Article

Real Estate Developers as Agents in the Simulation of Urban Sprawl

Geovanna Hinojoza-Castro [1,*], Montserrat Gómez-Delgado [1] and Wenseslao Plata-Rocha [2]

1 Department of Geology, Geography and Environment, University of Alcala, 28801 Madrid, Spain; montserrat.gomez@uah.es
2 Faculty of Earth and Space Sciences, Universidad Autónoma de Sinaloa, Culiacán Sinaloa 80040, Mexico; wenses@uas.edu.mx
* Correspondence: geovanna.hinojoza@edu.uah.es

Abstract: Urban expansion is one of the processes that generates the greatest impact on the distribution of land uses, leading to important territorial changes. Its evolution has become a highly relevant object of analysis and studies on the subject have gradually advanced from a focus on patterns of land use and cover, towards a more detailed analysis of the dynamic interactions between all the actors involved in these processes. Among the agents usually included as an active and decisive part of these dynamics are the real estate developers. This study aims to analyze these agents, identify their behavioral patterns, and categorize and better understand them. For this, a qualitative approach was employed, in which a structured questionnaire elaborated from the point of view of an expert was administrated to the real estate developers in the area of the Henares urban–industrial corridor, between Madrid and Guadalajara, where important processes of urban expansion have taken place. The information obtained from an interview with an expert and the questionnaire revealed important information about the work of real estate developers and will be of great help in the elaboration of an Agent-Based Model to simulate and analyze urban growth. This process is crucial to determine in a more empirical way the different decision rules that are necessary to develop this type of model.

Keywords: urban; agents; stakeholders; questionnaires; real estate

1. Introduction

Changes in land use/land cover have attracted the attention of scientists in recent years, as they represent one of the key processes of global environmental change [1,2]. These changes are the result of the rapid growth of urban areas, fires, and land degradation, among others, and are causing significant alterations in a large part of the earth's surface [1,3]. Urban sprawl is possibly one of the best-known changes; its rapid growth has had a great impact on the distribution of land uses, and rapid, unplanned, and unsystematic urbanization has resulted in significant alterations and changes in the territory [4,5]. Whether it is horizontal sprawl, dispersed urbanization, or peri-urbanization, the physical extent of urban areas is growing much faster than their population, which is leading to increased land consumption for urban development [6].

Urban areas, also defined as cities or metropolitan regions, are some of the most dynamic land-use change systems in the world, with strong additional urbanization expected in the coming decades, covering increasing areas of the earth's surfaces and housing the majority of the human population [7,8]. New data from UN-Habitat reveals that there are nearly 2000 metropolitan areas worldwide. In addition, it is estimated that by 2035, the majority of the population will live in metropolitan areas [6].

The evolution of these regions has become an extremely relevant object of analysis. Studies on the subject have gradually advanced from focus on land use and land cover patterns to a more detailed analysis of the dynamic interactions between all the actors involved in these processes [9,10]. Given this, the changes associated with urban growth

must be understood as the result of political/institutional, economic, cultural, technological, natural, and spatial driving forces, and all the respective stakeholders involved [11,12]. This growth is not only limited to city centers, but also includes many new urban–rural spaces functionally connected to a city [13], and these present negative impacts, particularly with respect to land-use planning, and will present new challenges including the influence of the real estate market and the planning of big cities [14].

Studying the dynamics related to urban sprawl is of utmost importance. Urban spatial planners and governments have tried to steer urbanization processes with the aim of developing sustainable cities and regions [15,16]. However, trying to understand these processes can be very complex. The need to plan for new urban developments, as well as to accelerate a transition to more sustainable urban futures, demands interventions that integrate the actors usually included as an active part of urban growth. There is a significant positive connection between stakeholder's participation and sustainability of development [17].

Real estate developers have become one of the main stakeholders in urban development and are one of the agents that make up the real estate market, which is composed of the complex interaction of several agents such as developers of non-building areas, redevelopment staff, homeowners, and resale and redevelopment designers [18]. In Spain, real estate developers have been responsible for an intense and rapid development of the territory, being one of the main causes of the rapid growth of housing [19]. These agents are driven by profit-making objectives. Therefore, it is estimated that their communication with planners, environmentalists, or other professionals in the urban sector is deemed to be insufficient, resulting in poor land-use management and uncontrolled growth of cities [20].

