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IDENTIFICATION OF INDICES TO QUANTIFY GENTRIFICATION

By A. X. Sophy and A. Lakshmi

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ABSTRACT

Gentrification is the process of altering a neighborhood's character through the influx of wealthier people and establishments. The research papers compiled in this issue concentrate on the new gentrification discussions, the rising residential allure of central cities, and the indices to measure this process according to its various varieties. This study aims to address a noticeable research gap in gentrification studies, specifically the need for a comprehensive set of indices to assess gentrification within a particular geographical area. Studies on gentrification that contain maps of historical change based on the identified indicators will aid in producing displacement risk maps, which will guide future interventions by allowing residents and policymakers to extrapolate into the future. Additionally, these maps give locals a glimpse into the future of their communities and serve as a political call to action in areas where residents are expected to be displaced. This study intends to pinpoint parameters and methods for measuring gentrification that can then be applied to create a spatiotemporal map of a region and tactics for its inclusive planning. An understanding of various approaches will enable planners and policymakers to select the best approach and create the appropriate plans

KEY WORDS Gentrification, quantification, indices, methods

Sophy Ann Xavier: M. Planning (Housing), Department of Architecture and Planning, College of Engineering Trivandrum, Thiruvananthapuram
Lakshmi A: Assistant Professor, Department of Architecture and Planning, College of Engineering Trivandrum, Thiruvananthapuram

1. INTRODUCTION

A shift in neighbourhood composition happens due to a newly built infrastructure and the influx of affluent households or businesses into a low-income neighbourhood changing it unaffordable to the original residents and eventually leading to their displacement. Gentrification is the process through which a neighborhood becomes socially mobile when younger and/or higher-class residents move there, which raises housing costs and raises the cost of living (R, 2004). While the studies mostly highlight the gentrification processes and effects, there are only limited studies that concentrate on the research methodology or the parameters to quantify gentrification. Although mixed-methods approaches are rarely used in gentrification research, there is sometimes a discrepancy across quantitative and qualitative approaches that are meant to gather and analyse different kinds of data. This article aims to identify various indices and methods used to measure gentrification. This study also aims to know what each method adds in what situations planners might be able to find the best method when looking at gentrification, and which all indicators call for more involved and varied results. The research on gentrification in a

developing country like India is still in its early stages, and there is a significant gap in the field of gentrification studies. There is a need for more thorough spatial analysis, including the use of GIS and other spatial tools, to better understand the dynamics of gentrification and its effects on communities, even though some studies have employed spatial analysis to map gentrification in India. Also, it is difficult to compare two cities on the basis of gentrification due to a lack of information. Only a small number of studies have looked at how to quantitatively measure gentrification and the most efficient ways to do so, whereas the majority of studies concentrate on the effects of gentrification. There is a need for more comprehensive and interdisciplinary research to better understand the dynamics of different types of gentrification in India.

1.1. Need of the study

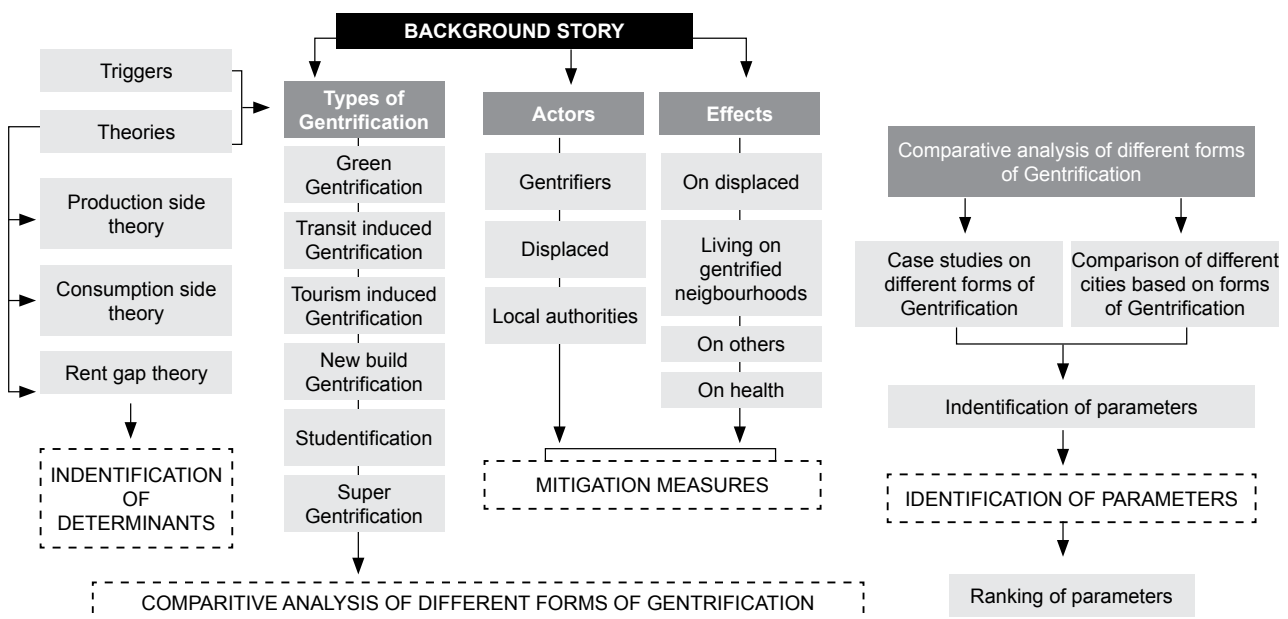
Researchers have only recently started to investigate whether sustainable development initiatives like urban greening and brownfield repair encourage gentrification. Only a few studies have developed metrics for measuring gentrification in areas with high social vulnerability, particularly in developing nations like India. Quantification and identification of gentrification indices can help develop comparative studies and

