Radboud Universiteit Nijmegen

DETERMINING REQUIRED HOUSING STOCK BY MONTE CARLO SIMULATION: ISTANBUL CASE STUDY

MASTER THESIS

BY

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Abstract

The basis of planning is the idea of creating a 'good' city (Steele and Ruming 2002). Therefore, planning discipline needs to analyze market needs well and create balance with public interest while preparing implementation plans. However, sometimes current practices cannot fully respond to market dynamics and efficiently integrate uncertainties into the system. This situation leads to deficiencies while determining the required stock of urban functions and interpreting the needs. Luckily, it is possible to integrate more parameters into the systems and test many variations. Thus more effective studies can be realized based on these detailed analyses. This thesis examines the integration of many parameters into the system during the planning process. On this purpose, this study explores the development of future based projections for planning decisions by the Monte Carlo Simulation method. It runs the desired repetition in the specified variable range and tests possibilities with nonparametric data sets to determine the housing stock to be needed.

Keywords: Monte Carlo Simulation, Reducing Uncertainties, Urban Planning, Housing Stock

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1. INTRODUCTION

Several studies had addressed the application of the Monte Carlo Simulation method in real estate related disciplines. Baroni et al. (2006) and Young (2007) used this method in asset valuation, while Atherton et al. (2008) used it in profitability analysis. Balcombe and Smith (2007) applied the Monte Carlo simulation method while reducing the financial risks in the cost-benefit analysis as well as the planning of real estate projects. Gimpelevich (2011) used it for risk management and decision-making in project valuation. Unlike previous studies, the Monte Carlo Simulation is applied to the planning phase of zoning plans.

The decision-making process plays a key role in spatial planning. It is crucial to be careful in demand analysis well during the planning decision process and to determine urban function needs. In particular, investment decisions and prospect constructions are the results of these analyses. Therefore, decision-makers should be aware of the importance of this process and take steps accordingly.

Monte Carlo simulation can be used as a tool to measure realistic and natural uncertainties, including forecasts used to model long-term planning decisions and as an opportunity to reduce the unexpected results of constructions. In this direction, it is possible to determine the parameters by considering the past years' actualized values including extreme distributions. The simulation offers users the opportunity to interpret uncertainty. In other words, a structured and purified approach can be created in Monte Carlo Simulation by integrating the uncertainties into the decision-making model.

Kirkpatrick (1994) and Gimpelevich (2011) described three factors that have contributed significantly to real estate project evaluation. These factors are: (i) government interventions required in cases where the market is damaged; (ii) determination of public investment decisions for economic growth as a result of reduced capital efficiency; (iii) expanding the cost-benefit analysis, both to increase project integration and to improve policy analysis and to include concerns about sustainable development and environmental impact. Since zoning plans are the product of government policies, this study was directly focused on the decision-making process of planning to create efficient implementations.

1.1. Problem Statement

The real estate market is one of the most dynamic sectors in Turkey. At the same time, it has a large share in the national economy and acts as a pioneer. Therefore, it is very important to make the right moves at the right time and prevent possible mistakes at the beginning of the planning phase. However, the real estate market faces many problems due to the practices in the planning process such as inadequate analysis or misuse of the power etc. The two major problems as a result of this process can be defined as follows.

The first problem is that the processes followed during the preparation of the zoning plans cannot be managed efficiently and there is a low consistency on the layered planning system. As a result of these type of applications irreparable situations can be observed such as traffic, vision and air pollution, destruction of historical textures, increase in building density, ecological problems, unplanned growth and so on. Unluckily, Istanbul is a good example of this situation with high building density and uncontrolled population growth. It is difficult to say that people in Istanbul live in high-quality living spaces when it is examined in terms of urban functions. According to the Mercer Quality of Living Ranking 2019 survey, Istanbul ranked as 103 out of 231 cities.

The second problem is the process followed when developing real estate projects. The decisions taken by real estate developers before starting the project are of great importance. Relatedly, zoning plan regulations have an important role in the decision process of investors and real estate developers. It is crucial for the future of the real estate market to prepare zoning plans with high spatial efficiency. This can be provided not only by adhering to the traditional planning tools but also by comprehensive analyses that take into account market dynamics. Decision makers on planning phase cannot look aside market needs. These decisions will designate the future of the market. Therefore, urban capacities should define with a market-oriented approach and needs. With this approach, it is possible to create cities with healthier living spaces and also an attractive market for developers. Plans that exclude market dynamics and prepared based on traditional physical planning approach performs insufficiently in İstanbul and it is a crucial area to research. The motivation of this study is to develop a successful method proposal for the solution in this field.

In recent years many office, residential and shopping centre projects have been developed in line with the objective of Istanbul Environmental Plan 2009 which is horizontal growth of the city and the creation of multiple centres in the city. It can be observed that the Istanbul Environmental Plan 2009 is not mounting on the efficient analysis. Because the projects developed have either changed their functions, could not be rented or have a low sales rate. This study has been prepared with the motivation of this and similar situations where analysis and planning are insufficient. Another project on the agenda of Istanbul is the Canal Istanbul project. An alternative ship crossing line to the Bosphorus crossing is aimed with this canal project. Commercial areas, factories, houses, in other words, a new city will be created around this channel. The national government had planned 1.2 million population in this area. Now it is reduced to 500.000 people. This region will be a district of Istanbul, not a new city. Therefore, it is thought that with this canal project, which will change the history and the future of the city, the solutions proposed by this thesis can be evaluated at least in the new planning and real estate development studies. In this study, unlike conventional planning principles, Monte Carlo simulation is used as an alternative method which includes many different parameters in determining the size of urban function areas. It is possible to foresee future demand by considering the existing stock capacity and market response with this method. Monte Carlo simulation provides interpretation based results. According to the projection time, the system can be operated with the required number of repetitions and offers all the results to its users. It is undoubtedly left to the planners to determine how the urban functions will be distributed in the context of the internal dynamics and the relationships they establish with other functions and how the land use structure will be in local areas. Nevertheless, it is thought that this consistent quantitative analysing method will make an important contribution to the decision-makers in the planning stage. This method can be useful, especially in the calculation of housing density and thus in the development of high-quality urban living spaces.

