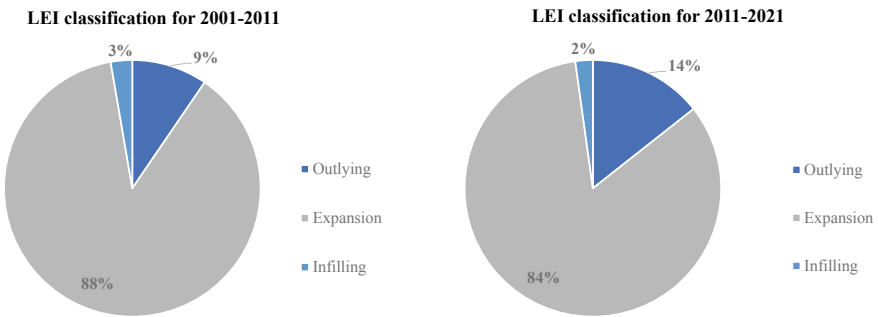
Fig. 15 Temporal comparison of LEI for the period 2001–2011 and 2011–2021

Table 4 Gentrification locations in identified Clusters for research in the study area

Cluster no.	Major gentrification locations	Phase of development
Cluster 1	Mahadevpura, Hoodi and Whitefield	Nucleation phase, Peripheral agglomeration I and Peripheral agglomeration II
Cluster 2	Electronic city	Initial phase, Nucleation phase
Cluster 3	Attibele	Peripheral agglomeration II
Cluster 4	Anekal	Peripheral agglomeration II

Source Compiled by authors

were established during the phase of Peripheral agglomeration II. Most of the KBIs are present in cluster 1 due to ITPL and other technology parks like Salarpuria G R tech park, Sigma soft tech park, Divyashree techno park in Whitefield and Bagmane tech park and Bhoruka park in Mahadevpura, respectively.
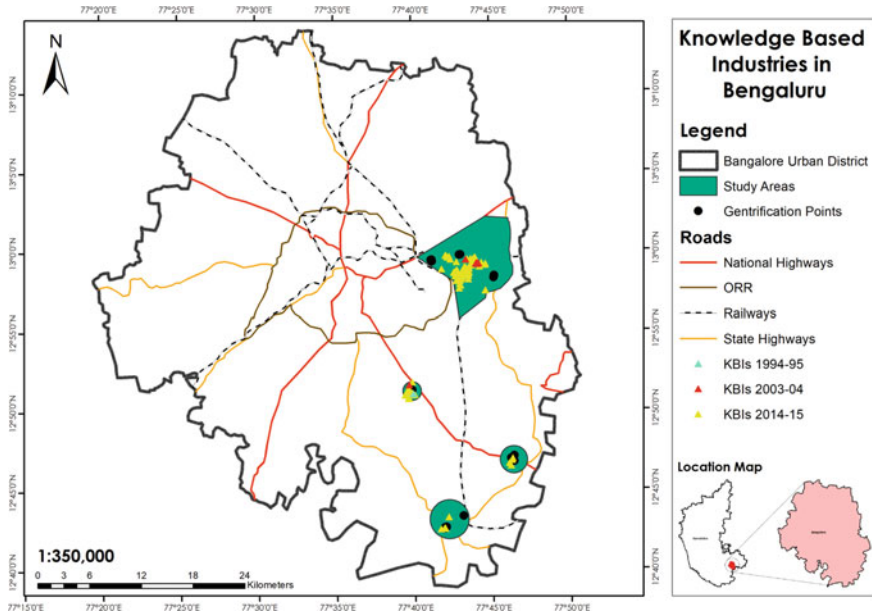
Fig. 16   Spatio-temporal evolution of KBIs in identified clusters

The gentrification process is witnessed at many locations of Bengaluru during the reconnaissance survey. The illustrations in Figs. 18 and 19 capture the ground situation of Clusters 1, 2, 3 and 4. In cluster 1, the gentrification pattern in Mahadevpura is an example of new build typology, whereas the gentrification pattern in Hoodi and Whitefield display the peripheral pattern. The peripheral gentrification in these areas is characterised by the development of high-rise apartments and the transformation of low-density areas into high density zones. In some areas, the traditional neighbourhoods are also transforming by mid-rise apartments, developed jointly by real estate developers and the plot owners.