best practices to combat gentrification. As an initial step to further gentrification studies, the goal of this study is to find gentrification indicators in socially underprivileged neighborhoods that can be used to track a neighborhood's gentrification over time.

1.2. Methodology

The methodology includes background study which involves data on different types of gentrification, its triggers, and major theories related to Gentrification. The major actors involved and the impacts were also discussed. A comparative analysis of different forms of Gentrification is also conducted. Based on case studies different methods and parameters for quantification are identified. The ranking of parameters is conducted based on no. of papers cited. Not all forms of gentrification are addressed here; the study is only focused on a few like green gentrification, transit induced gentrification, tourism-induced gentrification, and new-build gentrification. Also, the identified indicators found in this study alone cannot establish gentrification in a neighborhood. Also, a spatio-temporal analysis map of an area can be created and strategies for inclusive planning can be proposed using the identified gentrification indicators.

Figure 1: Methodology



2. MAJOR THEORIES ON GENTRIFICATION

2.1. Production side Theory

According to Neil Smith, who developed the theory of urban gentrification, gentrification is an economic process that results from the various connections between capital investments and the development of urban space. The major determinants of Gentrification by Neil Smith are; Land value, House Value, and Sale Price.

LAND VALUE: Land value can be inversely related to the distance from the city core. This can increase the ground rent of a redeveloped property inside the city.

HOUSE VALUE: Increased house values make an area accessible only to High-Income groups of people.

SALE PRICE: Another housing issue is that, as the land is typically sold along with the buildings it can accommodate, the sale price includes not only the value of the house but also a portion for rent. Since the price of land does not reflect the amount of labor that has been put into it, as with the worth of actual commodities, it is preferable to speak of ground rent in this context rather than land value. (Smith, 2007)

2.2. Consumption side Theory

The fundamental claim of the consumption-based theory is that gentrifiers are the forces that lead to the displacement of low-income groups and that this creates the conditions for real estate enterprises to prosper through capital investment. The major determinants of Consumption side theory are; Demographic changes, Housing market dynamics, Urban amenities, and Changes in the economic base.

Demographic Changes - The increasing presence of people especially young professionals inside the city puts pressure on the housing market.

Housing Market Dynamics- Pressure on the housing market may affect the investment patterns inside the city

Urban Amenities - The amenities in urban areas attract more people to the city centre

Changes in economic base- Changes in the economy of the country can affect the housing market dynamics of an area.

The consumption pattern of the people and the housing market dynamics affect the process of gentrification. (Smith, 2007)

2.3. Rent gap Theory

The difference between the actual ground rent capitalized under the current land usage and the potential ground rent level is known as the rent gap. Gentrification happens when the gap is large enough for developers to affordably buy land, pay for construction costs and rehabilitation profits, and then sell the finished property for a profit that provides a satisfying return to the developer. Several different players in the land and housing market may start gentrifying a neighborhood once the rent gap is large enough. (Smith, 2007)

3. DIFFERENT FORMS OF GENTRIFICATION

3.1. Transit-induced Gentrification

Transit-oriented development (TOD), a crucial component of smart growth and new urbanism, is one of the most often employed solutions for lowering the transportation footprint. The higher accessibility provided by transit proximity is frequently factored into the cost of real estate. Low-income residents were displaced as a result, which is referred to as transit-induced gentrification, which leads to the affordability conundrum of TOD. (Romi Bramantyo Margono, 2020) The goal of TOD is to develop liveable, sustainable communities that have access to public transportation and are fair to all people. Contrarily, Transit-induced Gentrification takes happens

when the expansion of the transport network results in increased property values, the eviction of low-income inhabitants, and the influx of wealthier residents in areas close to transit hubs. As a result, low-income populations frequently lose access to affordable housing, cultural and social variety, and transportation.

The negative effects of Transit induced Gentrification in India can, however, be reduced with the help of TOD. By encouraging the construction of affordable housing close to transportation hubs, TOD can help to enhance the supply of affordable housing and lessen the eviction of low-income households. In addition, TOD can promote walkability and lessen the demand for automobile ownership, encouraging sustainable transportation and lowering air pollution and traffic congestion. Affordable housing incentives, inclusionary zoning regulations, community involvement, accessible transit, walkability and bicycle access, and mixed-use development are some examples of TOD policies. By implementing these regulations, it will be possible to guarantee that the advantages of transit upgrades are shared fairly and that low-income citizens have access to cheap housing and transportation options close to transit stations.