1.2. Research Objectives

The aim of this study in line with the motivation is testing the applicability of the Monte Carlo simulation method, which can be used simultaneously with a large number of parameters, in order to determine the spatial size of urban functions in the planning process. Monte Carlo simulation has been used to determine the total demand for housing stock in Istanbul case within 15 years projection. The aim is to compare the simulation results with the current housing stock and to determine the market gap to be fulfilled in this projection or if there is an overstock in the market, evaluating it critically.

In this study, it is questioned whether the stock need can be determined by considering the market demands throughout the city for the housing function in Istanbul. An alternative method has been offered for the preparation of zoning plans in accordance with the standards specified in the Spatial Plans Construction Regulation. The population growth is calculated based on past years increases and the real estate market dynamics are used while calculating the required housing stock. The applicability of the Monte Carlo Simulation method at determining the size of urban functions in cities is opened to discussion in this way. The Monte Carlo Simulator is suitable for analysing non-parametric data in a time series and foreseeing future demand for the determined planning period. The data obtained in the light of this study is suitable for comparing the spatial sizes of urban functions determined by traditional methods with the existing stock and discussing in the direction of future market needs. In particular, this method was tried by considering the need for an efficient analysis with the concern of the continuous development of new projects in Istanbul and the increase in the density of the buildings with the growth of the city horizontally and vertically. Thus, a different perspective is presented for public institutions with the planning authority and academicians in the spatial planning discipline. It also provides concrete results not only to decision-makers and academicians in the planning process but also to professionals in the real estate sector for use in project development processes. In this context, the main research question based on the purpose of the thesis is:

- How can planning decisions be improved with nonparametric data analysis and simulation methods?

And there are a couple of supportive sub-research questions to answer the main research question. These are listed as follows:

- What kind of dynamic base documents can be created for decision-makers in urban planning process?
- How can uncertanities be reduced with simulation models?
- How can projection models be improved?
- How can the required housing stock be estimated?
- How can market needs be integrated into the existing planning system?

1.3. Relevance

1.3.1. Societal Relevance

This study seeks to provide solutions for urban planning in developing countries and uncontrolled growing cities. But also the created base system can be adapted to other countries. Parameters or country dynamics may vary in each case. However, basic human rights such as accommodation, enough living space and healthy urban planning should be provided by states and this is the main social concern of this study.

It is not appropriate to consider Istanbul as an ordinary city because it is a unique city with its own dynamics. Especially the population density, continuous development and uncontrolled growth bring many negative conditions to the table. As mentioned earlier, according to the Mercer Quality of Living Ranking 2019, this city is the 103rd out of 231 cities. Besides, according to Euronews (2019), Istanbul is in the last place among the 34 cities in the World Cities Culture's latest report, with 2.2% green space. This situations make spatial planning very crucial about future implementations and also for inhabitants healthy life.

One of the main goals of developing countries' is continuously expanding their economies. The continuous increase in business opportunities depending upon national government policies cause continuous migration to the big cities which also increases density in living spaces. Istanbul is the economic centre of the Turkey and one out of four of the population lives there. This uncontrolled growth performed unstable over many years in the city. Many data can be used to measure the growth in the economy, such as unexpectedly changing exchange rates due to political or other reasons, population growth, immigration and housing offerings, increased population density, employment rate and so on. Because of the unstable atmosphere, uncontrolled development and misuse of power, Istanbul have had problems in terms of planning implementations, and also better-living conditions.

It may not be possible to reverse previous planning mistakes. But it is thought that prospective planning can be made more efficiently. Alternative studies can be developed to create greener, more useful living spaces for the people of this gorgeous city. Especially, it has been progressed on the basis of creating as "required" (not much!) residential areas for everyone. Therefore, it was aimed to warn the decision-makers with the minimum housing in 2033 and to prevent excess stock with the new projection. By transforming these overstock areas into green spaces or social facilities instead of new housing, the quality of life of the people can be improved and the city can become more attractive. In addition, development plans fed by such comprehensive analyzes will increase public confidence and cause politicians to provide more efficient services and public trust in them. It is thought that this study considers the public interest and presents improvements in the current planning system in line with the development objective of the country, thus helps stable economic growth.

On the other hand, it is important to develop functional projects for real estate developer. Therefore, decisions taken during the project development phase are of great importance. It can be possible to achieve targeted revenues with well-planned projects and allocations.

Otherwise, especially after the completion of large-scale projects, the possibility of making changes on functions and reaching to the target revenues are very limited. Real estate developers can foresee the stock needs of the city and make new investment decisions based on past years analysis and reflection on future predictions which is presented by this study. This also affects the people who are living in this new investment area. Real estate development cannot be evaluated only for making a profit. It is also related to the people in the specific development region.