The gentrification pattern in cluster 2 represents peripheral gentrification where urban expansion is happening on the edges. In Attibele in Cluster 3, rural gentrification is observed where multi-storeyed buildings are being developed on agricultural lands. In Anekal, in cluster 3, the gentrification pattern represents peripheral typology, with a characteristic of plotted development. The LEI confirms the conversion of more agricultural land to residential purposes in clusters 3 and 4. The analysis further emphasises that few of the new urban patches intersected with the existing urban patches in cluster 1. It reflects the lack of developable land availability in this cluster. The Electronic city and Whitefield are recognised as the software hub of Bengaluru, and these localities are amongst the most preferred locations for the knowledge workers (Sheikh et al. 2017).
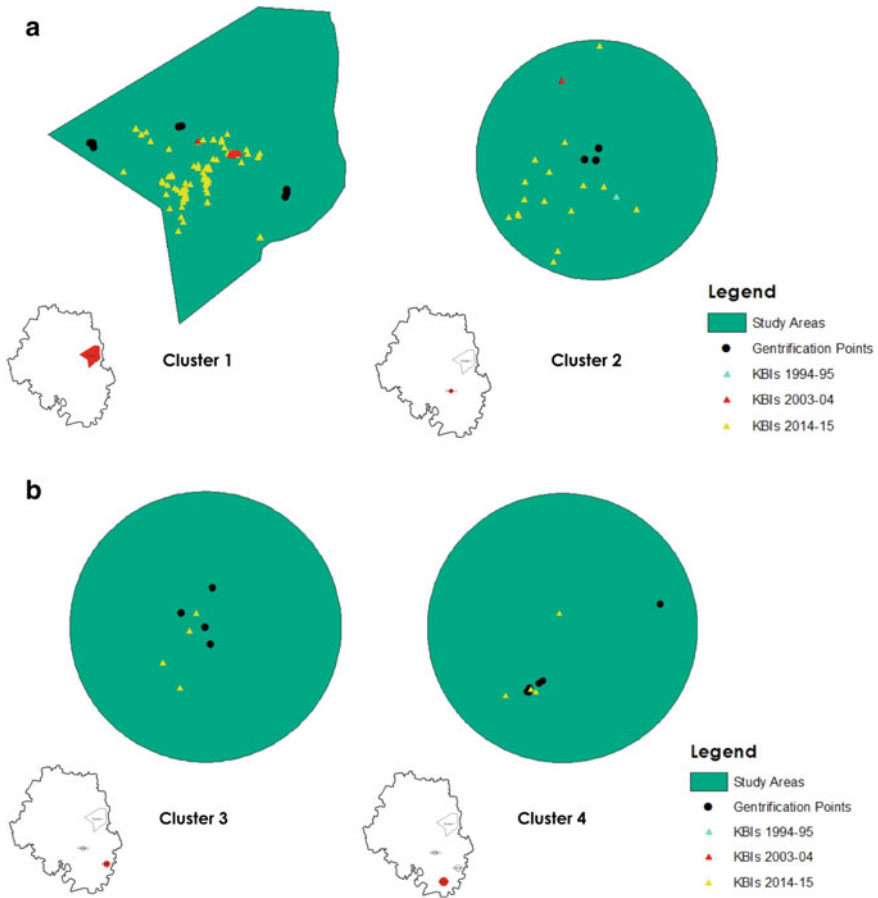
Fig. 17 **a** Spatio-temporal evolution of KBIs in Cluster 1 and Cluster 2; **b** Spatio-temporal evolution of KBIs in cluster 3 and cluster 4

The state government and private enterprises are continuously investing in the city's peripheral areas, fuelling the increasing residential supply and thus aggravating the gentrification process. When original residents are forced to leave their neighbourhood due to a drastic increase in property values, coercion, or buyouts, gentrification becomes a problem. Low-income neighbourhoods in Bengaluru are frequently being transformed into high-end neighbourhoods with housing alternatives such as high-rise apartments. This transformation leads to other types of gentrifications, transforming residential areas to cafés, apparel stores, large chain stores and restaurants, recognised as "commercial gentrification", causing skyrocketing rents and socio-cultural conflicts in residential neighbourhoods (Jeong et al. 2015; Ryu et al. 2020). There has been an increase of 50.9% pubs in Bengaluru from 2014 to 2018 (Shruthi 2018).
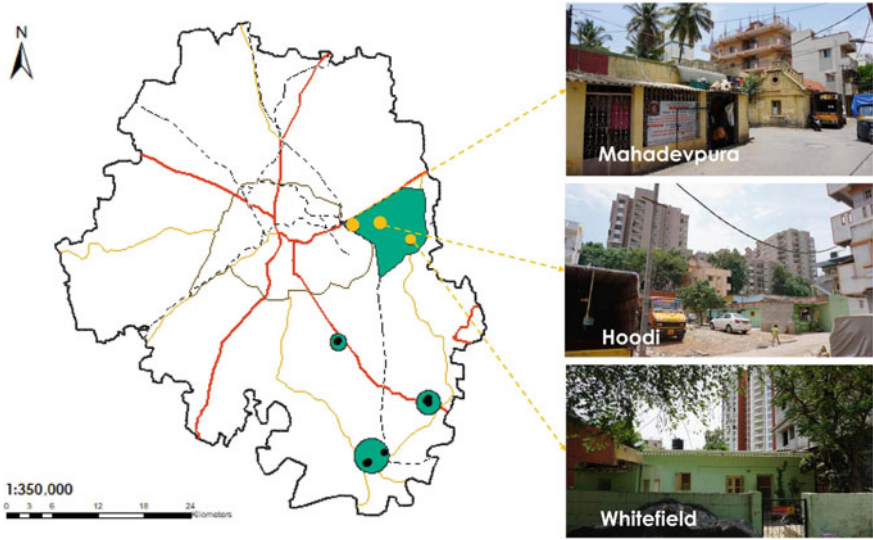
Fig. 18 Gentrified points in Cluster 1