3.2. Green Gentrification

Clean-up of pollution or provision of green amenities boosts local property values and draws wealthier residents to a formerly polluted or underprivileged neighborhood. known as Green gentrification. (Eckerd, 2011) The price of real estate can be raised due to this and can cause environmental inequality. Green areas and other environmental amenities can improve a community's health and well-being, but they can also contribute to gentrification and the eviction of low-income inhabitants. For instance, the construction of a park or other green space in a previously run-down neighborhood may raise property values, attract richer residents, and drive out low-income individuals who no

longer have the means to reside there. (Lena Ali, 2020)

India suffers enormous environmental difficulties, such as problems with waste management, water scarcity, and air pollution. Many cities have adopted green efforts, such as tree planting, park and green space creation, and energy-efficient infrastructure installation, to solve these issues. Through these activities, the neighborhood is not only made more aesthetically pleasing but also more appealing to middle- and upper-class people. The advantages of GG are not dispersed equally, though. As property values increase, low-income tenants are frequently evicted, making it more challenging for them to find affordable homes. India has several instances of Green Gentrification, including the renovation of parks and waterfronts in Mumbai and the growth of eco-friendly residential neighborhoods in Bangalore. Mumbai has become a more desirable place to live and work as a result of the redevelopment of its parks and waterfronts, which has inflated property values and compelled the eviction of residents with low incomes. It is now more challenging for low-income households to locate affordable accommodation in Bangalore as a result of the growth of eco-friendly residential developments.

3.3. Tourism-induced Gentrification

A middle-class neighbourhood was transformed into a relatively wealthy and exclusive neighbourhood characterized by a proliferation of corporate entertainment and tourism establishments. This causes an influx of visitors which makes it unaffordable for the original inhabitants there. Residential areas are being converted to commercial (tourist) areas, with original businesses being displaced by amusement parks and other tourist attractions (Gotham, 2018). The urban-rural gap and its associated societal problems, such as those of the economy, education, medical care, and social security, are made worse by urbanization (L, 2010).

Governments have made improving the competitiveness of rural areas a top priority to close this gap. They have done this by actively promoting rural travel and tourism development initiatives (Lan Xue, 2017)

In India, gentrification brought on by tourism is a growing problem, especially in well-liked vacation spots like Goa, Jaipur, and Kerala. For instance, Goa has seen a sharp spike in tourism in recent years, which has increased property values and raised the cost of living there. Low-income locals, such as farmers and fishermen, have found it impossible to afford to dwell in the area as a result. Traditional areas in Jaipur, such as the Pink City and the Walled City, have undergone gentrification as a result of the tourism sector's explosive rise. Low-income residents find it difficult to afford to dwell in the neighborhood as a result of rising property values. Kerala, a popular tourist destination famed for its beaches, backwaters, and wildlife preserves, is another illustration of a place that has undergone gentrification as a result of tourism. The influx of tourists has resulted in the commercialization of traditional communities, leading to the loss of cultural and community diversity. Additionally, the increase in tourism has caused traditional communities to become commercialized, which has resulted in the loss of cultural and community diversity.

3.4. New-build Gentrification

New build Gentrification takes the shape of the construction of expansive, opulent apartment buildings or the construction of a new development project which the middle classes then occupy. Techno-centric development which is closely related to new-build Gentrification entices young, tech-savvy individuals and businesses, which might increase local property values and displacement. Old industrial brownfield lands are converted into upscale new developments as a result of New Build Gentrification (Mark Davidson, 2009). A narrow definition concentrates on in-fill projects on unused land or reclaimed

brownfields and others also involve demolishing or rebuilding existing residential neighborhoods (Patrick Rerat, 2009). New Build Gentrification is characterized by four key features: (i) capital reinvested, (ii) social upgrading of the area by incoming high-income groups, (iii) alteration in the landscape, and (iv) direct or indirect displacement of low-income groups. According to (Mark Davidson, 2009), These elements support and validate the use of the concept of new-build gentrification. Except for when old housing is not renovated as part of the demolition/reconstruction process, there is no direct population displacement (Boddy, 2016). Also, the regeneration of one location frequently boosts the attractiveness of nearby areas where the phenomena of replacement may happen due to "Price shadowing" (indirect displacement effect caused by an increase in the value of land and properties) (Mark Davidson, 2009).

New Build Gentrification and Techno-centric Development are closely related in that they are both driven by the desire for new, cutting-edge infrastructure and amenities. Techno-centric Development, or technology-focused developments, are typically large-scale urban redevelopment projects that incorporate new technologies, such as smart cities or sustainable energy solutions, into their design. It's critical to establish a balance between Technocentric Development and New Build Gentrification's advantages and disadvantages. This can be accomplished by including affordable housing rules in the design of technocentric developments, such as inclusionary zoning, to guarantee that new construction includes a mix of affordable and market-rate housing. Additionally, by putting policies like rent control and tenant protection laws into place, governments can aid in preventing displacement.

3.5. Super Gentrification

According to (Lees, 2008) Super gentrification is defined as when an already-gentrified neighborhood experiences one more stage of gentrification. Super gentrification is a process that includes significant community interaction changes, indications of social replacement (rather than displacement), and a significant step shift in the social class composition (Tim Butler, 2006). Here, the upper-middle-class area that has already undergone gentrification is further turned into an enclave that is even more upscale and expensive. A greater financial or economic investment in the neighborhood is required for super-gentrification to occur. Only neighborhoods in large cities with convenient access to the world's financial centers, such as the City of London and San Francisco, are at risk.