1.3.2. Scientific Relevance

As stated before, the Monte Carlo Simulation method is not unfamiliar for the real estate market. Baroni et al. (2006) and Young (2007) used this method in asset valuation. Balcombe and Smith (2007) applied the Monte Carlo simulation method to reduce the financial risks in the cost-benefit analysis. Gimpelevich (2011) used it for risk management and decision-making in project valuation. Leung (2014) used if for real estate development. There are many other academic studies related to this method but none of them combined this simulation method with urban planning. As it is explained detailed in the method section, the Monte Carlo Simulation method provides the desired number of results about uncertainties and possibilities. These are crucial key points while deciding about urban function usage. This study is trying to fill the gap of non-parametric parameters effect on analysis while allocating the urban functions in the cities.

The data sets that are used in the Monte Carlo Simulation are non-parametric and may vary from year to year. Therefore, when we want to analyse the current system and see the dimensions of growth, it is necessary to focus on non-parametric studies. As stated above, the aim of this study is to determine the required housing stock in Istanbul in 2033 according to the non-parametric data sets and to flash on a new perspective to ensure that the obtained values are used in planning studies. It is not possible to reach a specific result with unstable data sets. Therefore, instead of statistical tests that yield definite results, simulation methods that present the final results and are open to interpretation are examined. While doing this analysis, it is aimed to improve previous implementations' projections.

In the case of Istanbul, current housing stock, population, population increase, average household size, living space per person are examined within the scope of this study. In this respect, the parameters' range is predicted for each data set with Monte Carlo simulator and the stock requirement is calculated. Most of the traditional planning systems have the projections for the future. These are the basic calculations which do not consider market dynamics and non-parametric changes in the countries. It is aimed to calculate the housing stock that will be needed in 2033 in Istanbul by analyzing these non-parametric data sets and improve existing academic studies with a new perspective. The results shed light for professionals and scholars in the planning discipline.

2. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1. Planning and Conceptual Discussion

According to Steele and Ruming (2012), the starting point of modern western planning is organized with strong reformist ideals around improving living conditions and questioning "good" city and region with intellectual and professional movement approach. Planning systems implemented in this sense have common sets of characteristics. These are a legal framework, a regulatory system, political decision-makers and the ratification process (Carmona and Sieh, 2004). According to Louis Albrechts (2004), the land use plan is concerned about the development of land required for various land uses. Plans embody a proposal on how the land will be used for future expansion and restructuring in line with existing policies.

Planning legislation in European countries was prepared at the beginning of the 20th century to overcome the increasing population density and problems arising from uncontrolled developments. Cultural, institutional, legal differences and the specific objectives of countries' have created a wide range of planning traditions and systems in Europe (Albrechts 2004). Plans have been prepared with a focus on the regulation of the physical development of cities with the pressure of restructuring and Fordist urbanization after World War II and determining which function will take place in the twentieth century. Almost all over the world, a planning model based on the ideals of hierarchy (horizontal-vertical relations between planning layers) and dirigism (the implementation of plans under the leadership of the state) was supported (Rivolin 2008).

The creation of safe, healthy and functional living environments has been a central rationale for modern urban planning while minimizing the negative social, economic or environmental impacts of private developments. But the principles of sustainability agenda challenges this authority by expanding its borders. For instance, the decomposition of potentially competing land uses is seen as a symbol of the modern Anglo-American planning trend. It is implementing through zoning plans. However, especially the increase in usage of personal vehicles, the separation of land uses in this way caused new environmental problems (car addiction, traffic congestion, air pollution) with the supply of new housing provided far from work and other public services. More "sustainable" approaches to land use planning emphasize the necessity of mixed-use projects, and are suggesting that they should be located around public transport, preferably to reduce car dependency, dispersed developments, to involve urban development with higher density forms of construction (Newman and Kenworthy 1999; Talen and Knaap 2003; Gurran and Bramley 2016).

According to Berry and McGreal (1995), planning regulations are a pioneer factor as affecting the socio-economic framework and capacity for real estate investments. In addition, the authors point out that there should be a balance between planning regulations and new investment opportunities. Berry and McGreal (1995) argue that planning systems should be equipped with market priorities in parallel with the changing role of the state in the post-Fordist economies. Land and real estate are part of the strategies in the financial sector as an investment instrument. In addition, portraying a positive and flexible image for economic growth, sustaining and expanding existing investments in favour of new investments in alternative locations are important for increasing overall investor confidence (Keivani et al. 2001). The decision-makers should pay extra attention to balancing the needs of the market and objectives of the state.

Authorities that shape and determine spatial-economic development in cities are obliged to include the existing building environment in the system and mediate the real estate market. Therefore, the development and role of real estate markets are crucial to the competitive stance and success of cities in developing global economies (Keivani et al. 2001). According to Oxley (2004) and Gleeson et. al. (2004), one of the goals of planning is responding to market failures and imbalance issues with an emphasis on cost and benefit analysis. The market cannot guarantee regular productivity and cannot shed light on planners to make 100% accurate decisions. Therefore, it would be better for planners to act with traditional methods rather than purely market-oriented approach. According to Whitehead and Monk (2006), a key productivity objective of planning is to produce higher societal values by directly considering externalities and other market failures and ensuring an adequate supply of public goods. Therefore, an efficient land use planning system produces both higher social welfare and land values due to increasing demand as a result of a well-regulated urban system.

In general, if we connect the supply and demand relation; If all other factors remain the same with increasing supply, the density will be increased. As the number of units increases in any land, it reduces the cost of land per unit. In the planning phase, it is necessary to maintain this harmony by considering the global economy, produce as much as the growth potential of the region and to create a balanced system for investors and the urban needs.