Fig. 19 Gentrified points in Cluster 2, Cluster 3, Cluster 4

7 Conclusion

The latest tides of knowledge driven development have intrinsically transformed the urban morphology of many cities. A basic approach has been adopted in the present

study to reflect the urban morphology of Bengaluru city by describing the patterns of landuse to understand a multitude of choices and decisions about locational attributes. Investigation of the knowledge economy in Bengaluru deciphered the genesis of Bengaluru as a knowledge city and factor attributing to its global recognition of being India's Silicon Valley, Global outsourcing city and fastest growing tech hub (Economic Times 2021). Bengaluru has not only witnessed influx of human capital and knowledge-based industries but is also continuously undergoing structural and spatial rearrangement, especially in the patterns, functions, densities and layouts of its neighbourhoods.

Temporal assessment of the urban growth pattern highlighted that the present growth direction of the city is towards the North, following the new Bengaluru international airport. However, the peripheral agglomeration is not visible between the Bengaluru international airport and ITPL. The growth direction in the previous decade was mainly towards the South-Eastern part of the city, between electronic city and ITPL. The over-saturation of the area also led many KBIs to locate their offices in Hyderabad (Hariharan and Biswas 2020a, b).

Bengaluru has still a very strong geographical inertia for attracting economic growth factors based on a study of its knowledge-based industries (Hariharan and Biswas 2020a, b). The advent of gentrification in Bengaluru is primarily influenced due to the drastic demographic change in the last three decades. These changes are attributed to the influx of human capital employed in knowledge-based industries in the city (Sen 2014; Asian Cities 2017). A high volume of human capital into the city from across the country and globe upscale its residential demand and capacity. The first and second phases of peripheral agglomeration witnessed maximum development in the knowledge economy as many technology parks emerged.

This chapter is an assessment of the patterns of gentrification influenced by knowledge-based industries in Bengaluru. 83% of the highlighted gentrified area are based on the feature of expansion or peripheral gentrification. Most of the peripheral agglomeration is witnessed in Cluster 1 constituting the neighbourhoods of Whitefield, Mahadevpura and Hoodi. Increasing percentage of rural gentrification in the study area re-emphasises on the rapid urban transformation of nearby rural areas. Infilling or new build construction were primarily witnessed in Cluster 1 and Cluster 2. The scope of new urban patches withing the existing urban areas are mostly based on the characteristic of reconstruction or redevelopment as many real estate projects for high rise buildings have been observed in cluster 1 and cluster 2. Electronic city became the focal arena of knowledge-based industries in the initial phase that catered to the economic foundations for many rural areas in proximity through cluster orientation. Anekal's and Attibele's huge housing market potential and availability of land for local clusters and support the core knowledge based industrial clusters to be more productive.

Landscape expansion index strives to be very useful tool to assess the spatial segregation based on the principle of patch based landuse classification. Further study on the impact of gentrification in the neighbourhoods of Bengaluru city can be

carried forward to evaluate the relationship of growth dependent variable and socio-economic performance. This will enrich with major frontiers to balance development and socio-economic inequalities for an improved regional landscape.

References

Accel Partners (2019) Bengaluru innovation report. Research, Bengaluru, Accel Partners, 3one4 Capital, IdeaSpring Capital

Annaswamy TV (2003) Bengaluru to Bangalore: urban history of Bangalore from the pre-historic period to the end of 18th century. Vengadam Publications, Bengaluru

Asian Cities (2017) Gentrification—inescapable in economic development? https://asiancities2017.wordpress.com/2017/02/13/gentrification-inescapable-in-economic-development/. Accessed 31 July 2021

Asian Development Bank (2007) Moving toward knowledge based economies: Asian experiences. Asian Development Bank, Mnaila

Atuesta LH, Hewings GJD (2019) Housing appreciation patterns in low-income neighborhoods: exploring gentrification in Chicago. J Hous Econ 44:35–47. https://doi.org/10.1016/j.jhe.2018.08.005