Here are a few examples of super gentrification:

Brooklyn, New York: Old industrial neighborhoods in Brooklyn have seen a major gentrification wave in recent years, becoming wealthy, tech-focused communities. For instance, Williamsburg, which was once a center for artists and working-class families, is now one of New York City's most expensive neighborhoods thanks to the influx of wealthy professionals and IT employees.

California's San Francisco: Another city that has recently undergone severe super gentrification is San Francisco. For instance, the Mission District, which was formerly home to a sizable Latino population, has undergone a rapid makeover as older structures have been torn down and rebuilt with brand-new, upscale ones.

3.6. Studentification

A process occurs when a neighborhood becomes predominately populated by students, frequently resulting in the eviction of long-time inhabitants and small businesses. It may result in a rise in obtrusive behavior such as littering, noise, and other types of nuisance behavior, as well as a decrease in the standard of living for long-term inhabitants. Additionally, it may lead to an increase in rent and property values, making it more expensive for low-income individuals and small companies to remain in the area. While limited to cities with higher education institutions, the phenomenon of Studentification creates particular urban landscapes whose social and cultural components require exploration (Hubbard, 2008)

Studentification happens in the higher education sector, which may not always have a downtown area. Gentrification happens gradually and slowly, whereas Studentification happens very quickly since it is influenced by how long students are there—on average, 4-5 years. As a result of its impact on the economy, new occupations with a wider variety started to appear in the region that was gentrified and studentified. There is a distinction in the socio-cultural factors as well. Modifications in the community's social structures define gentrification. On the other side, the effect of students' typically student-oriented lifestyles serves as a sign of Studentification. (Santy Paulla Dewi, 2019). It is characterized by some features, including:

- Demographic changes: A rise in the number of students residing there and a commensurate fall in the number of inhabitants who are not students.
- Housing: Increased student-oriented housing, such as purpose-built student accommodations, shared houses and apartments.
- Economy: An increase in businesses and services catering to students, such as convenience

stores, fast food restaurants, and bars.

- Noise and disturbance: An increase in noise levels, parties, and other forms of disturbance, especially during term-time.
- Land use changes: Studentification can also include changes in patterns of land use such as the conversion of homes into student accommodation.

3.7. Comparative analysis of different forms of Gentrification

The different forms of gentrification are compared and analysed based on their causes, main features, type of gentrifier and consumer, duration of gentrifiers, displacement, and the pace of neighborhood change

Table 1: Comparison of different types of Gentrification

TYPE OF GENTRIFICATION	TRANSIT INDUCED	GREEN GENTRIFICATION	TOURISM INDUCED	STUDENTIFICATION	NEW BUILD GENTRIFICATION
CAUSE	Improved transit accessibility and Transit-oriented development policies causes displacement of the poor	Process in which cleaning up pollution or providing green amenities increases local property values and attracts wealthier residents to a previously polluted neighbourhood	Replacement of residential land-uses with commercial (touristic) land-uses and displacement of original businesses by entertainment corporations and tourist attractions	Process that takes places when a neighbourhood becomes predominately populated by students	Gentrification brought on by a new development project.
FEATURES	Improvement to public transportation, increased property values, changing demographic pattern, displacement of LIG, increased economic activity	Development of green spaces, increased property values, changing demographic makeup of the neighbourhood, displacement of LIG, increased economic activity	Increased investment in tourism, change in demographic makeup of the neighbourhood, displacement of LIG, loss of cultural identity, increased economic activity	High concentration on student renters, demand for rental housing, changing demographic pattern, noise and disturbances, landuse changes	New construction, rising property values, displacement of LIG, loss of cultural heritage, upscale amenities
CONSUMER	Middle class	Middle class	Middle class	Studentifiers	Middle class
TYPE OF GENTRIFIER	Commonly young adults with families	Commonly young adults with families	Tourists	Students who are single and no children	Commonly young adults with families
DISPLACEMENT	Yes	Yes	Yes	No	No
DURATION OF GENTRIFIERS	For a long duration	For a long duration	Temporary	Temporary	For a long duration
PACE OF CHANGE	Slow change	Slow change	Slow change	Rapid change	Slow change
EXAMPLES	Bangalore, Mumbai, Delhi, Hyderabad, Chennai	Bangalore, Delhi	Goa, Jaipur, Kerala	Bangalore, Delhi, Hyderabad	Bangalore, Mumbai, Delhi, Pune, Chennai

4. TRIGGERS AND IMPACTS OF GENTRIFICATION

4.1. Positive impacts

Some of the positive impacts of Gentrification are;

- The stabilisation of deteriorating areas
- An increase in property values, an increase in local tax revenues,
- Encouragement and increased viability of further development, a reduction in suburban sprawl
- an increase in the diversity of the population

- An increase in consumer spending power at neighborhood businesses. (R, 2004)

4.2. Negative impacts

- Displacement due to rent/price increases;
- Displacement and housing demand pressure on neighboring poor areas;
- Secondary psychological costs of displacement;
- Community resentment and conflict;
- Loss of affordable housing;

- Unsustainable speculative property price increase;
- Homelessness; commercial/ industrial displacement;
- Displacement; displacement; displacement; displacement;
- Increased cost and charges to local services;
- Increased crime;
- Under ownership and population decline to gentrified areas (R, 2004).