Urban plans are implementation and design tools to use in the organization of space, not a goal. The aim is to reach the target with the least energy and time loss, with the most effective and rational result within a certain period of time, and a plan is a tool to achieve these goals. Land use regulation is a legal or administrative system that specifies what kind of use can be allowed in a particular land parcel. "Use" illustrates both the type of activity defined (i.e. housing, industry, trade and the like) and the type, scale and shape of the buildings that are the product of such usage rights. This regulation comes into play when landowners try to change or implement the "use" of land; this type of use can be defined as “development". There may be two main reasons why this form of regulation is associated with planning. The first reason for that, it is in the form of a map (i.e. a literal zoning plan), which also shows the current situation, a common and natural way of expressing existing or permissible land use models. The second reason is that the decisions about future land use to be allowed are often brought up in the context of forward-looking comprehensive policies and documents, also known as a plan (but this time the time dimension is emphasized) (Bramley 2008). Urban planning combines urban, natural, socio-economic, structured environmental data and information obtained from local values according to the settlement principles developed in accordance with the guiding decisions and the identity that the city gained during the historical development process. In this respect, it acts as a tool that provides settlement order and balance by providing various functions in urban land use.

According to academic studies, the concept of urban planning has a “process” feature in, and it includes all the stages from the determination of the objectives and targets of planning to its implementation. In other words, planning is a preparation, decision and selection process that will be made before the implementation in order to reach the determined objectives. In particular, it constitutes a system that will lead to action. Thus, it presents the theoretical, hypothetical structure that will lead the action and determines the way of thinking. This process can be summarized in 3 steps; defining objectives, producing plans and following the implementations. In this context, plans ensure the efficient development of the city/region and besides provide information to real estate investors for future investments. Because land-use plans directly affect land values, therefore investor decisions.

To sum up, the task of urban planning is to design stable underlays that depict the ideal form of the city in the future. But it should be remembered that this is a process and has many dynamics. In particular, it is considered that the studies that ignore the market and public needs will not be successful.

2.2.Regulatory planning system

Land use planning is a regulatory mechanism which is aimed to increase the efficiency of land and ensuring greater equality of land use (Hall ve et. al. 1973; Evans 2004). Land planning in Europe has undergone several transformational stages. Nowadays two different systems are used as regulatory planning and discretionary planning. The regulatory planning approach involves a high degree of consistency, objectivity and certainty in decision-making processes in line with the legal framework. The discretionary system is a method that is sensitive to individual conditions, flexible and provides a negotiating environment (Steele and Ruming 2012).

According to Gurran and Bramley (2016), land use plans may comprise a neighbourhood, a whole city or a wider region. They are produced in relation to a range of overarching objectives, current developments, infrastructure and environmental or physical characteristics with different urban functions. Steele and Ruming (2012) says that the regulatory planning approach divides living spaces into separate regions. It determines the spatial environment by determining which urban functions will be built in these sub-regions. The main purpose of this approach is to create certainty by removing and separating non-functional parts that may cause inappropriate uses and investments in land planning. The strict structure of the regulatory planning system aims to provide a strong economic, social and environmental life by guiding the disposition and change together with the control of land use. Albrechts (2004) defines the regulatory planning system as a land use plan that includes the link between target and control. It compares the possible impacts for housing on the prepared plans and checks for compliance. He interprets the discretionary system as making decisions based on managerial and political perceptions. According to him, the main task of the plan is to be a general guide. In the regulatory system, the focus is on ‘legal certainty", whereas, in the discretionary system, certainty cannot be observed.

The regulatory planning system has three main features: First, it is an economic tool to protect immovable values based on zoning conditions, the second is a social tool that protects public comfort by leaving undesired applications out of the system, and the third is an environmental tool that aims to isolate potentially harmful uses by regulating the effects of pollution Steele and Ruming (2012).

The preparation and approval of regulatory plans are usually the responsibility of local governments, and can sometimes be prepared and approved by other government institutions. The state institutions collaborate and the relevant institutions and consultants are participating in the process of planning. In addition, it is a general responsibility to seek and sometimes consult to public opinion. Unfortunately, it is limited in practice. Nevertheless, the manner and participation of the public in planning varies by country (Albrechts 2004).

Regulatory plans are instruments that are based on the legal framework and are precise as explained. These plans are used as a pedestal for real estate development and shape investment decisions in line with the growth trends of cities. In particular, large-scale and long-term plans are intended to guide investors through future steps. In general, such land use plans are valid after approval by the authorities until a new plan is needed. Hence, if we take into account the environmental plans, they can provide 15 years of foresight for developers. The positive elements of the regulatory mechanism allow only development. But unless the market considers it valuable or the government provides additional incentives, they cannot ensure development. Adding to this, a fully implemented and bounded regulatory planning system excludes profitable development. Moreover, the objective of having a system in planning should be to produce different results that the market will also support (Whitehead 2006).

Ideally, the planning process should provide maximum certainty for landowners, developers and inhabitants as to what kind of developments are allowed in the region and in what circumstances. In addition, the process needs as much precision as possible. It will help to predetermine the parameters and give the interested parties the flexibility to evaluate plans for their own benefit. Significant and processable data sets are needed to ensuring that land use plans can accommodate future demands and opportunities without jeopardizing important social and environmental values. When there are limited resources for detailed planning, users are required to finance the studies and take an active role in the research, development and evaluation stages in order to make the decision-making process efficient (Gurran and Bramley 2016).

2.3.Relationship between planning and real estate market

One of the principles of planning is the continuation of strong market-led trends in the centralization or expansion of urban settlements. Myers and Kitsuse (1999) state that there are practices in ‘growth control’ in the United States and the United Kingdom. The authors emphasize that there has been a discussion of 'growth controls' in the United States to create larger metropolitan. The issue of growth controls is often in alliance with the 'new urbanism' movement, which aims to promote a design-oriented approach to increase the value of urban life and the viability of city centres and towns. Accordingly, Bramley (2008) say that this movement has reminded of the concerns of the United Kingdom's planning system in 1947 and emerged in response to 'urban sprawl'. This expansionary approach is advancing against numerous limits in terms of environmental resources, financial capacity and social sustainability.