Autor D, Levy F, Murnane RJ (2003) The skill content of recent technological change: an empirical exploration. Q J Econ 118(4):1279–1333. https://doi.org/10.1162/003355303322552801

Balasubramanyam VN, Balasubramanyam A (2002) The software cluster in Bangalore. In: Dunning JH (ed) Regions, globalisation, and the knowledge economy. pp 349–363. https://doi.org/10.1093/0199250014.003.0014

Basant R (2006) Bangalore cluster: evolution, growth and challenges. Working Paper, Ahmedabad. Indian Institute of Management, Ahmedabad

Bengaluru Development Authority (2005) Bengaluru master plan 2015. Bengaluru Development Authority, Master Plan, Bengaluru

Bengaluru Development Authority (2017) Revised master plan for Bengaluru 2031. Bengaluru Development Authority, Master Plan, Bengaluru

Bevilacqua C, Pizzimenti P, Maione C (2017) S3: cluster policy and spatial-planning. Knowledge dynamics, spatial dimension and entrepreneurial discovery process. Scientific report MAPS-LED Project. MAPS-LED Project – Horizon 2020, Boston

Bounfour A, Edivinsson L (2006) Intellectual capital for communities: nations, regions, and cities. Butterworth-Heinemann, Boston

Brannen J (1992) Mixing methods: qualitative and quantitative research. Routledge, London. https://doi.org/10.4324/9781315248813

Bridge G, Butler T, Lees L (2012) Mixed communities—gentrification by stealth? Policy Press, Bristol

Britton M (2017) Global cities—the changing hierarchy. Oxford Economics, Research, Oxford

Burnett KE (2014) Commodifying poverty: gentrification and consumption in Vancouver's Downtown Eastside. Urban Geogr 35(2):157–176. https://doi.org/10.1080/02723638.2013.867669

Cappellin R (2007) The territorial dimension of the knowledge economy—collective learning, spatial changes, and regional and urban policies. Am Behav Sci 50(7):897–921

Carrillo FJ (2004) Capital cities: a taxonomy of capital accounts for knowledge cities. J Knowl Manag 8(5):28–46. https://doi.org/10.1108/1367327041058738

Carrillo FJ (2011) Knowledge cities—approaches, experiences and perspectives. Routledge, New York

Castells M (1989) The informational city. Information technology, economic restructuring, and the urban-regional process. Blackwell Publishers, Oxford

Census of India (2011) Migration Tables. Office of the Registrar General & Census Commissioner, New Delhi, India

Chapple K, Sideris AL, González SR, Kadin D, Poirier J (2017) Transit-Oriented Development & Commercial Gentrification: TOD Study. UC CONNECT, Los Angeles

Chatterji T (2014) Local mediation of global forces in transformation of the urban fringe. LAP LAMBERT Academic, Germany

Cho W, Kim M, Kim H, Kwon Y (2020) Transforming housing to commercial use: a case study on commercial gentrification in Yeon-nam District, Seoul. Sustainability 12:1–17. https://doi.org/10.3390/su12104322

Cohen M (1983) San Francisco's neighborhood commercial special use district ordinance: an innovative approach to commercial gentrification. Golden Gate University Law Review, pp 367–397

Davidson M, Loretta L (2005) New-build 'gentrification' and London's riverside renaissance. Environ Plan 37:1165. https://doi.org/10.1068/a3739

Davoudi S (2003) Polycentricity in European spatial planning: from an analytical tool to a normative agenda. Eur Plan Stud 11(8):979–999. https://doi.org/10.1080/0965431032000146169

Den Hertog P, Bergman E, Remoe S (2001) Innovative clusters: drivers of national innovation systems (enterprise, industry and services). OECD, Paris

Dezan Shira & Associates (2019) Bangalore: economy, industries, and infrastructure. https://www.india-briefing.com/news/city-spotlight-bangalore-6371.html/

Dharma A, Gupta N, Makkar A, Madan M, Tiwari A (2020) Global capability centres (GCCs) pulse survey 2020—driving the transformation agenda. Summary form. Ernst & Young LLP, New Delhi

Drucker PF (1992) The age of discontinuity, 2nd edn. Routledge, New York

Duffy M, Chenail RJ (2011) Values in qualitative and quantitative research. Couns Values 22–38. https://doi.org/10.1002/j.2161-007X.2009.tb00111.x

Dvir R (2005) Knowledge city, seen as a collage of human knowledge moments. In: Carrillo FJ (ed) Knowledge cities: approaches, experiences, and perspectives. Butterworth-Heinemann, Burlington, pp 245–272

Economic Times (2021) Bengaluru world's fastest growing tech hub, London second: Report. https://economictimes.indiatimes.com/tech/technology/bengaluru-worlds-fastest-growing-tech-hub-london-second-report/articleshow/80263653.cms?from=mdr. Accessed 29 Jul 2021

