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EXPLORING URBAN MODELING METHODOLOGIES TO BETTER FIGURE OUT URBAN GENTRIFICATION DYNAMICS IN DEVELOPING COUNTRIES

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ABSTRACT: *Gentrification has enjoyed the spotlight as a topic of academic inquiry in economics, politics, and sociology for about four decades. The application of urban modeling methodologies for testing ideas and hypotheses relating to urban gentrification dynamics is proved most sophisticated rather the other spatial analysis methods. This article is going to explore the components of urban gentrification in developing countries and find the useful test-bed models to study the phenomenon based of theory-informed scenarios. It is intended to compare the current platforms based on methodologies improved for further work. Ultimately the article will introduce the most reasonable methodology and instruments for modeling and simulating the complex phenomenon of urban gentrification in developing countries' inner city that was not applied hitherto.*

Keywords: *Developing countries, Gentrification, Urban Modeling, Complexity theory*

Introduction

Most of the gentrification studies come to the point that appearance of the already formulated origins of gentrification are time and place-specific (Torrens and Nara, 2007; Guzey 2006; Ergun 2004; O'Sullivan 2002). Gentrification is an evolutionary process and through its evolution from the late 1950s as a result of an increasing rent gap, sporadic and small in scale or from the 1970s with the invasion of the inner city by the gentrifiers and/or a new middle class (Bounds and Morris 2006) to the 2000s opening up new discussions on the increasing effects of government policies in addition to the appearance of a new class of young and high-income, educated white collar professionals, different preconditions have brought different logics and outcomes of gentrification in different geographies (Guzey 2006). The first diversity originates from the class explanations of gentrification taken as a driving mechanism by itself or as an effected body of capital formulations.

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The new class of the 21st century is more powerful on shaping space in accordance with a life style formed with the power of economic capital (Guzey 2006). Thus more reflects the logic of capital, in other words it reflects Smith's logic of capital which has gained more power with the globalized interests within the aura of their cultural and life style preferences. So it is worth to argue that this new class should not be missed with the 1970s' middle class gentrifies. Thus it is worth to discuss the logic of gentrification in different geographies.

If we give the name of gentrification to all invasion attitudes of the upper classes, we will conclusively be trapped in the major cities. However if we can develop different phases for different periods of gentrification redefining its logic in different development patterns, we will more likely to understand its time and place specific appearances.

The breadth of exploratory landscape across socioeconomic, cultural, political, and spatial factors of gentrification often needs more sophisticated methodologies to overcome the artifact results, moreover, the variety of scales of observations, as well as diversity of agents and relevant factors, makes researchers to explore methodologies to find the one that can be more realistic.

Automata have been used successfully to model a wide variety of complex urban phenomena (Benenson and Torrens 2004): Urban growth, land use change, pedestrian dynamics, residential mobility, socio-spatial segregation, vehicle traffic, and so forth.

There is less study of gentrification in developing countries by modeling or simulating compared to developed countries. A synthetic simulation environments for exploring ideas behind such a complex process is needed that might not otherwise be investigated on the ground. I am aware of POTECIAT model that have applied in Brazil by Niara Clara Palma and Romlo Krafta (2007) as an extended Cellular Automata.

In this paper the objective is to clarify the significance of treating the new wave of gentrification as a complex urban phenomenon and describe the best model and tool par excellence for examining such process.

Complexity Theory

"Complexity" has been among the stronger currents in scientific thought during the last two or three decades (Crawford et al 2006). Researches across disciplines apply complexity theory to issues from economic development to earthquake prediction (Manson & O'Sullivan 2006). "Complexity "began with catastrophe and bifurcation theory, building on nonlinear approaches to biological systems, paralleled by work in deterministic dynamics leading to chaos theory. This has culminated in ideas about transition, order, and edge-of-chaos, best seen in ideas about self-organized critically (Batty 2005).

Principle of superposition, equilibrium, and linearity are useful because they simplify problems by providing tractable models and clear indications of causality which are necessary for theory building. These principles have a drawback, however, in that the implicit assumptions of seemingly prosaic methods, such as the enforced choice of independent and dependent variables in regression, actively guide the kinds of questions that can be asked.