For years, attempts have been made to design discrete choice models to simulate the market and better understand its behavior [21]. Agent-Based Models (ABM) emerge as a powerful analysis tool in the processes of land-use change or urban growth since these types of models are focused on considering the behavior of all the agents involved. The ABM principle is based on the ability to model multiple and locally interacting agents, whose decisions led to emergent properties at the aggregate level, as is the case with urban growth [22–32].

ABMs have been applied to study a wide range of phenomena. Regarding studies describing models of the real estate market, we have already found different applications in the literature, among which we can highlight works such as that of Gilbert et al. [33], in which they introduce an ABM in the English real estate market. This model replicates the key features of a real-world real estate market using some of the main properties of the English market such as interactions between buyers, real estate agents, and sellers [33]. Continuing with this type of work, we find the study carried out by Filatova [34], where she presents a model of the urban real estate market of the city of Beaufort, USA, and which is mainly focused on economic agents. It is based on economic theory and uses spatial data and econometric analysis [34]. On the other hand, Zhuge et al. [35] present a model that incorporates information on residential location and the price of real estate developments to evaluate the land-use dynamics of Baoding, China. The model can simulate home purchase and sale negotiations by incorporating variables such as housing price and affordability [35]. Focusing on more recent work, Yun and Moon [36] develop a real estate market ABM with macro-prudential policy experiments in Korea. This simulation model is used to examine the effects of a policy setting on loan-to-value and debt-to-income, which are used by some types of government to regulate the real estate market [36]. For years, attempts have been made to design discrete choice models to simulate the market and better understand its behavior [21], but many of these have been focused on economic issues and financial interest.

With this background, we can say that many of the works carried out are more focused on studying the economic issues of the real estate market, forgetting to study the agents involved in land-use changes and specifically in urban growth. The challenge is to develop more complete models from a more spatial point of view, and thus make new contributions

to the work presented. Therefore, this research is presented as a first step and focuses on analyzing and studying the behavior of one of the main agents causing urban growth specifically in Spain.

Given this, the objective of this research is to categorize and better understand the dynamics of real estate developers in Spain. To do so, it is proposed to obtain information from questionnaires and interviews that will help us to better determine their behavior and, in turn, allow us to identify the different profiles of developers working in the Henares urban–industrial corridor. This process is crucial for the development of an ABM to simulate and analyze urban growth. This research would give us the necessary information to define in a more empirical way the rules of behavior, i.e., the rules that motivate agents to take actions and which are an important component in the basic structure of ABMs.

2. Study Area

The study area chosen for this research is the Henares urban–industrial corridor, located between the cities of Madrid and Guadalajara (Spain). Previous studies have shown that urban sprawl in the Madrid metropolitan area increased significantly during the 1990s, reaching 200% of the construction area [37]. This dynamic expands mainly to the municipalities that compose it; thus, for this research, a part of this metropolitan area has been selected as a study area, specifically the urban–industrial corridor of Henares. According to previous studies, the corridor has presented important processes of urban expansion, which have surpassed its limits [38,39], highlighting its privileged strategic location.