Edlund L, Machado C, Sviatschi M (2015) Bright minds, big rent: gentrification and the rising returns to skill. Institute for the Study of Labor, Bonn

Ergazakis K, Metaxiotis K, Psarras J (2006). An emerging pattern of successful knowledge cities' main features. In: Carrillo FJ (ed) Knowledge cities—approaches, experiences, and perspectives. Taylor & Francis, New York, pp 3–15

Feldman M, Francis J, Bercovitz J (2005) Creating a cluster while building a firm: entrepreneurs and the formation of industrial clusters. Reg Stud 39(1):129–141. https://doi.org/10.1080/0034340052000320888

Florida R (2002) The rise of creative class and how its transforming work, leisure, community & everyday life. Basic Books, New York

Florida R (2003) Entrepreneurship, creativity and regional economic growth. In: Hart DM (ed) The emergence of entrepreneurship policy: governance, start-ups, and growth. Cambridge University Press, Cambridge, pp 39–60

Forman RT (1995) Land mosaics: the ecology of landscapes and regions. Cambridge University Press, Cambridge

Ghosh M, Amaresha M (2020) Comparative analysis of price trends of residential real estate properties in Bangalore. Int J Commer Manag Res 70–73

Glaeser EL, Resseger M, Tobio K (2009) Inequality in cities. J Reg Sci 49(4). https://doi.org/10.1111/j.1467-9787.2009.00627.x

Glass R (1964) London: aspects of change. MacGibbon & Kee, London

Gotham KF (2005) Tourism gentrification: the case of New Orleans' Vieux Carre (French Quarter). Urban Stud 42(7):1099–1121. https://doi.org/10.1080/00420980500120881

Hackworth J, Rekers J (2005) Ethnic packaging and gentrification: the case of four neighborhoods in Toronto. Urban Aff Rev 41:211–236. https://doi.org/10.1177/1078087405280859

Hall P, Pain K (2006) The polycentric metropolis: learning from mega-city regions in Europe. Earthscan, London

Haralambos M, Holborn M, Chapman S, Moore S (2013) Sociology themes and perspectives, 8th edn. Collins, London

Hariharan AN, Biswas A (2020a) A critical review of the Indian knowledge based industry location policy against its theoretical arguments. Reg Sci Policy Pract 431–454

Hariharan AN, Biswas A (2020b) Global recognition of India's knowledge based industry evolution through empirical analysis. J Knowl Econ. https://doi.org/10.1007/s13132-020-00673-x

Hoyler M (2011) External relations of German cities through intra-firm networks—a global perspective. Raumforsch Raumordn 69:147–159. https://doi.org/10.1007/s13147-011-0100-8

Isaksen A (2006) Knowledge-based clusters and urban location: the clustering of software consultancy in Oslo. In: Cumbers A, MacKinnon D (eds) Clusters in urban and regional development. Routledge, New York, 187–204

Jeong Y, Heo J, Jung C (2015) Behind the bustling street: commercial gentrification of Gyeongridan, Seoul. Procedia Soc Behav Sci 170:146–154. https://doi.org/10.1016/j.sbspro.2015.01.024

Kalra R (2006) High technology and urban development in Bangalore, India. In: Gatrell JD, Reid N (eds) Enterprising worlds. The GeoJournal Library, Dordrecht, pp 71–81

Kamath S (1990) Chapter 2—History. In: Karnataka state gazetteer: Bangalore district, by Karnataka Gazatteer Department. Government of Karnataka, Bengaluru, pp 49–122

Kar SM (2016) Locating Bengaluru as India's Silicon valley. Artha J Soc Sci 15(2):49–68. https://doi.org/10.12724/ajss.37.3

Kelly J (2017) These are the most dynamic cities in the world—and they're not the ones you'd expect. https://www.weforum.org/agenda/2017/01/these-are-the-most-dynamic-cities-in-the-world-and-they-re-not-the-ones-you-d-expect. Accessed 4 July 2021

Kennedy M, Leonard P (2001) Dealing with neighbourhood change: a primer on gentrification and policy choices. The Brookings Institution Centre for Urban and Metropolitan Policy, Berkeley, CA

Komninos N (2002) Intelligent cities—innovation, knowledge, systems and digital spaces. Spon Press, New York

Kosta EB (2019) Commercial gentrification indexes: using business directories to map urban change at the street level. City Community 18(4):1101–1122. https://doi.org/10.1111/cico.12468

Krauss G, Stahlecker T (2001) New biotechnology firms in Germany: Heidelberg and the BioRegion Rhine-Neckar triangle. Small Bus Econ 17:143–153. https://doi.org/10.1023/A:1011145615243