In contrast, the explicit model-focused epistemology of complexity theory relies on a heightened awareness of the role of models and of the possibility of a variety of modeling approaches. Guided by an underlying ontology of entities and their relationships, complexity research turns us away, from reductionist aggregation and simplification of the characteristics or behavior of entities within a system and towards representation of individual entities and their relationships with few a priori assumptions of how these should be represented (Manson & O'Sullivan 2006).

Such a theory, as a premise that directs attention to the kinds and strengths of relationships in a system, a focus shared with such divergent schools of thought as actor-network theory (law 1992) and critical realism (Harvey and Reed 1996).

This breadth of perspective in complexity allows the application of ideas from complexity science across the continuum of realist to constructivist approaches to science. In fact, "complexity" cannot be treated as antithetical either to realism or to constructionism, because collections of atomic elements maybe either "real" or not (O'Sullivan et al 2006).

Complex systems are difficult to frame, they are not closed and easily distinguishable from the embedding environment, although they are rather open. They also has the nature of ever-changing and the system feedbacks are bilateral, meaning that the actions influence the system and the system affects the actors to degree that they have to be ready to change the rules, learn new behavior and evolve new strategies.

The other characteristic of "complexity" is the bottom-up generation of structures rather than allocation of activities in a top-down manner. Such theory dealt with aggregate patterns and attempts an explanation using variables at an equivalent level.

Computational modeling is the dominant epistemology of complexity science, largely because of the need to focus on entities and their relationships, especially with respect to emergence (Manson and O'Sullivan 2006).

According to Brian Arthur (1994) use of such models is essential because they allow researchers to understand how emergent phenomena result from the indications of many entities. This contrast with methods that simplify systems by reducing them to weakly interacting aggregate components, or 'variables', for example via statistical assumptions (O'Sullivan et al 2006).

According to Michael Batty (2005) the physics of far-from equilibrium structures is important, as is the notion of decentralized decision making. Processes that lead to surprising events, to emergent structures not directly obvious from the elements of their process but hidden within their mechanism, new forms of geometry associated with fractal patterns, are applicable to highly complex systems such as cities.

Modeling complexity

Mathematical and theoretical models have long been used to attempt to reduce complexity and encode a clear and concise understanding of some aspects of urban structure (Waddell 2004).

Despite the value of theoretical models in convenience of better understanding some underlying principles of urban development and transportation, much of these works are too simplified in their assumptions and too summarized to be of real world dynamics

of agencies required to inform decision makers and delineate specific policies and investments in particular urban settings.

Computerized models representing urban travel and land use began to be developed and used from at least the 1960s (Waddell 2004). Complexity theory has been used to generate many useful simulations of urban phenomena in last twenty years (Wyatt 2008).

Simulation models of urban-activity location started from large scale, aggregate spatial representation in a static equilibrium and currently are undergoing a transition to finer scale disaggregate forms where dynamic processes are the prime focus of the simulation (Torrens 2003). Automata are applied in realm of model development regarding this transition.

Succinctly, an automaton is a processing unit, which itself can be characterized using variables of any description. Besides, an automaton is endowed with the ability to process information contained in other neighboring automata (Torrens 2003). Researchers in geography and urban studies begun to use automata in order to develop models of urban systems in 1980s, one class of automata in particular, cellular automata (CA), have been used by them in a widespread condition. Urban development modeling, land use simulation, and land-use/land cover dynamics are the most common examples of application of such automata (Benenson and Torrens 2004). Briefly, an automaton A belonging to a CA lattice can be defined as follows:

$A \approx (\mathbf{S, T, R})$ (1)

Formally, a finite automaton A can be represented by means of finite set of states $\mathbf{S}=\{S_1, S_1, S_1, \ldots, S_1\}$ and a set of transition rules **T**, that define an automatons state, S_{t+1}, at time t+1 depending on its state, S_t (S_t , $S_{t+1} \in \{\mathbf{S}\}$), and input, $\mathbf{I}_t$, at time step t:

$\mathbf{T}: (S_t , I_t)$ S_{t+1} (2) ⟶

Therefore, in equation 1, **R** denotes automata neighboring A, and defines the boundary for drawing input information **I**, which is necessary for application of transition rules **T** (Benenson and Torrens 2004).