4.2.1. IMPACTS ON THOSE WHO GOT DISPLACED

Due to the neighborhood upgradation The relocation of friends and family, the disappearance of familiar businesses or services, or the neighborhood's overall transformation to the point where they no longer want to live there may cause some people, who might be able to afford the higher rent in the gentrified area, to choose to move elsewhere. (Betancur, 2011).

There is the negative impact of gentrification on health in which moving can make it more difficult to access social networks, good food, and medical treatment for the displaced. (Freeman, 2009) Even though gentrification doesn't result in displacement it can cause damage to the sense of community and social networks to dissolve. Gentrification decreases the number of affordable housing options. Due to a lack of affordable housing options, low-income inhabitants of gentrified districts may be obliged to remain there while finding a way to pay their higher rent.

In gentrifying districts, there is evidence of racial discrimination and greater segregation, according to a study of mortgage lending in significant U.S. cities. (Hammel, 2016) Also, studies show that gentrifying communities frequently start more diverse than other neighborhoods and tend to stay that way throughout the gentrification process. (Raphael.W.Bostic, 2016)

4.2.2. EFFECTS ON THOSE WHO LIVE IN GENTRIFIED NEIGHBORHOODS

Gentrification should result in higher tax collections for local governments, which raise the quality of municipal services. These services' characteristics frequently change to meet the needs and preferences of new inhabitants as a neighborhood's demographics change. Also, there are debates on how gentrification reduces and increases crime which eventually creates an impact on those who reside in gentrified

neighbourhoods. Some studies have shown that gentrification lowers crime rates, while others have shown that it raises crime. (Ingrid Gould Ellen, 2010)

4.2.3. GENTRIFICATION AND ITS IMPACT ON HEALTH

Gentrification can bring investment and development to previously underserved neighborhoods, the addition of new social services, and increased access to healthy food options. These will boost physical activity, reduce contaminants in the environment, and eventually improve health outcomes. Higher stress levels increased exposure to environmental dangers, and limited access to healthcare services can occur due to displacement. Gentrification will result in the loss of community assets and social networks, reducing social capital and increasing isolation. Displacement can result in a variety of physical and mental health issues, such as elevated incidence of anxiety, depression, and cardiovascular disease. Through supporting community health centers, encouraging active transportation, and promoting green spaces the negative impacts of gentrification on health can be reduced.

4.2.4. MITIGATION MEASURES

- Zoning Ordinance - Zoning regulations can help to preserve the existing local businesses, small-scale industries and affordable housing
- Affordable housing preservation - Low-income residents can avoid being displaced by protecting existing affordable homes through rent control regulations and inclusionary zoning principles.
- Community land trusts - This stabilizes property values and prevents the eviction of the community's poorer residents
- Rent control - Rent control limits the amount that can be charged to prevent the eviction of current tenants due to rising rates. This discourages property

value speculation, reduces no. of vacant homes, and restricts the housing supply for new occupants.

- Promoting mixed-income housing - This will prevent the concentration of low-income residents in any one neighborhood. This can be accomplished by inclusionary zoning and offering incentives to developers to provide affordable homes.
- Support for small businesses - Through tax incentives and business incubator programs, small companies in gentrifying neighborhoods can be preserved.
- Community involvement - Through community organizing and campaigning, it is possible to ensure that residents' viewpoints and needs are taken into account when making choices about neighborhood development.

5. INFERENCES FROM CASE STUDIES

The identified parameters from case studies were further classified based on the different forms of gentrification, the method used for analyzing, primary indicators in determining gentrification, secondary indicators, and others. Various variables need to be taken into account to establish that a neighborhood has undergone gentrification. This includes

- Household Income
- Age
- Educational attainment
- Occupation
- Gender
- Population
- Race/Ethnicity
- Land use change
- Build use,
- Homeownership,
- No. of affordable rental units,
- Homeownership
- Increase in property values

Certain parameters based on the various types of gentrification assist in determining which type of gentrification is taking place in the area and, consequently, can propose possible mitigation strategies.