Krugman P (1991) Geography and trade. MIT Press, Cambridge, MA

Kumar N (2014) Chapter 5—National Innovation Systems and the Indian Software Industry Development. In: Shyama V, Ramani (ed) Innovation in India—combing economic growth with inclusive development. Cambridge University Press, New Delhi, pp 143–185. https://doi.org/10.1017/CBO9781139794640.006

Lees L (1994) Gentrification in London and New York: an Atlantic gap? Hous Stud 9(2):199–217

Lees L, Slater T, Wyly E (2008) Gentrification. Routledge, London, UK

Lei Y, Flacke J, Schwarz N (2021) Does Urban planning affect urban growth pattern? A case study of Shenzhen, China. Lans Use Policy 101:1–13. https://doi.org/10.1016/j.landusepol.2020.105100

Ley D (1986) Alternative explanations for inner-city gentrification: a Canadian assessment. Ann Assoc Am Geogr 76(4):521–535

Liu X, Li X, Chen Y, Tan Z, Li S (2010) A new landscape index for quantifying urban expansion using multi-temporal remotely sensed data. Landsc Ecol 25:671–682. https://doi.org/10.1007/s10980-010-9454-5

Liu X, Ma L, Ai B, Li S, He Z (2012) Simulating urban growth by integrating landscape expansion index (LEI) and cellular automata. Int J Geogr Inf Sci 148–163. https://doi.org/10.1080/13658816.2013.831097

London B, Palen J (1984) Gentrification and neighbourhood revitalization. State University of New York Press, Albany, NY

Luthi S, Thierstein A, Bentlage M (2012) The relational geography of the knowledge economy in Germany: on functional urban hierarchies and localised value chain systems. Urban Stud 50(2):276–293. https://doi.org/10.1177/0042098012452325

Maillat D (1995) Territorial dynamic, innovative milieus and regional policy. Entrepeneurship Reg Dev Int J 7(2):157–165. https://doi.org/10.1080/08985629500000010

Maillat D (1998) From the industrial district to the innovative milieu: contribution to an analysis of territorialised productive organisations. Louvain Econ Rev 64(1):111–129

Manimala MJ (2006) Evolution of the Bangalore ICT cluster: the 'Crystal Growth' model. Ind High Educ 20:249–255. https://doi.org/10.5367/000000006778175775

Manimala MJ (2017) Bangalore: development through intercultural interaction. In: Piero (ed) Entrepreneurial renaissance—cities striving towards an era of rebirth and revival. Formica, Springer, pp 57–80

Mattar NA, Thierstein A, Förster A (2014) "Alternative futures": a methodology for integrated sustainability considerations, the case of Nuremberg West, Germany. Local Environ 19(6):677–701. https://doi.org/10.1080/13549839.2013.841135

McKinnish T, Walsh R, Kirk White T (2010) Who gentrifies low-income neighborhoods? J Urban Econ 67(2):180–193. https://doi.org/10.1016/j.jue.2009.08.003

Meentemeyer RK, Tang WW, Dorning MA, Vogler JB, Cunniffe NJ, Shoemaker DA (2013) FUTURES: multilevel simulations of emerging urban–rural landscape structure using a stochastic patch-growing algorithm. Ann Assoc Am Geogr 103:785–807

Meltzar R, Ghorbani P (2017) Does gentrification increase employment opportunities in low-income neighborhoods? Reg Sci Urban Econ 66:52–73. https://doi.org/10.1016/j.regsciurbeco.2017.06.002

Moghadam SA, Karimi M, Habibi K (2018) Simulating urban growth in a megalopolitan area using a patch-based cellular automata. In: Transactions in GIS. Wiley, pp 1–20. https://doi.org/10.1111/tgis.12309

Moos M, Revington N, Wilkin T, Andrey J (2018) To knowledge economy city: gentrification, studentification and youthification, and their connections to universities. Urban Stud 1–18

Morisson A, Bevilacqua C (2019) Balancing gentrification in the knowledge economy: the case of Chattanooga's innovation district. Urban Res Pract 12(4):472–492. https://doi.org/10.1080/17535069.2018.1472799

Nagendra H, Unnikrishnan H, Sen S (2014) Villages in the city: spatial and temporal heterogeneity in rurality and urbanity in Bangalore, India. Land 3:1–18. https://doi.org/10.3390/land3010001

O'Sullivan D (2002) Toward micro-scale spatial modeling of gentrification. J Geogr Syst 4:251–274. https://doi.org/10.1007/s101090200086

ODI (2009) Tools for policy impact. Overseas Development Institute, London

OECD (1996) The knowledge based economy. Organisation for Economic Co-operation and Development, Paris

Ong PM, Pech C, Ray R (2014) TOD impacts on businesses in Four Asian American neighbourhoods. UCLA Centre for the study of Inequality, UCLA TOD Study, Los Angeles