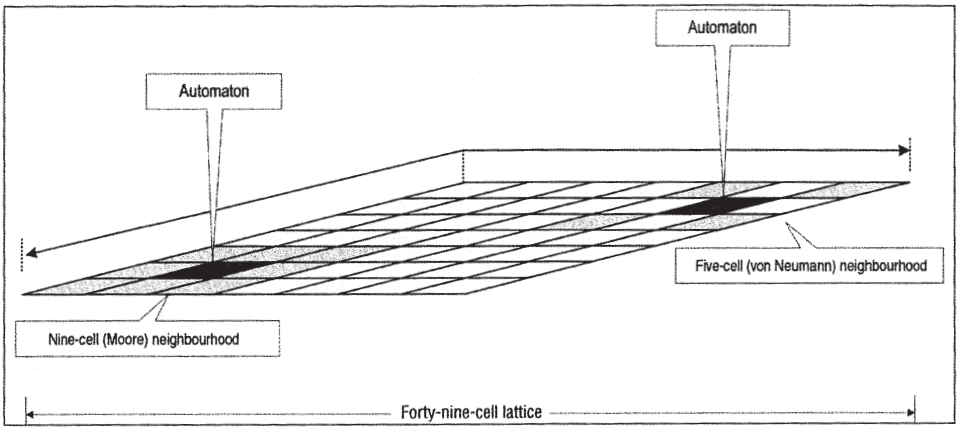

Figure 1: Two-dimensional cellular automata arranged in a regular lattice tessellation

Another form of automata, multi-agent systems (MAS), is adopted for use in urban modeling. MAS models of urban systems have been constructed for a variety of purposes: simulating residential location dynamics (Torrens 2001a; Beneson, Omer and Hanta 2002), traffic systems (Barret et al 2001) and urban population dynamics (Benenson and Torrens 2004).

The components of automata listed above have closed analogies with cities. Most urban entities ,phenomena and systems can be specified as automata(Batty 2005,O'Sullivan 2002,Torrens 2003).Transition rules may be specified in such a way that they incorporate any geography theory or methodology, for example :bid rent theory ,spatial cognition, gentrification , sprawl, space-time budgets , etc (O'Sullivan 2002 , Torrens 2003).

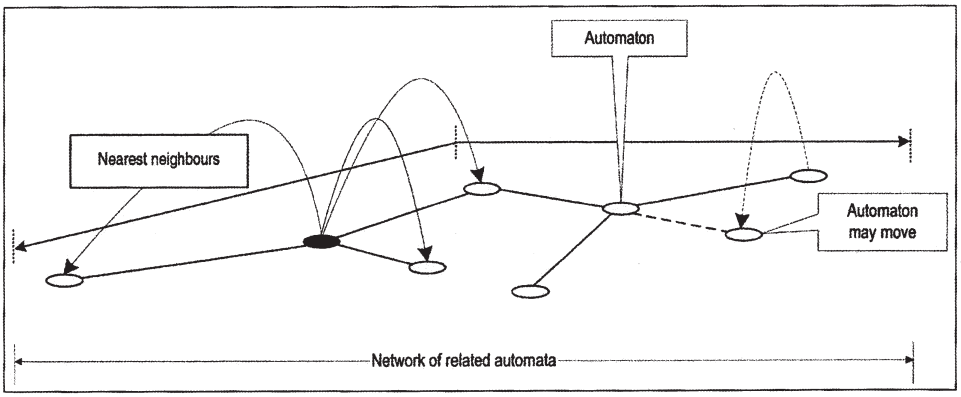

Figure 2: Two-dimensional multi-agent systems related by nearest neighbours

Some advantages of automata models are as below:

1. Decentralized nature, therefore the ability to accomplish tasks from “Bottom-up”.
2. Capability to represent simulated objects at very high resolutions.
3. The emphasis on interaction, therefore any emergent behavior may result.
4. The dynamic nature of automata.
5. Simplicity, this is appropriate for any urban systems where almost chaotic end states are understood to result from simple initial conditions.
6. Their ability for spatial modeling, CA can be designed to mimic various geographies.

Some disadvantages of automata application in urban modeling and simulations are as below:

1. Uncertainly of CA models in terms of size and type of neighborhood.
2. Micro- scale data dependence, to achieve more realistic urban simulation.
3. Homogeneity of the regular cellular structure.
4. Centrality of the neighborhood concepts of its rules.

More integrated technology is required for urban simulation modeling (Hammam et al 2007, Torrens and Nara 2007).integrating cellular automata (or according to Hammam vector automata VA) and multi agent systems has been proven that can provide a flexible and dynamic environment in the simulation complex systems like gentrification (Torrens and Nara 2007 ,Diappi and Bolchi 2008 ,Hammam et al 2007).