5.1. Parameters for Tourism induced gentrification

Table 2: Parameters for Tourism induced Gentrification

SI NO	TYPE OF GENTRIFICATION	CITIES ANALYSED	OBJECTIVES	INDICATORS USED	METHOD USED	PAPER REFEFFERD
1	Tourism induced Gentrification	Malaga, Valencia	To propose a methodology for indentifying pattern of tourism intensification in cities	<ul style="list-style-type: none"> ▪ Citizen initiatives ▪ Population ▪ Airbnb ▪ Tourist accomodations ▪ Cultural equipment ▪ Catering trade 	Pearson correlation analysis	Measuring tourism intensification in urban areas through their associative network: Case studies from the Spanish Mediterranean coast (2006)
2	Tourism induced Gentrification	Barcelona	<p>To understand the role of visitors and Airbnb in driving gentrification</p> <p>To understand neighbourhood change in tourist cities by considering the role of migrants from advanced economies as gentrifiers in these neighbourhoods</p>	<ul style="list-style-type: none"> ▪ Proportian of population ▪ Number of tourists beds per 100 inhabitants in 73 neighbourhoods of Barcelona ▪ Population btw 25-39 ▪ Population of young adults ▪ Age ▪ Gender ▪ Home ownership 	Mixed methods, sociodemographic shifts, participant observations, interviews	Transnational gentrification, tourism and the formation of 'foreign only' enclaves in Barcelona (2020)
3	Tourism induced Gentrification	Lisbon	To discuss the consequences of tourism gentrification and strategies that the city of Lisbon could implement	<ul style="list-style-type: none"> ▪ Local lodging establishments ▪ Vacant properties ▪ Proportian of local population 	Mixed methods, observations, municipality data	Tourism Gentrification (2018)

5.2. Parameters for Transit induced gentrification

Table 3: Parameters for Transit-induced Gentrification

SI NO	TYPE OF GENTRIFICATION	CITIES ANALYSED	OBJECTIVES	INDICATORS USED	PERIOD OF TIME	METHOD USED	PAPER REFEFFERD
1	Transit induced Gentrification	Cleveland, San Francisco, San Diego, Pittsburgh, Buffalo Portland, Sacramento, San Jose, Los Angeles, Denver, Dallas	To what extent is the presence of a light rail station associated with gentrification?	<ul style="list-style-type: none"> ▪ Ethnicity ▪ Income ▪ Education 	10,20 and 30 years (dt 1980-2010; op 1980-1999)	Spatial auto-regressive models	Baker, Lee, 2017
2	Transit induced Gentrification	Dhaka	To evaluate the challenge of gentrification that Dhaka is going to face in TOD planning and implementaion	<ul style="list-style-type: none"> ▪ Income ▪ Occupancy type ▪ House rent ▪ Travel behaviour ▪ Transport cost ▪ Affordability ▪ Vacant land and redevelopment ▪ Willingness to pay 	Not specified	Door to door survey, structured interviews, reviewing transit and land development policies	Transit induced gentrification on possible threat for TOD Planning in socio-economic
3	Transit induced Gentrification	Bangalore	Examine whether a large-scale influx of public and private capital occuring in TOD areas and whether it is leading to gentrification	<ul style="list-style-type: none"> ▪ House price rents ▪ House area ▪ HH size ▪ House and building age ▪ Migrations ▪ Tenure ▪ Vehichle ownership ▪ Age ▪ HH with public assistance ▪ Income ▪ Occupation ▪ Mode choice 	Not specified	Comparison and analysis of variance	Chava et al., 2018
4	Transit induced Gentrification	Los Angeles	Analyse effects of gentrification on commute mode (transit use, car) for residents living near rail	<ul style="list-style-type: none"> ▪ Car ownership ▪ Rent price ▪ House price ▪ Occupation ▪ Education ▪ Ethnicity ▪ Tenure ▪ Income 	10 years	Difference-indifference analysis	Dominie, 2012

SI NO	TYPE OF GENTRIFICATION	CITIES ANALYSED	OBJECTIVES	INDICATORS USED	PERIOD OF TIME	METHOD USED	PAPER REFEFFERD
5	Transit induced Gentrification	Los Angeles	Effects of the Orange	<ul style="list-style-type: none"> ▪ Car ownership ▪ Rent price ▪ House price ▪ Occupation ▪ Education ▪ Ethnicity ▪ Tenure ▪ Income ▪ Mode choice 	8 years	Difference-indifference analysis, regression model	Brown, 2016
6	Transit induced Gentrification	Washington, DC	Explores the extent to which the population profile of workers living near rail	<ul style="list-style-type: none"> ▪ Migration ▪ HH size ▪ Age ▪ Education ▪ Income ▪ Ethnicity ▪ Mode choice 	Not specified	Difference-indifference analysis	McKenzie, 2015
7	Transit induced Gentrification	Portland	Examine change in a socio-economic index near light-rail	<ul style="list-style-type: none"> ▪ Index based on education ▪ Income ▪ Occupation 	6-25 years	Correlations, OLS regression, GIS hot spot	Rochester, 2016
8	Transit induced Gentrification	Atlanta	Identify changes in the neighbourhood characteristics of six types of transit-rich neighbourhood	<ul style="list-style-type: none"> ▪ Ethnicity ▪ Age ▪ HH size ▪ Education ▪ Occupation ▪ Tennure ▪ Vacant homes 	Not specified	Before-after	Wang, Woo, 2017
9	Transit induced Gentrification	Atlanta	Examine whether access to public transportation plays a significant role in determining	<ul style="list-style-type: none"> ▪ Poverty ▪ Ethnicity 	Not specified	Regression, 2SLS regression, propensity score matching techniques	Pathak et al., 2017
10	Transit induced Gentrification	Portland	Assess change in jobs, people and gentrification	<ul style="list-style-type: none"> ▪ Ethnicity ▪ Income ▪ House price 	0-6 years	Difference-indifference analysis	Hinners et al., 2018