This area is located in one of the main logistics hubs in Spain (Figure 1), with a large demographic increase and strong demand for housing. Its distribution along the most important transportation axes such as the A-2 highway, which links Madrid and Barcelona, and the railroad network that also links these two strategic areas of the national territory makes it an attractive area for future developments. These characteristics, along with the expansion of a promising real estate and industrial market, make the urban dynamics of the corridor active and are reflected in important territorial changes [40].
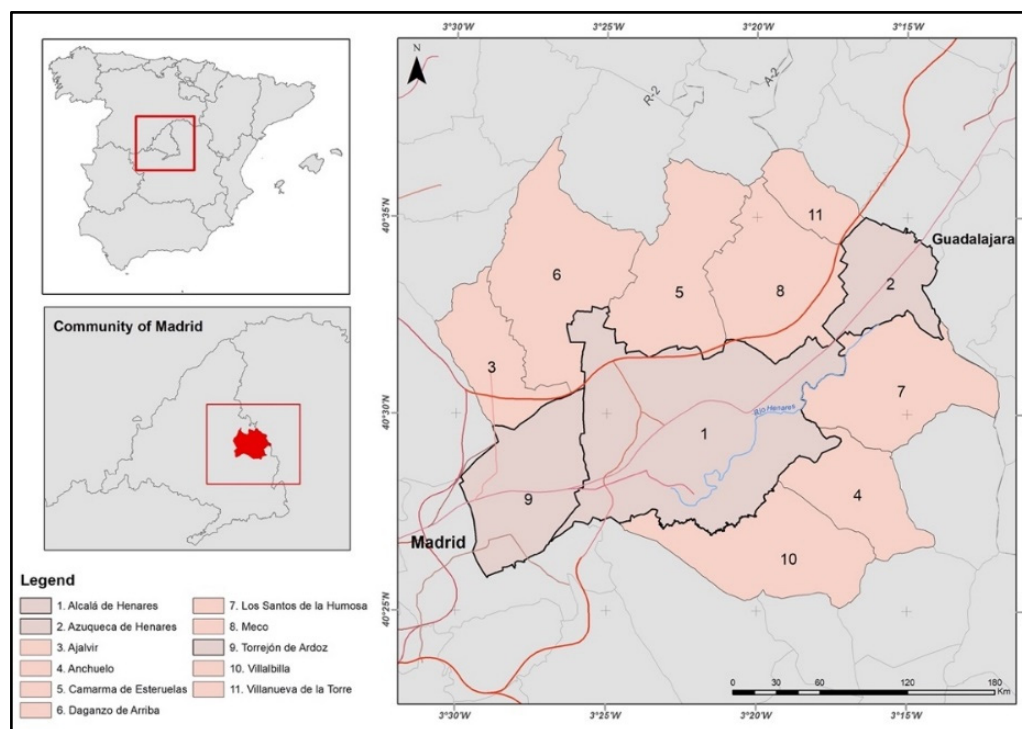

Figure 1. Study area.

In recent decades, the corridor has witnessed a renewed expansion due to the Spanish real estate boom [41]; therefore, for this research, it was decided to work with a sector of the corridor, where, according to official data from the municipal census (Table 1), as of 1 January 2021, the population was 427,371 inhabitants [42], becoming an important industrial and residential corridor towards Guadalajara. Its central axis, composed of Torrejón de Ardoz, Alcalá de Henares, and Azuqueca de Henares, together with the municipalities of the southern and northern axes, present a very dynamic area in terms of urban development [43].

Table 1. Population growth per municipality.

	Population	
Municipality	**2011**	**2021**
Alcalá de Henares	203.686	195.982
Azuqueca de Henares	35.236	34.195
Ajalvir	4111	4676
Anchuelo	1135	1359
Camarma de Esteruelas	6682	7555
Daganzo de Arriba	9268	10,520
Los Santos de la Humosa	2297	2729
Meco	12,554	14,903
Torrejón de Ardoz	122.589	132.771
Villalvilla	10.465	15.049
Villanueva de la Torre	6284	6591
Total	**413.266**	**427.371**

Source: Own elaboration based on data from Instituto Nacional de Estadística (INE) https://www.ine.es/index.htm (accessed on 30 May 2022).

3. Methods

Among the methods used for the collection and interpretation of data in research, we can find qualitative and quantitative methods. This study adopted a qualitative approach that focused more on understanding people's experiences, attitudes, behavior, and interactions.

3.1. Identification of the Agents

The most important defining characteristic of an agent is its ability to act autonomously; agents are equipped with behaviors that allow them to make independent decisions. Agents are normally active, initiating actions to achieve their internal objectives, rather than simply passive, responding reactively to other agents and the environment [44].