What is the gentrification?

Ruth in 1963 coined the term “gentrification” as the process of middle class residential expansion into hitherto working class area of the city (Hamnett, 2003).

According to Merriam Webster, gentrification is the process of renewed rebuilding accompanying the influx of middle class or affluent people into deteriorating areas that often displaces poorer residents.

It refers to the transition of property markets from relatively low value platforms to higher value platforms under the influence of redevelopment and influx of higher income residents, often with spatial displacement of original residents and an associated shift in the demographic, social, and cultural fabric of neighborhoods under its influence (Torrens and Nara 2007).

There are two dominate mainstream ideas in the geographic literature: humanistic and Marxist approaches. Hamnett summarizes the distinctions between the two terms as the differences between “the liberal humanistic who stresses the key role of choice, culture, consumption, and consumer demand, and the structural Marxists who stress the role of capital, class, production and supply.

Bondi (1999), Filion (1999), Ley (1996); Van Kempen and Van Weesep (1994) have suggested the phenomenon as modifications in the socio cultural structure and residential policies as other significant factors that might lead to a process of gentrification.

Members of the middle class, working in the city center, want to live in the inner city in order to be closer to their works and socio-cultural activities and also they have intended to be closer to those similar of themselves. In humanistic approach, therefore, the area of interests, habits and demands for setting and keeping a life style at a certain standard, are very important factors (Ergun 2004).

On the supply side approach, which was mainly supported by Smith (1996), claims that it is capital, given appropriate conditions , which finds it is worth investing in decayed urban areas , due to the potential gains from substantial increases in land rent and land value; population turnover represents a physiological consequence of the process.

The life cycle of a building, characterized by an initial stage of construction, successive use and maintenance regime, then disinvestment and decay may show a new revitalization process triggered by reinvestments. This is due to gap that has been created between the current rent and the expected rent after rehabilitation, i.e. between capitalization rent and potential rent, following Smiths definitions (Diappi and Bolchi 2008). This is the rent gap theory (RGT).

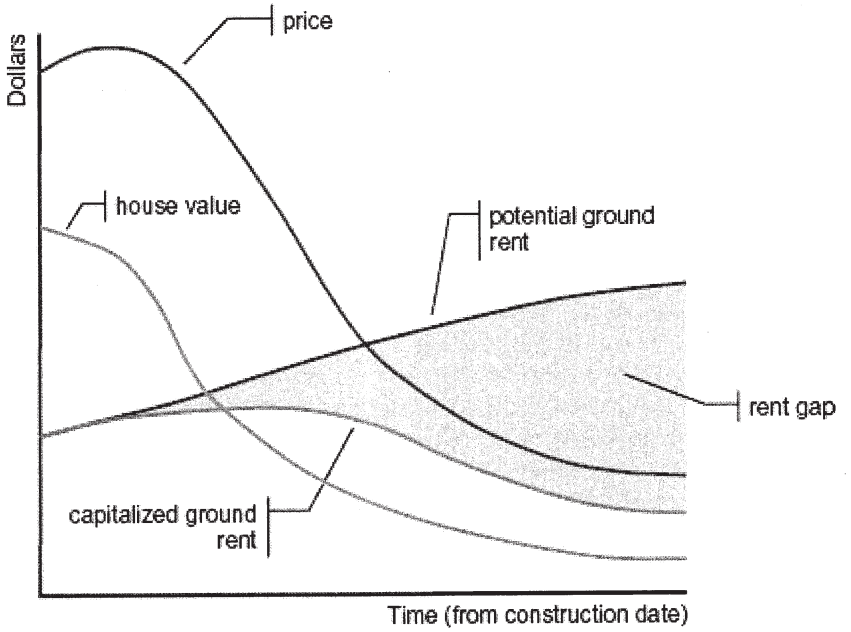

Figure 3: The Rent gap hypothesis: Changes in Rents and Values in an Inner city Neighborhood

The character of gentrification has changed dramatically in the past two decades. Wyly and Hammel (2001) periodized the gentrification process in the U.S. context. They defined three gentrification waves in the U.S. (Bounds and Morris 2006).