There is controversy as to how planning regulations and associated practices affect economic activity for dynamic sectors and locations. In general, most of the planning implementation does not have direct negative or local economic impacts on sectors and its field of activity (Lambert and Bramley 2002). In fact, it is possible to say that a successful planning system increases employment and brings the real estate sector to the forefront in terms of investment instruments and contributes to economic development.

Individual motivations of all actors are crucial within a complex system and under the government or market interferences. Indeed, especially the motivation of landowners and developers, and their reaction to specific planning environments under different circumstances lead the real estate sector. According to Gurran and Bramley (2016), new opportunities cannot be provided to support the market supply-demand balance when all actors are not acted according to their own motivation. Therefore, it would not be wrong to say that the market and state (planning authorities) should act harmonically. They say that, if we ask what motivates governments, whether, at the local, regional or national level, the most common answer would be 'economic development'. Roseland (2000) states that the development process provides an opportunity to create jobs and local population growth in real estate and other related sectors as well as direct and indirect economic contribution to the region (which increases local demand for goods and services). In addition, he says that a sustainable economic benefit is needed to provide balanced and sustainable employment opportunities supported by free configurations of land uses, infrastructure and services. Mainly scholars point out that, planning to ensure the economic growth of any region will result in more jobs, salary increases, more satisfaction, better living conditions and so on. Undoubtedly, the real estate sector will also benefit from this economic development. For instance, land values will increase, more investment will be made and new project development opportunities will occur in the region.

The real estate or land development process shape the urban landscape of the future. This is because property development in collaboration with planning institutions govern future land use and spatial distribution of urban functions. For this reason, real estate development offers urban planners a tool for directing urbanization. According to Power (2004), to put it more clearly, real estate development allows urban planners to enable residents to adapt, create jobs and contribute to a more vibrant economy and provide a more sustainable environment.

Broitman and Koomen (2015) emphasize that real estate development and its dynamics will vary in each region. Therefore, it is important to divide places into sub-regions and evaluate them as a specific case. Moreover, Mayer and Somerville (2000) emphasize that these sub-regions are as important as political and economic conditions, including supply-demand, land use regulations and local government strategies. From this point of view, it can be said that real estate development also gives a reflection on planning. Understanding the dynamics in real estate development and evaluating them regionally will support economic development and have a direct impact on the quality of life in these sub-regions.

Landowners and developers control the initiation of development in the regions and which units are completed and placed on the market. Because they have their own business strategies and priorities, and this needs to be in line with market development. Gurran and Bramley (2016) state that landowners are not under short-term pressure and may want to maintain the option of selling their land for a higher price with the added value that planning will create in the region. It is necessary to acknowledge that every planning step has a direct impact on real estate values and is a mechanism intertwined with the market.

2.4.Planning and Public Interest

The main purpose of the planning is to produce plots with social amenities at the maximum level and to take into account public benefits. Consequently, urban conservation policies are increasingly used to manage growth in metropolitan areas in this manner (Pendall et. al. 2002; Nelson and Dawkins 2004). The urban planning field should evaluate public participation and the ideals of public debate (Friedmann 1998). The code of ethics of the American Certified Planners Institute says: 'We shall give people the opportunity to have a meaningful impact on the development of plans and programs that may affect them. Participation should be broad enough to include those who lack formal organization or influence. ' (American Planning Association 2005). Planners seek and attach great importance to the public interest in managing the development process.

The plan, which defines the usage patterns and structuring patterns in the living spaces in accordance with normative criteria and which is accepted to serve the public interest in accordance with these definitions, is a product that should be used unchanged during the implementation phase. From a public perspective, since it is accepted that appropriate and beneficial solution is achieved in this way, the society must adhere to the plan decisions undisputed (Demirci 2004).

However, in the twentieth century, urban planning rarely achieved these goals. According to Gnas (1962), Jacobs (1961) and Hall (1988), during the 1950s and 1960s, many administrative planning programs, including urban renewal or transportation projects, destroyed vivid urban areas despite strong neighbourhood opposition. Krumholz (1982) says that numerous researchers on this issue objected to the claim that the planning process was measuring accurately and precisely the needs of the planned or affected population of the project. These researchers argue that planning is not democratic because it does not reflect the needs and wishes of the affected parties and even serves to exclude certain stakeholder groups from the negotiating process. This is a major challenge for public authorities. Because, according to Davidoff (1965), “if the planning process is to encourage democratic urban governance, then it should work beyond exclusion from participation in the process.”.

Fainstein (2010), one of the ‘good’ urban interrogators, introduced the concept of 'fair city'. According to him, the goal of a ‘good city' should be more egalitarian, not the creation of conditions for how people will grow. Fainstein's (2010) concept of the 'fair city' should include the concepts of ‘democracy, equality and diversity in the process of change and development of public principles on a metropolitan scale. From his perspective, all urban policies or plans should address the ways in which they can contribute to urban democracy, equality and diversity.

2.5.Turkish Planning System

The concept of zoning includes the objective of making land belonging to real or public legal entities by planning horizontally and rendering it doable. However, the concept of zoning reaches this goal with the concept of planning (Yaşar 2008). Zoning aims to establish a certain order in the terminological sense. Zoning practices consist of different activities of many people or institutions acting for a wide range of purposes (Geray 1960). When the zoning arrangement is mentioned, it is understood as a whole that the rules governing the type and characteristics of the buildings to be constructed on the immovable property with an official or special quality and including different urban uses (Zevkliler 1982).