3.2. Characterization of Real Estate Developers

The identification of behavioral patterns and human decision making can play a fundamental role in any process on urban dynamics, but it can also be a great challenge as it is extremely complex [45]. This is why experts have used different types of methods to try to understand and identify these patterns. Among the methods used for the empirical characterization and parameterization of human decision-making processes, we can include expert knowledge, surveys, interviews, and participant observation, among others [46], and in many cases it is necessary to iteratively combine several methods. Two of these methods were used for this study: expert knowledge and questionnaire.

3.2.1. Expert Knowledge

Expert knowledge ranges from conceptual mappings by the experts themselves to informal conversations from which expert knowledge and information can be obtained [47]. In this case, and given the importance of real estate developers for this research, we contacted the Madrid Real Estate Developers Association (Asociación de Promotores

Inmobiliarios de Madrid) (ASPRIMA), where we had the opportunity to have a dialogue with the person in charge of the general management. We were able to obtain access to important information about real estate development in the corridor and access to some of its associated developers. In addition, with this information and their advice, it was possible to improve and better target a questionnaire that was subsequently sent to a group specializing in urban planning and real estate development.

3.2.2. Questionnaire

With respect to surveys or questionnaires, these are an established method of data collection in the social sciences, mostly consisting of a list of questions, each with pre-defined sets of possible answers, and are usually disseminated by email, in person, or by telephone [46,48]. Questionnaires are the primary means used to collect information through a survey. The design of a questionnaire can be structured in a pyramidal way, i.e., in the initial part we have the general principles, and as it progresses, we find the more specific principles. The idea of this structure is that there are a smaller number of general design principles that expand to a larger number of specific principles [49]. When using this type of method, it should be kept in mind that there is a potential conflict between the information the researcher wishes to obtain and the information the respondents wish to provide [50]. Therefore, it is important to prepare a clear, straightforward questionnaire of reasonable length.

The design of the questionnaire was self-made with the help of ASPRIMA staff and was intended to find out the reasons that induce the real estate developer to make certain decisions regarding new urban developments.

The questionnaire was divided into three sections with a total of 18 questions and was structured as follows:

Section one: This part of the survey was based on general questions of the agents, in order to obtain a better understanding about the type of developer and what kind of projects were being developed by their company. Some of the questions included were based on what kind of specific work this promoter does; that is, in real estate development there are different phases (phases of the real estate process), and it was important to know in which of these phases the agent was involved. Another important question in this section was related to potential demand: whether they work with a specific target demand or whether they work on the basis of market demand. This was to understand the characteristics and needs of the potential demand, which helps us to know what services or type of developments the population is requesting.

Section two: This section focused on the activity developed by the developer; the objective was to obtain information related to the reasons why a real estate developer chooses a specific area for urban development. In this section, information was pointed out related to the importance of the purchasing power of the population when looking for new development areas and what kind of information is taken into account to study market demand, for example, employment volume, income levels, mortgages, indicators of the level of economic activity, etc. In addition, it was considered important to ask if they use any information of the employment and unemployment rate in the area. To close section two, some questions on demographic profiling and the level of importance of different factors when analyzing the real estate market, among others, were added.

Section three: This part of the survey focused on the future of real estate developers. The questions here were related to the generational changes that are taking place and whether these have any significance in the approach to new developments. It was also emphasized whether studies on urban growth, specifically those using future scenarios, were taken into account. Finally, questions were added about the objective of the new developments, whether they consider continuing with the same type of projects, or whether their offer will change with the arrival of the new generations.

The questionnaires were distributed via email, except for a few of them, which were made directly to real estate development experts present at a collaborative mapping work-

shop held at the University of Alcala [51]. Respondents were not financially compensated for responding to the survey.

4. Results

4.1. Real Estate as Agents

After analyzing the urban dynamics of the study area and reviewing the literature, it was possible to identify real estate developers as the agents to be studied.

Real estate developers are among the actors whose decision making can produce real changes in the territory, being one of the main agents that promote the construction of new housing [39]. The Spanish Building Law (Ley de Ordenación de la Edificación) (LAW 38/1999, of 5 November 1999) defines real estate developers as "natural or legal persons, public or private, who decide to promote, program and finance building works with their own or other people's resources" [52].