5.3. Parameters for Green gentrification

Table 4: Parameters for Green Gentrification

SI NO	TYPE OF GENTRIFICATION	CITIES ANALYSED	OBJECTIVES	INDICATORS USED	METHOD USED	PAPER REFEFFERD
1	Green Gentrification	Barcelona	New parks and gardens (Barcelona), new greenbelt created and informal green spaces removed (Medellin), and climate adaptation strategies (New Orleans)	<ul style="list-style-type: none"> ▪ Percent of population with a bachelor's degree or higher ▪ Percent of immigrant population whose nationality is from ▪ Immigrant population whose nationality is from the Global South ▪ Race or ethnicity ▪ Home sale value ▪ Household income 	Regression and spatial analysis	Anguelovski et al., 2018
2	Green Gentrification	Bangalore	Environmental remediation through restoration of previously polluted artificial lakes, creation of parks	<ul style="list-style-type: none"> ▪ Increase property values ▪ HH income ▪ Landuse change ▪ Pollution ▪ Restriction to HH needs 	Qualitative data analysis (mapping data) and descriptive statistics (survey data)	Derkzen et al., 2017
3	Green Gentrification	New York City, NY (USA)	Environmental remediation (i.e., brownfield development) in three neighbourhoods of New York City	<ul style="list-style-type: none"> ▪ Sense of community ▪ Neighbourhood character ▪ Attitude of newcomers 	Qualitative study-content analysis	Pearsall, 2012
4	Green Gentrification	USA, Tuxedo area	The HOPE VI development includes green space and parks	<ul style="list-style-type: none"> ▪ Physical activity - children ▪ Physical acivity - adults ▪ Race or ethnicity ▪ Safety of parks before and after Hope VI redevelopment ▪ Scenic beauty of the parks 	First statement analysis, then cluster formation, bridging values, cluster ratings, t-tests and pattern match	Dulin-Keita et al., 2016
5	Green Gentrification	Atlanta, San Antonio	New greenways: Atlanta Beltline and Leon Creek Greenway in San Antonio	<ul style="list-style-type: none"> ▪ Race or ethnicity ▪ Crime and safety ▪ Cultural benefits ▪ Amount of free time ▪ Constraints to use green areas 	Descriptive statistics and ordinary least squares regression	Keith et al., 2018
6	Green Gentrification	Chicago, IL (USA)	New greenway developed (The 606)	<ul style="list-style-type: none"> ▪ Perceptions on trail use ▪ Sense of safety ▪ Motivations for use ▪ Impact on physical activity 	Mixed methods Descriptive statistics and multi-variable regression models	Kraft et al., 2018
7	Green Gentrification	Atlanta, GA (USA)	New greenway developed (Atlanta Beltline)	<ul style="list-style-type: none"> ▪ Greenway use ▪ Sense of connection to one's neighbourhood ▪ Race or ethnicity 	Quantitive confirmatory factor and analysis, independent samples t-tests, and structural equation modelin	Palardy et al., 2018

SI NO	TYPE OF GENTRIFICATION	CITIES ANALYSED	OBJECTIVES	INDICATORS USED	METHOD USED	PAPER REFEFFERD
8	Green Gentrification	Barcelona (Spain)	Parks, squares with vegetation and playgrounds. All green spaces can be used as play spaces by children. Some green spaces were recently built.	<ul style="list-style-type: none"> ▪ Age ▪ Gender ▪ Educational attainment ▪ Origin ▪ Safety ▪ Perception of parks by children, adults and families 	Mixed methods Descriptive statistics (observations), mixed-effects logistic regression (survey) and thematic analysis using	Oscilowicz et al., 2020
9	Green Gentrification	Ghent (Belgium)	Living street project (integration of street trees)	<ul style="list-style-type: none"> ▪ Gender ▪ Age ▪ Home ownership ▪ Occupation ▪ Educational attainment ▪ Sense of community ▪ Social interactions 	Qualitative analysis: interviews were analysed in Nvivo 10	Goossens et al., 2020
10	Green Gentrification	Oakland, CA (USA): West Oakland area	Freeway rerouting (environmental remediation) and building street-level boulevard (with trees and other greenery)	<ul style="list-style-type: none"> ▪ Vehicle emissions ▪ Near roadway pollutants ▪ Concentration of Nox and black carbon 	Quantitive spatial analysis	Patterson & Harley, 2019

5.4. Parameters for Studentification

Table 5: Parameters of Studentification

SI NO	TYPE OF GENTRIFICATION	CITIES ANALYSED	INDICATORS USED	METHOD USED	PAPER REFEFFERD
1	Studentification	New York	<ul style="list-style-type: none"> ▪ Interior renovations ▪ Building additions ▪ Demolition/new construction ▪ Location of BCCR shops (Bar, coffee, corner stores, restaurants) ▪ Rental properties 	Getis* Ord statistics	Down with Templetown: The understanding and classification of American studentification
2	Studentification	Delhi	<ul style="list-style-type: none"> ▪ Rental value ▪ Individual paying capacity ▪ Distance from nearby markets and ease to procure daily items ▪ Availability of random space, furniture, number of bathrooms, water supply, intern etc. ▪ Environment for study ▪ Maintenance for building ▪ Safety and security against crime and theft ▪ Nearby recreational facilities 	Personal observation and questionnaire	Effects of studentification of residential neighbourhood (2013)