1. From 1950s until the fiscal crisis of 1973, it relied on public subsidies and urban renewed, directed at countering suburbanization. This wave is assumed being led by owner occupiers. Evisceration of urban programs regarding to 1970s recession was one of major aspects in the first wave. Although its effect on gentrification was ambiguous.

2. The second wave started from late 1970s, gaining momentum in the 1980s. The players in this period were entrepreneurial and speculative developers and owner occupiers.

The important characteristic of second wave according to Wyly and Hammel are as below that is mostly due to integration of gentrification into a range of national and global economic and cultural processes.

- The rise of global cities.
- Internationalization of property industry.
- Transnational professional elite
- The focus of planning ideology on public private cooperation in the creation of spaces of spectacle as Baltimore's inner harbor.

The second wave was "crashed on the rocks" of the early 1990s recession. But it is believed that the endpoint of this wave is not mature.

3. Shortly after the last above time mentioned the gentrification start to running again. Following conclusions are Wyly and Hammels explanation:

    - At the first and second round the gentrification moves beyond the neighborhoods.
    - One of the main roles is played by the larger developers who are the survivors of the 1990s recession.
    - Neighborhood resistance subsides as "the gutting and privatization of city services forced one-militant community organization to assume the role of housing and social service providers.
    - The state intervention to remove barriers for the developers to renewal.

According to Wyly and Hammel, the current situation of gentrification can be explained on part of local and federals public housing policy. Guzey (2006), examined the gentrification phenomenon in five regeneration projects in Ankara, Turkey. He also believes that gentrification is an action of state-led urban regeneration policies as a reflection of global urban restructuring with the incentive of land and property capital more than being a result of a class-led invasion of urban land.

Nilgun Ergum (2004) in Istanbul has got the result that the process reviews shows the footprints of Royal capitals in different eras of history as a political factor as well as economic considerations.

Seong-Kya Ha (2004) studied the gentrification in Seoul, Korea which has occurred through the Joint Redevelopment Project (RPJ) and the outcomes have shown the displacements of low-income groups that has mentioned by Guzy, as well.

The explanation of gentrification has largely been associated with major cities until recently (Smith 1996, Hamnett 2003, Helms 2003, Bounds and Morris 2005) but some discussions suggest that the process is mobile and adaptable at all levels in urban hierarchy, even across the countries. So it is worth to discuss the logic of gentrification

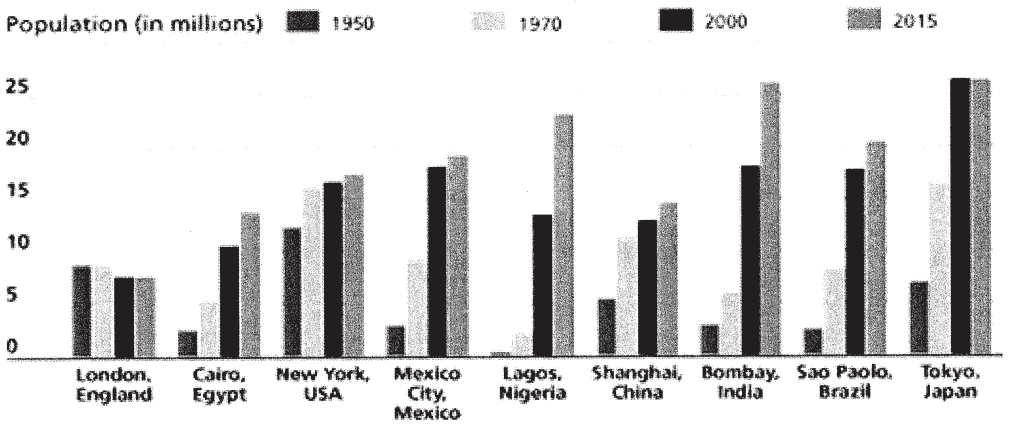

Figure 4: The fastest growing cities are in developing world

In the other statistics, it is announced that currently, 40% of the population of the developing countries lives in cities; by 2030 it will be 56%.It shows that today the fastest growing cities are in developing world. Therefore it is necessary to take into consideration the process of urbanization and consequently the urban phenomena like urban gentrification, marginalization, rural-urban migration and so forth.

Gentrification as a highly controversial process in which there are households, state and developers and land, housing type as main agents. The tangible displacements and dynamics of populations and prices make the process as a complex phenomenon in urban context of developing world.