According to Amadeo (2021), we can highlight that within the real estate market we can distinguish four types of real estate developments [53]:

1. *Residential developments*, which include both new construction and renovation/resale properties. The most common type of housing is single-family homes, although we can also find multi-family, mixed, vacation homes, etc.
2. *Commercial developments* include shopping centers, medical buildings, hotels, offices, etc. In addition, private apartment buildings are often considered commercial, although in some cases they fall into the mixed category.
3. *Industrial developments* include buildings for storage, production, and distribution of goods. Some of the distribution buildings can be considered as commercial. These types of developments are classified differently by their spatial location.
4. *Developments of undeveloped areas*, including undeveloped areas and vacant land. These developments in some cases are combined with other adjacent properties in order to increase their density and the value of the property.

Although much of the real estate market is driven by economic principles, there are several factors that were taken into account when considering future developments that may prompt real estate developers to act (Table 2). The following table lists some of these factors.

Table 2. List of driving factors on real estate developers.

General Factors	Description
Interest rates	*Investment rates affect the cost of mortgages*
Taxes	*Interest rates may vary by country. Each one establishes different interest rates that end up affecting the cost of the loans. That is, a low interest rate will allow more people to acquire a property, since the cost of the mortgage is lower*
Investments	*The value of properties tends to increase over time, which makes them an investment opportunity, leading to an increase in demand.*
Local Factors	
New construction	*Increases the supply of the real estate market by providing new properties for sale/purchase*
Transportation	*Having easy access to public transportation increases the demand for a real estate development*
Land use limitations	*One factor to take into account is the use that can be made of the land, since it may be limited according to the urban classification assigned to it*
Job availability	*Access to jobs directly affects local real estate demand*
Age	*In most cases, the age of the population plays an important role. For example, on many occasions, the retired population chooses to downsize and move to quieter developments*

Source: Own elaboration based on https://realtyna.com/blog/how-does-the-real-estate-market-work/ (accessed on 1 July 2021).

From a general point of view, it is possible to point out that the real estate market is, by nature, unobservable, which makes it difficult to understand entirely. However, it can be evaluated from different perspectives.

4.2. Analysis of the Stakeholder's Participation

After studying the information obtained from the meeting with the real estate market expert and analyzing the data from the questionnaire conducted with the developers, it has been possible to approach some factors that influence their behavior and understand some of the reasons that lead a real estate promoter to build new developments.

Initially, a first approach was made to some of the real estate developers in the area without much success. Subsequently, and in collaboration with ASPRIMA, the questionnaire was distributed to the associated promoters. A total of 25 surveys were sent out and 10 of them were answered. It is important to mention that abstentions were found in some of the questions and 20% of the respondents did it anonymously.

Following the order and structure of the questionnaire, in the **first section** it is possible to highlight that the information being used comes from developers dedicated to the use of single-family homes, mixed residential (housing and commerce or services), and multi-family use (high-rise blocks). On the one hand, there are the developers that expand the city through the construction of urban land, corresponding to the horizontal growth of the city, as it expands along the peri-urban edges. On the other hand, we have the developers who extend the city in height, multiplying the urban land vertically; these types of developers tend to build and rebuild within the city, and thus, they are intervening in the urban dynamics modeling and remodeling the city and the periphery. In the case of previously constructed buildings, they are venturing into rehabilitation to achieve modern and dynamic environments. In addition, the questioned agents were involved in different phases of the real estate process. Based on the fact that 40% were in charge of the "potential offer" (where a soil analysis is made for investment and the potential areas for building are studied), this is the first stage of the process. On the other hand, 40% reported that their work within the company was limited to "potential demand"; this the stage of the process where everything related to economic information is carried out, for example, by demographic analysis, segmentation of demand by price, etc. Finally, 20% indicated that they were involved in each of the phases of the real estate process, including "current real estate developments", where they are in charge of marketing, new construction licenses, and construction follow-up, among others. The last part of section one of the questionnaire focused on trying to understand where their offer was concentrated, i.e., whether they work with a certain target or if they work according to market demand. Here the responses indicated that real estate mostly works according to market demand; however, they also depend on the type of developments they are carrying out and, in turn, on the different types of demands, and at other times they are more focused on the client and on a previous optimal product study.