Planning, which aims to balance the different land uses, aims to embody the planning objectives and policies on the land. While implementing this, the development plan, which brings an order related to property for the benefit of the public, stands out as a legal instrument. Zoning plans are defined in the literature as 'a type of complex structured process that includes both general rules and a scheme showing the application of these rules in relation to the region' and are recognized as the regulatory system (Tekinsoy 2008).

Sets of rules are needed to live together in a healthy and peaceful way. Therefore, it is crucial to set a certain order in the field of urban planning, too. If the settlements are arbitrary and irregular, distorted and unhealthy urbanization will create a danger to public needs. The fact that the zoning activities are not regulated is most beneficial for those who have power and who benefit from the disorder. Due to these reasons, the necessity of regulating zoning activities rules emerge (Yılmaz 2002).

Section 2.2 describes the basic features of the regulatory planning system. The Reconstruction Law No. 3194 and the Spatial Planning Regulation explain the gradual relationship between the sub-regulations to be followed and the associated plans. However, this overlaps at some points in terms of planning between approving authorities. This will be discussed in section 2.5.1 . The main feature of the Turkish planning system is ensuring compliance with each of the hierarchical relationship of plans at different scales according to the present legislation. The plan decision taken on the lower scales should be consistent with the plan on the upper scale.

Directing the planning in Turkey 'zoning regulations' refers to the planning function as a regulatory activity (Ersoy 2005) and describes the shape of the living environment and land use regulation as one of the important tasks of planning. This situation emphasizes the regulatory feature of the Turkish planning system. The Turkish planning system defines land uses clearly, identifies the diversity of urban functions on a regional basis, distributes it to parcels, determines and controls construction densities. All of these indicates it as a regulatory system. Other layers operating this system; plan types, plan hierarchy and planning authorities will be explained in detail below.

Another feature of the Turkish planning system is 'rigidity'. According to the regulations and laws that bound all plans prepared in Turkey, plans would have become conclusive after the approval of the authorized party. In other words, it is necessary to act in accordance with these plans in all building constructions. Uncertainties and possible solutions are taken into consideration and are tried to be clarified in the plans. In the Turkish planning system, it is not possible to include open-ended approaches in the approved plans. The Turkish planning system has a structure that is not constantly renewed, prepared with long-term objectives in mind and as strict as possible. It exhibits a strict attitude with this feature (Ersoy 2005).

In the planning phase, priorities such as parcelling, distribution of public needs, technical equipment are added in line with the needs of the regions, and in practice, these plans are implemented as specified in Article 18 of the Reconstruction Law. Therefore, all implementations are made on the basis of plans. In particular, this relationship can be seen clearly between overarching zoning plans and implementation zoning plans.

The Reconstruction Law No. 3194, which was published in the Official Gazette dated 9 May 1985 and numbered 18749, is the zoning law in force today. This law is designed to ensure that the structures in the settlements conform to the plan, technique, health and environmental conditions. With this law, local authorities have been given the authority to prepare a plan and approve it, for the first time in the Turkish planning history.

The types of plans in the Turkish plan system are defined by Law No. 3194, which is the basic law of the Turkish Zoning Legislation, and the Regulation on the Principles of Plan Making. However, the Regulation on the Principles of Plan Making was abolished and the Spatial Planning Regulation, which entered into force upon publication in the Official Gazette dated 14.06.2014 and numbered 29030, and new types of plans to be included in the planning system are defined.

Plans are defined in terms of their scope and objectives in the title of planning stages of the Reconstruction Law no. 3194, which is the basic law of Turkish Reconstruction Legislation. They are divided into two as 'Regional Plans' and 'Zoning Plans' and 'Zoning Plans' are divided into two as 'Master Plans' and 'Implementation Plans'. Although definitions vary across the world, zoning plans need to be open to continuous development. In general, the countries that adopt the regulatory planning system have 3 levels which are in a top-down relationship with national, regional and local plans.

The upper-scale plans are the development plans in line with the main objectives of the country and in accordance with the determined policies, they define the use of the land pieces in the cities in line with the development goals of the country. Lower-scale plans are regulatory documents prepared in accordance with upper ones. Upper-scale plans have the function of directing, controlling, and defining the framework of the lower-scale plans. Upper-scale plans are the upper frame that feeds many different lower-scale plans to be produced in the region and integrates them into the system in line with the same objectives (Ersoy and Keskinok 2000).

Local plans continue to be the main tool for transforming land use planning decisions and are the focus that enables local authorities and communities to address future options for growth and development. Therefore, according to Gurran and Bramley (2016), local plans should provide greater accuracy to landowners and developers.

As one of the characteristics of the regulatory planning system, the plans of different scales need to be correlated with the lower or higher level plans and be compatible with each other. This is defined as ‘gradual association principle' of the plans (Ersoy and Keskinok 2000). In the planning hierarchy, the relationship between the plans needs to be clarified. There is a hierarchical planning structure in Turkey. Development plans, strategic plans, regional plans, regional spatial strategy plans and environmental plans are upper scale plans in the Turkish planning system. Master and implementation plans are lower-scale plans. In this context, upper scale plans layered in the following order; development plan, strategy plan, regional plan and spatial strategy plan. In lower-scale plans, the master plan is followed by the implementation plan. The lower and upper relations of the plans of different scales according to their functions are clearly stated in the legislation. Accordingly, the lower-scale plan should always be compatible with the upper-scale plan. Control mechanism is provided by feedback method between the scales and possible deviations of unforeseen changes were prevented (Ersoy and Keskinok 2000).