Therefore, treating gentrification as a complex system can lead planners, decision makers and developers to find the focal points and according to pros and cons surrounding the practice of gentrification can anticipate the real future in order to provide a sustainable area.

A Hybrid Approach

In previous section we discussed the advantages and disadvantages of application of automata in urban modeling and simulation and offered a rational for developing hybrid CA_MAS models.

Torrens suggests that geographic automata systems (GAS) framework which integrates CA and MAS is most suitable method. According to characteristics of gentrification, GAS that has the ability of showing a geographic and object-based view of urban system is the tool par excellence. By GAS, urban modelers can experience much more functionally than basic automata urban system both in top down and bottom down processes (Torrens, 2003).

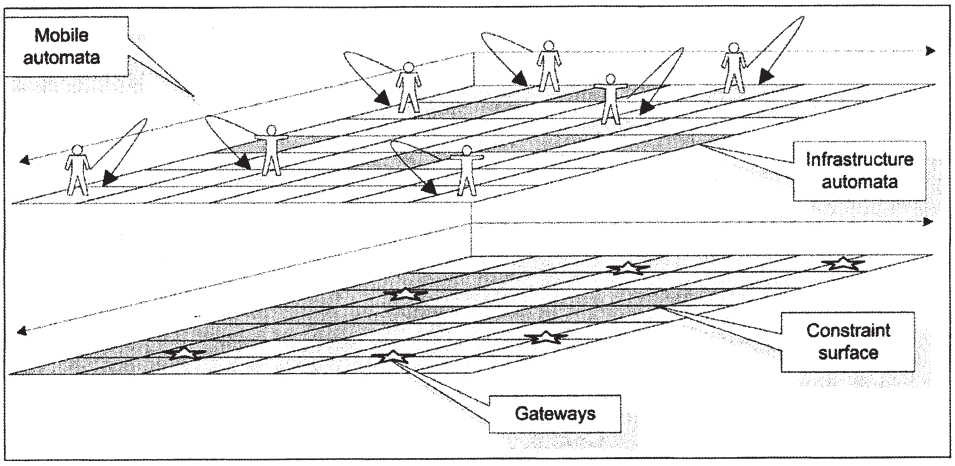

Figure 5: Cellular Automata and Multi-agent systems as information layers

By hybrid approach one can simulate the planning regimes. The hybrid approach can take into consideration the exogenous factors as well this is what makes the simulation of urban gentrification more realistic. The questions remain is which geographically rooted software can develop such type of approach.

A number of libraries enjoy widespread use of automata application like Swarn (Swarn development group 2001), RePast (Recursive porous agent simulation toolkit, university of Chicago 2003), MASON (Multi Agent Simulator of Neiborhoods), Netlogo (North

Western University, Centre for connected learning and computer based modeling, Wilensky, 1999) and UrbanSim (Urban Simulation Project University of Washington, 1998).

According to literature review and the most currently used research projects in terms of integrating CA and MAS, Netlego is reasonable platform that through its patch and turtles there can be take into consideration both fixed and mobile agents (Torrens and Narra 2007, Diappi and Bolchi 2008) .

But another platform that is more akin to GIS and can take the data management and visualization abilities of ARCMAP GIS through agent analyst extension is RePast.

Therefore author intends to use the RePast platform through agent analyst extension to examine the gentrification phenomena in Johor Bahru, Malaysia as a developing country.

Conclusion

In this paper the nature of “Complexity Theory” was reviewed and its components were explored to find it as close as the other last applied theories to model the gentrification phenomena with two mainstream ideas was explained. the per iodization of this process in one of its ‘ birth places (New York) according to Wyly and Hammel (2001) was reviewed the significance of examining and finding the main components of gentrification in developing countries regarding to speedy growth of urbanization in such areas is too clear.

However, by exploring the other experiences in modeling and simulating urban phenomena and refer to nature of gentrification process, it can be concluded that an integration of CA and MAS is par excellence method (Beneson and Torrens T,2004;Torrens 2003;Torrens and Narra 2007).

Ultimately the report platform through the agent analyst extension of Arc GIS can be most suitable toolkit in order to building the model of simulation in developing countries inner cities.

The review suggests that there are more rooms for future works in urban gentrification. As decided in prior sections it has subsequent works like marginalization and segregation that can be studied through urban studies.

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