Van Oort FG (2003) Urban growth and innovation: spatially bounded externalities in the Netherlands. Ashgate Pub Ltd., London

Pabari S, Supriyo C, Ankur B (2021) Global capability centres (GCCs)—driving manufacturing innovations at scale. Research Report, Deloitte, New Delhi

Pani N, Radhakrishna S, Bhat KG (2010) Bengaluru, Bangalore, Bengaluru: imaginations and their times. Sage Publications India Pvt Ltd., New Delhi

Paul R, Kenway S, McIntosh B, Mukheibir P (2018) Urban metabolism of Bangalore City—a water mass balance analysis. J Indus Ecol 22(6):1413–1424. https://doi.org/10.1111/jiec.12705

Penco L (2013) The development of the successful city in the knowledge economy: toward the dual role of consumer hub and knowledge hub. J Knowl Econ. https://doi.org/10.1007/s13132-013-0149-4

Philips M (1993) Rural gentrification and the processes of class colonisation. J Rural Stud 9(2):123–140. https://doi.org/10.1016/0743-0167(93)90026-G

Plechero M, Kulkarni M, Chaminade C, Parthasarathy B (2020) Explaining the past, predicting the future: the influence of regional trajectories on innovation networks of new industries in emerging economies. Indus Innov. https://doi.org/10.1080/13662716.2020.1780419

Porter ME (1990) The competitive advantage of nations. Macmillan Press, London

Porter ME (1998) Clusters and the new economics of competition. Harward Business Review

Porter ME (2000) Location, competition, and economic development: local clusters in a global economy. Econ Dev Q 15–34

Raman A (1994) Bangalore-Mysore. Orient Longman Limited, Chennai

Raspe O, Van Oort F (2006) The knowledge economy and urban economic growth. Eur Plan Stud 14(9):1209–1233. https://doi.org/10.1080/09654310600933322

Registrar General and Census Commissioner of India (2011) Urban agglomeration and cities—census of India. Registrar General and Census Commissioner of India, Census, New Delhi

Reis JP, Silva EA, Pinho P (2015) Spatial metrics to study urban patterns in growing and shrinking cities. Urban Geogr 37:246–271. https://doi.org/10.1080/02723638.2015.1096118

Rerat P, Soderstrom O, Piguet E, Besson R (2010) From urban wastelands to new-build gentrification: the case of Swiss Cities. Popul Space Place 16:429–442. https://doi.org/10.1002/psp.595

Richardson J, Mitchell B, Franco J (2019) Shifting neighbourhoods: gentrification and cultural displacement in American Cities. Research Report, National Community Reinvestment Coalition, Washington D.C.

Ryu H, Kim D, Park J (2020) Characteristics analysis of commercial gentrification in Seoul focusing on the vitalization of streets in residential areas. Sustainability 12(21). https://doi.org/10.3390/su12218877

Saini J (2019) Y2K bug: how a bug helped India strengthen its IT Sector. https://medium.com/@jessicasaini/y2k-how-a-bug-helped-india-strengthen-its-it-sector-4753000be4bf. Accessed 29 July 2021

Saxenian AL (1983) The urban contradictions of Silicon Valley: regional growth and the restructuring of the semiconductor industry. Int J Urban Reg Res 7(2):237–262. https://doi.org/10.1111/j.1468-2427.1983.tb00592.x

Saxenian A (2001) Bangalore: the Silicon Valley of Asia? Working Paper no 91. Stanford University, Stanford

Schneider A, Woodcock CE (2008) Compact, dispersed, fragmented, extensive? A comparison of urban growth in twenty-five global cities using remotely sensed data, pattern metrics and census information. Urban Stud 45(3):659–692. https://doi.org/10.1177/0042098007087340

Schumpeter JA (1947) Capitalism, socialism and democracy. Routledge Classics, New York

Sen P (2013) Changing urban traits—a study of Bengaluru urban agglomeration, India. Asian Soc Sci 9(1):122–129. https://doi.org/10.5539/ass.v9n1p122

Sen P (2014) Suburbanisation and gentrification in Sathanuru satellite township, Bengaluru—an ultimate dilemma. Afro Asian J Soc Sci 1–10. https://www.theguardian.com/global-development/gallery/2012/apr/06/india-technology-not-helping-poor-in-pictures

Sengupta S (2010) The Bangalore story: the outsourcing capital of the world. Tholons, New York

Seo J-K (2002) Re-urbanisation in regenerated areas of Manchester and Glasgow: new residents and the problems of sustainability. Cities 19(2):113–121. https://doi.org/10.1016/S0264-2751(02)00006-9

Shaw A, Satish MK (2007) Metropolitan restructuring in post-liberalized India: separating the global and the local. Cities 24(2):148–163. https://doi.org/10.1016/j.cities.2006.02.001