According to Spatial Planning Regulation, it is stated that the development plan, regional plan, regional development strategies and objects out should be taken into consideration while preparing spatial strategy plans and environmental planning plans. The same regulation also states that 'spatial strategy plans' are related to development policies and regional development strategies at the spatial level. In addition, it is stated that the regional plans are prepared by taking into consideration the physical thresholds, targets and strategies in line with the social and economic potentials and that establish relations between the sectors. Environmental plans are defined as plans made in accordance with the targets and strategy decisions of spatial strategy plans if any. Accordingly, it can be interpreted that environmental plans should be in accordance with spatial strategy plans.

There are too many types of plans, institutions and organizations that have the authority to prepare plans in the Turkish planning system, which are summarised in Figure 2.1.

Plan Type	Plan Name	Authorized Institution
National	Development Plan	Ministry of Development (with approval of parliament)
	National Strategy for Regional Development	Ministry of Development
	National Spatial Strategy Plan	Ministry of Environment and Urbanization
Regional	Regional Plans	Ministry of Development / Development Agencies
	Regional Spatial Strategy Plan	Ministry of Environment and Urbanization
	Environmental Plan	Ministry of Environment and Urbanization, Metropolitan Municipalities
Local	Master Plan	Municipalities
	Implementation Plan	Municipalities
Special Purposes	Long Term Development Plan, Culture and Tourism Protection and Development Plan, Integrated Coastal Zone Management Plan, Transportation Coastal Structure Plan, Metropolitan Zoning Plan	Central Administration Authority

Figure 2.1 Plan Types, Names and Autorized Institution

When the plan-making powers are examined, the authority to prepare the Development Plan, one of the biggest upper-scale plan, is under the Ministry of Development and these plans are discussed and approved by the Turkish Grand National Assembly. Decree No. 644 defines the preparation and approval institutions of many plans. According to that decree, the Regional Development Agency is authorized for regional plans while the Ministry of Environment and

Urbanization is authorized for spatial strategic plans. According to the Reconstruction Law, the Ministry of Environment and Urbanization is authorized to prepare metropolitan zoning plans and to approve and amend them when necessary.

While there was a conflict about authority on preparing Environmental Plans, this was tried to be regulated by Decree-Law No 644. Mainly, this authority is defined to the Ministry of Environment and Urbanization and it is stated that related institutions and organizations should be in collaboration during the process. However, the authority of the environmental plans within the metropolitan area is given to metropolitan municipalities (e.g. Istanbul, Ankara, İzmir etc.). However, according to the legislation, if the environmental plan cannot be made by the relevant metropolitan municipalities within the period defined by the Ministry, the authority to prepare and approve the plan is adjourned to the Ministry of Environment and Urbanization. The environmental plan defines the use of urban functions in a way that is compatible with the upper-scale plans. In other words, it defines urban functions use in settlement areas in accordance with the national plans, which contains the population, development and this kind of national targets.

The Ministry of Environment and Urbanization is authorized to prepare, modify, approve and implement environmental plans of all sizes within the scope of special cases specified in Decree-Law No 644. These special cases are listed below.

- Areas determined in line with the decision taken by the Council of Ministers
- Public investments within the jurisdiction of central administrations
- Facilities for national security
- Military forbidden zones, private security zones and general shelter areas
- Regions for telecommunication and energy facilities

In addition, in some cases, the Ministry of Environment and Urbanization is authorized under the same Decree Law to accelerate the process. Namely, the Ministry of Environment and Urbanization is authorized to prepare and approve the plans of all scales in order to accelerate the process when the plans are not approved in three months by the authorized institution.

The authority to prepare lower-scale plans, master and implementation zoning plans, are regulated in the Reconstruction Law. According to the law, the authority to prepare these plans in line with the regional and environmental plans is given to the relevant municipalities.

The steps of the lower-scale planning are given below.

- Plans are prepared by the relevant municipalities in the areas within the boundaries of the urban area. If the 'urban area' is a metropolitan municipality, the plan is prepared by local municipalities and then submitted to the metropolitan municipality for approval. Plans that are not disputed during the suspension process are approved.
- In areas outside the boundaries of the urban area, the governorate is authorized. Plans can be prepared in-house or outsourced by the governorate. Plans that are not disputed during the suspension process are approved.
- Various ministries have the authority to prepare and approve the zoning plan in line with the related regulations and laws. The authority to approve the zoning plans is given to the ministry which prepared the plan. Plans that are not disputed during the suspension process are approved.
- In some cases, opinions of other public institutions and organizations should be sought while preparing zoning plans. The consultation process is under the control of the public institution which prepares the plan. The Reconstruction Law does not limit the expiry date of the zoning plans. In line with the developments in the region, zoning plans can be revised or new zoning plans can be prepared.

Special purpose sectoral plans are purposeful plans prepared in accordance with special laws. They are prepared by the relevant administrative management institution. While preparing sectoral plans, it is necessary to pay attention to the existing upper-scale plans. However, as discussed in more detail in the next section, this situation may be a problem in urban regeneration plans, and incompatible studies with the upper-scale plans can be made in the region.

With the Law No. 6306 on the 'Transformation of Disaster Risk Areas', the Ministry of Environment and Urbanization has been authorized to prepare and approve the plans in areas where areas are declared to be risky due to loss of life or property. Likewise, the Ministry of Environment and Urbanization has been authorized to prepare the zoning plan of all sizes and to prepare urban design projects in the urban areas where the land found to be vulnerable to earthquakes in the Decree-Law no 644.