Now, focusing on the information about the activities carried out by the developers (**second part of the survey**) and the demands they have for new urban projects, we highlight that more than 60% consider purchasing power to have medium importance, while 40% consider it to be a point of major importance at the time of developing new projects. One of the important points that is not taken into account on many occasions is the one related to the data these agents use to study the potential demand of the real estate market. According to the answers given, *price evolution* is the most used type of information for the study of potential demand, in addition to information on income levels, employment volume, and economic activity level indicators. Regarding current market demand, 25% said they used information on employment and unemployment rates in the area of interest, obtained from official websites and private initiative reports. It should be noted that most of the respondents omitted to provide information on how they determine the demographic profile of the population in the area where construction is planned. However, according to the data obtained, it is possible to say that in order to obtain this type of

information, they make use of sociodemographic and market studies with optimal product analysis, most of which are reports made by consulting firms.

Investigating a little deeper into the factors that are taken into account when analyzing the current real estate market or planning a new development, we can say that the answers provided are based on the type of projects of each developer and the information on the factors has been varied. Nevertheless, one of the factors that stood out the most was related to location, and specifically the location of the new homes with respect to communication networks (public transportation and highways). This brings us to the information related to the accessibility to urban means of transportation; here, the most relevant data for them are those related to the location of bus stops, train stations, and commuter trains. Along the same lines, another factor that developers take into account and that is important in the planning process of new developments is *risk factors*. These are considered to be the reason why a real estate development is not successful, and in this case, the question was open-ended, and respondents agreed on many of their answers among which we found were: the increase in construction costs, lack of demand, poor location, employment, and negative macroeconomic indicators. This information confirms that they do pay attention to information related to the study area and that on some occasions they tend to hide their actions. To conclude the second section of the questionnaire, it focused on asking about studies on urban dynamics. We were interested to know if studies on these dynamics are taken into account or if they do not analyze this type of information. Most of the respondents answered that they do not consult about these dynamics, and only three said they were informed about these studies, agreeing to consult the General Urban Development Plan, studies carried out by consultancies, or those prepared by ASPRIMA. This information is used to analyze future supply and the foreseeable timetable for new developments.

The **last part of the survey** was focused more on the real estate developers of the future and how the new generations can present themselves as a new challenge for real estate companies, i.e., the changes that can be requested compared to the current market. In this section, the interviewees provided different opinions on the future of their developments. Some consider that, with the new generations, the changes that are likely to take effect in comparison with the current market will be internal, i.e., they foresee that the focus will be on *Coliving*. This would be a new form of shared housing, to reside and telework under the same roof, and provide a flexible rental. The respondents also mentioned that they will be targeting a completely different customer than the current one and that for some developers it may become a problem of adaptation. On the other hand, there are those who believe that there will not be such an important change in future preferences; however, they are aware that the new projects will be more sustainable, and some changes will have to be made in relation to the advance of technologies. To conclude the questionnaire, it was interesting to know that out of all of the respondents, only one of them admitted to carrying out studies with future scenarios as support to visualize the real estate market in the upcoming years.

Taking into account the information obtained from the literature on real estate developers and despite the low participation in the survey, it is possible to say that valuable information has been obtained, which gave us a clearer idea of the behavior of developers. By analyzing the information, it was possible to define up to three real estate promoter profiles.

Traditional real estate developer. This type of developer does not take too many risks when planning new projects and follows the same pattern, i.e., they focus on the promotion of urban land to be built and leave innovation aside. They are mostly focused on building multi-family developments.

Innovative real estate developer. This type of developer tends to be cautious when planning a new project. They do, however, tend to study potential construction sites using available information such as income levels, transportation, and communication routes, among others. Most of them are multi-family and single-family developments.

Risky real estate developer. This type of developer is the one that takes the risk of carrying out more ambitious promotions, with larger developments and bets on building more modern homes, of which we can highlight single-family homes, but they also take the risk of building multi-family homes. They tend to be owned by larger companies and sometimes hire private companies to study the territory where they intend to build. However, these types of developers also build where there is the possibility of building and sometimes do not carry out the necessary studies.