Sheikh W, Dash M, Sharma K (2017) Trends in residential market in Bangalore, India. PRiMa Pract Res Mark 1–9. https://doi.org/10.13140/RG.2.2.33967.89768

Shruthi HM (2018) Bengaluru sees 50% increase in pubs in four years. https://www.thehindu.com/news/cities/bangalore/bengaluru-sees-50-increase-in-pubs-in-four-years/article24490251.ece. Accessed 29 July 2021

Smith N (1996) The new urban frontier: gentrification and the Revanchist City. Routledge, London and New York

Spencer GM, Vinodrai T, Gertler MS, Wolfe D (2010) Do clusters make a difference? Defining and assessing their economic performance. Reg Stud 44(6):697–715. https://doi.org/10.1080/00343400903107736

Srinivas S (1997) Urban development and the information technology industry: a study of Bangalore, India. UCL Press, London

Stehlin J (2015) The post-industrial "shop floor": emerging forms of gentrification in San Francisco's innovation economy. Antipode 48(2):474–493. https://doi.org/10.1111/anti.12199

Subrahmanya MHB (2017) How did Bangalore emerge as a global hub of tech start-ups in India? Entrepreneurial ecosystem—evolution, structure and role. J Dev Entrep (World Scientific Publishing Company) 22(1):22. https://doi.org/10.1142/S1084946717500066

Subrahmanya, M H Bala. 2019. Bangalore: a vibrant and dynamic Indian city with an uncertain future? https://www.urbanet.info/bangalore-economic-development/. Accessed 4 July 2021

Sudhira H, Ramachandra T, Subramanya MB (2007) City profile: Bangalore. Int J Urban Policy Plan 379–390

Sullivan DM (2014) From food desert to food mirage: race, social class, and food shopping in a gentrifying neighborhood. Adv Appl Sociol 4(1):30–35. https://doi.org/10.4236/aasoci.2014.41006

Tallmann S, Jenkins M, Henry N, Pinch S (2004) Knowledge, clusters, and competitive advantage. Acad Manag Rev 29(2):258–271

Taubenböck H, Wegmann M, Roth A, Mehl H (2009) Urbanization in India—spatiotemporal analysis using remote sensing data. Comput Environ Urban Syst 33(3):179–188. https://doi.org/10.1016/j.compenvurbsys.2008.09.003

The Hindu (2018) Bengaluru has the highest number of colleges in the country. https://www.thehindu.com/news/cities/bangalore/bengaluru-has-the-highest-number-of-colleges-in-the-country/article24648141.ece. Accessed 27 July 2021

Trippl M, Bergman EM (2014) Clusters, local districts, and innovative milieux. In: Fischer M, Nijkamp P (eds) Handbook of regional science. Springer, Berlin, Heidelberg, pp 439–456. https://doi.org/10.1007/978-3-642-23430-9_26

Uitermark J, Duyvendak JW (2007) Gentrification as a governmental strategy: social control and social cohesion in Hoogvliet, Rotterdam. Environ Plan A 39:125–141. https://doi.org/10.1068/a39142

Verma S, Chatterjee, Mandal NK (2017) Analysing urban sprawl and shifting of urban growth centre of Bengaluru City, India using Shannon's Entropy Method. J Settl Spat Plan 8(2):89–98. https://doi.org/10.24193/JSSP.2017.2.02

Wang F, Marceau DJ (2013) A patch-based cellular automaton for simulating land-use changes at fine spatial resolution. Trans GIS 17(8):828–846. https://doi.org/10.1111/tgis.12009

Weih RC, Riggan ND (2010) Object based classification vs Pixel based classification: comparative importance of Multi-resolution imagery. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XXXVIII-4/C7

World Bank (2007) Building knowledge economies: advanced strategies for development. World Bank, Washington DC

Xu C, Zhang C, An S, Yu W, Chen JM (2007) The spatiotemporal dynamics of rapid urban growth in the Nanjing metropolitan region of China. Landsc Ecol 22:925–937. https://doi.org/10.1007/s10980-007-9079-5

YEOH C, David D (2005) The Singapore edge in India's Silicon valley: new insights? In: Proceedings of the Pan-Pacific conference XII 2005. Research Collection Lee Kong Chian School of Business, Singapore, pp 438–440

Yoon Y, Park J (2018) Stage classification and characteristics analysis of commercial gentrification in Seoul. Sustainability 10(7). https://doi.org/10.3390/su10072440
Zukin S, Trujillo V, Frase P, Jackson D, Recuber T, Walker A (2009) New retail capital and neighborhood change: boutiques and gentrification in New York City. City Community 8(1):47–64. https://doi.org/10.1111/j.1540-6040.2009.01269.x