SI NO	TYPE OF GENTRIFICATION	CITIES ANALYSED	INDICATORS USED	METHOD USED	PAPER REFEFFERD
3	Studentification	Tembalang, Indonesia	<ul style="list-style-type: none"> Characteristics of occupancy Student's origin Relations with local communities Lifestyle changes 	Qualitative	The implication of studentification to community's physical and social-economic aspects in Tembalang higher education area
4	Studentification	Taiwan, China	<ul style="list-style-type: none"> Relative growth rate of average dwelling unit price Changes in the housing stock Directly affects whether local employment is dominated by the tertiary sector or not 	Empirical study	The economic impacts of studentification on local communities - A review of the literature based on cross-strait studies
5	Studentification	UK	<ul style="list-style-type: none"> Safe neighbourhood Affordability of accommodation Distance of house from student centre Independent lifestyle Friends who live there Socio-economic status of the neighbourhood Student life in the neighbourhood 		

5.5. Parameters for New Build Gentrification

- Development of new infrastructure project
- Employment opportunities
- People with bachelor's degree
- Elderly living alone

5.6. Classification of Parameters

Table 6: Classification of identified Parameters

RANKIN	INDICATOR
LEADING INDICATORS Strong signs Gentrification is happening	<ul style="list-style-type: none"> HH income Educational attainment Age Home ownership Race/Ethnicity HH size Occupation Land use change Gender Building use Health No of renovations Percentage of renters Number of new businesses Elderly living alone Dual career couples Affordable rental units Safe neighbourhood Distance from job centre Individual paying capacity Proportion of local population Travel behaviour Transportation cost Vehicle ownership Mode choice Socio-economic status of the neighbourhood

RANKIN	INDICATOR	
SECONDARY INDICATORS Less strong indicators for gentrification	<ul style="list-style-type: none"> ▪ Physical activity ▪ Small/childless households ▪ Unmarried couples ▪ Gay households ▪ Location of BCCR shops ▪ Independent life style 	<ul style="list-style-type: none"> ▪ Local lodging establishments ▪ Sense of community ▪ Constraints to use green areas ▪ Relative growth rate of average dwelling unit price
OTHER INDICATORS	<ul style="list-style-type: none"> ▪ Home mortgage lending ▪ Social media usage ▪ Vacant properties 	<ul style="list-style-type: none"> ▪ Near roadway pollutants ▪ Perception of green areas by children and adults

5.7. Methods used for measuring Gentrification

Table 7: Identified methods for mapping Gentrification

PAPERS	METHODS USED
Mohammad Ismail, Abukar Warsame and Mats Wilhelmsson, 2020	Gi* method, Hedonic method
Francisco José Chamizo-Nieto, Nuria Nebot-Gómez de Salazar, Carlos Rosa-Jiménez and Sergio Reyes-Corredera, 2006	Pearson Correlation Analysis
Chava, J, Newman, Peter Tiwari, Reena, 2018	Binary Logistic Regression Model
Isabelle Anguelovski, James J.T. Connolly, Laia Masip, 2017	Geographic Weighted Regression Model
Anastasia Loukaitou-Sideris, Silvia Gonzalez & Paul Ong, 2017	Data Triangulation

6. CONCLUSION

The goal of the paper was to comprehend the gentrification process by using its methodology and quantification criteria. It shows that gentrification is a dynamic phenomenon that cannot be adequately represented by a single indicator or data source. In these situations, using a variety of indicators and data sources, including secondary data as well as empirical research like field observations and stakeholder interviews, complements one another and helps create a more comprehensive picture of how gentrification has affected a region. It also demonstrated how gentrification might appear as a result of the synthesis of several empirical indicators that planners could apply in various contexts. Planners can use secondary data with sociodemographic and housing variables to get both a cross-sectional and longitudinal perspective on how these indicators have changed over time and how they compare to those in different neighborhoods. Systematic field observations can provide a wealth of information about the urban form and

social activities of a neighborhood at the parcel and street level, as well as aid in corroborating secondary data. The level of gentrification in a community can be better understood using each method, but planners may not always have the time or money to use several different study techniques. Over time, neighborhoods alter and evolve in a variety of intricate ways. We frequently come across differences in indications and assumptions regarding the type and severity of neighborhood change. This is because change is difficult to recognise, measure, and characterise, there are various information sets, and some data sources are inaccurate. Small errors and disparities may not be significant when data demonstrate the presence or lack of gentrification, but if gentrification is only beginning, they could result in incorrect assumptions. In these cases, using a range of indicators and data sources, such as secondary data as well as empirical research like field observations and stakeholder interviews, complements one another and aids in painting a more complete picture of how gentrification has impacted a region.

7. WAY FORWARD

This study can be used as a preliminary step to quantify gentrification in a neighborhood. The accuracy of the result can be improved by including qualitative indicators in addition to the defined parameters. Gentrification in a certain area must be mapped using secondary data, empirical studies like field observations, and expert discussions in addition to the identified indicators.

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