These three profiles represent the agents involved in the urban dynamics around the Henares corridor and are one of the main actors responsible for the land-use and cover changes in the area.

Real estate developers have been studied as a homogeneous group and their activities have been described as part of the urban changes or urban growth, even sometimes just economic transactions (sale/buy/rent), but the results in this study show the importance of distinguishing the differences between these agents, since based on their characteristics they can produce different effects in the territory.

There are a lot of aspects to take into consideration when talking about the impacts that these profiles have and have had on the land. In general, it is important to know different factors such as the size, type, or location of the new developments, and how these developers act according to their characteristics and their possibilities. Although the three profiles can work in a very similar way, there are certain variables that can be decisive when executing a new development. For example, traditional developers tend to work in areas closer to urban centers, while innovative developers do it in a more disperse way. In general, it can be difficult to summarize the impacts of each profile, as a lot of their impacts have to do with the time, the economic situation, and the opportunities that these agents have in the area. Sometimes risky developers have a greater presence in the area and can develop more houses than traditional developers and vice versa.

As a last point, it stands out that the importance of these results are as part of the development of an ABM, as these profiles are the first component (agents) of the model (Figure 2). These agents take into consideration different factors when developing the inter-actions with other agents (including territorial policies, land use, market demand, among others) mentioned in the questionnaire, and classifying the developers into these three profiles simplifies this process and helps to understand better the dynamics of the model.
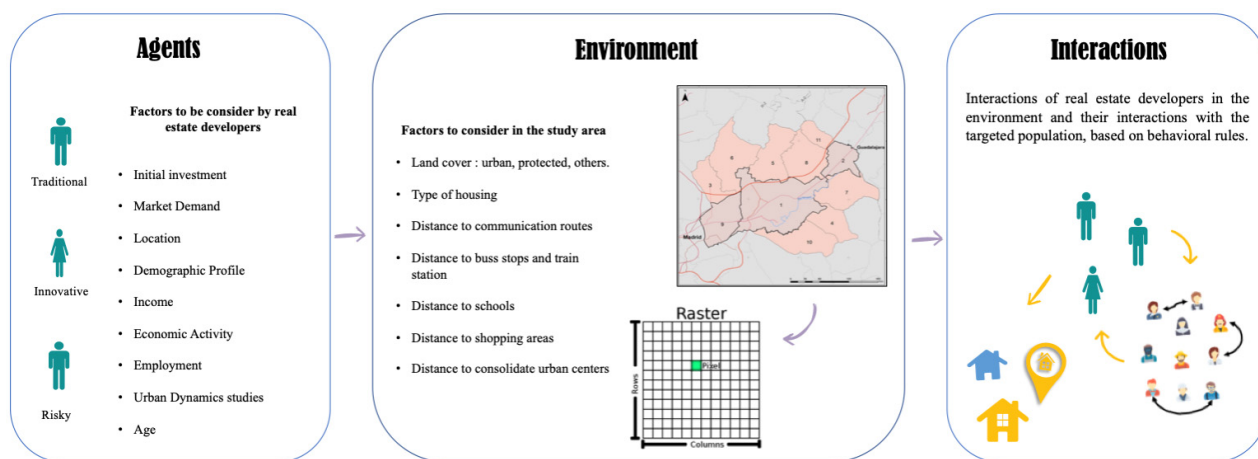

Figure 2. General framework of the components of an ABM.

5. Conclusions

Collecting the perspectives of different real estate developers has helped us to understand their behavior more when planning new developments. It is possible to say that the results obtained from this study show the different characteristics that a real estate developer can have, and this represents an advance in the study of these agents.

The use of stakeholders' participation in real estate development can be measured and enhanced to characterize these agents in a more empirical way. Using the Henares urban–industrial corridor as a study area and the methods applied for the characterization and parameterization of human decision-making, it was possible to comprehend the actions of these agents in the area.

This study highlights the different types of real estate developers and how these can produce different urban changes. However, it is important to mention that, although interesting answers have emerged from this study, is not exempt from limitations.

Likewise, it makes visible the need for better communication and interaction between all the agents involved in the urbanization processes, with the aim of developing sustainable cities.

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