2.5.1. Gaps and Conflicts in Turkish Planning System

In Turkey, there are many laws that regulate the issues of urbanization, zoning movements, land, settlement and infrastructure and there are many implementations regarding these laws. The assignment of such a large number of different institutions is becoming increasingly insurmountable. In particular, the existence of conflicts of authority in the executive phase has bad consequences. As a result, it is not possible to see effective planning implementations.

When the distribution of authority according to the institutions is examined, it is seen that the upper scale plans have been prepared and approved by the central administrations and the lower scale plans have been prepared and approved by the local administrations. However, in exceptional cases specified in the legislation, central administrations have the authority to prepare and approve a lower-scale plan. The concrete example of this is the planning powers given to the Ministry of Environment and Urbanization with the Decree-Law no. 644 published in the Official Gazette dated July 4, 2011 and numbered 27984.

Reconstruction Law No. 3194 that forms the basis of planning in Turkey is supposed to be whole rather than clashing or overlapping other regulations and laws. The fact that too many institutions are authorized in different areas leads to conflicts in their jurisdictions. Among all these institutions, it is a major shortcoming that there is no joint system to coordinate the process, even if some planning processes are managed in collaboration.

The fact that multiple institutions and organizations are competent and that there is no coordination system can also lead to suspicious activities. In some applications, institutions lose control while carrying out their activities according to their jurisdiction and excessive construction density may arise. In such cases, it can be said that public interests fall behind. There should be no room for such suspicions in properly constructed plans. Public needs and interests should be at the forefront. Especially in Istanbul, there are zoning plans approved by different institutions which can be shown as examples in this regard.

Even if it is seen that this system has been constructed efficiently in section 2.5, the planning system has been dragged into chaos with additional planning authorities. It can be said that it is from a system that works efficiently in the theoretical structure of Zoning Law No. 3194. However, the additional powers granted by other regulations damage the discipline of planning and the real estate sector. And this distracts Turkish planning system from well-planned systems. The present appearance of Istanbul is a clear reflection of this situation.

Besides, one of the typical shortcomings is being slow to complete or renew plans. Therefore, it is observed that existing plans do not reflect existing demands and remain an important gap for discretion. Much of the delays characterizing development control decisions particularly over larger developments, stemming from the negotiation caused by this discretion. These negotiations often have consequences for market actors and cause them to pay more (Bramley 2008). Therefore, plans should be prepared in line with the current situation and take into account the market actors.

2.6. The Conceptual Framework

As Steele and Ruming (2012) point out, this study adopts the approach of questioning and creating 'good' city and region. Together with the research question and sub-questions, it is aimed to create the best possible living spaces for people and to develop spatial development in this way. 'good' city can be simply defined as creating nice places to live. These places should be safe, healthy and functional (Gurran and Bramley 2016). Adding to this, socio-economic balance (Berry and McGreal 1995) and spatial economic development (Keivani et. al 2001) should not be forgotten.

As Oxley (2004) and Gleeson et. al. (2004) mentioned, it is thought that planning should also address market dynamics. Whitehead and Monk (2006) also point out, spatial planning cannot ignore externalities and must learn from market failures. Of course, the abandonment of traditional planning methods is not a discussion point in the context of this study. Rather, the emphasis is on developing existing methods and addressing market demands and dynamics within. As Bramley (2008) states, urban planning is a tool for future land usage with historical and identical data from the site.

As explained in section 2.2, it is believed that planning systems should be regulatory to cover all the features like administrative, layered and hierarchical. Because rigidity, certainty and transparency of regulatory systems are important values. This study aims to produce the plans prepared within existing mechanism with more efficient analysis and to consider more parameters in the preparation process. While doing this, it also brings conflicts of authority in existing planning systems, gaps, misuse of power to the forefront. Because supportive base documents of the development plans are accessible and it is thought that this simulation can be one of these documents. Thereby, decisions are taken based on this analysis can be more trustful and clear.

In addition to all of the professional planning principles, the relationship with the market should not be ignored. As mentioned in Section 2.3, the effects of urban sprawl and market impact on the US in the 1940s, the motivation of individual actors and their integration into the system are crucial for the creation of an efficient real estate market. And this can be reached through plans prepared as a result of detail analysis. As Gurran and Bramley (2016) mentioned, one of the criteria of successful planning is to provide efficient economic development in which supply-demand balance is created. Undoubtedly, the 'public interest' principle of planning, which is mentioned by lot of academicians, should be forgotten while making the market actors happy. This study has proceeded in line with this approach and tried to create an alternative to the systems that cannot respond to market needs and satisfy public benefit.

3. METHOD

As described in Section 2, the Turkish regulatory planning system is not open for innovation and change. It can be seen that especially upper-scale plans are precise and they are prepared based on future projections (population, development, etc.). In this section, it is aimed to make modelling with Monte Carlo Simulation in order to develop/improve the method currently used and thus to establish a system suitable for the needs of the market. Therefore, first of all, the definition of modelling and simulation are defined. Then the instruments and other steps of the process when creating the model are explained.

3.1.System, Modelling and Simulation

A system is defined as a whole composed of multiple components of physical or conceptual qualification, which have relationships between them to achieve one or more goals and outcomes. Operational research is defined as the application of various tools, methods and techniques to the controllable components of the system, to find the optimum solution to the problems that will arise in the system in parallel with the system approach (Öztürk 2004). The main objective of these approaches is to identify the problems of the systems, and then to develop the solution methods by addressing these problems as a whole. One of the important tools in the development of these solutions is the simulation methods.

There are two main methods to make an examination in the system regarding for the purpose of the study. The first one is to experiment it with the real system and the second one is to create the model of the system (Kavcar 2004). The most important part of modelling is its applicability. The results of the model should be practicable on the real system. Figure 3.1 shows the classification of the models that can be made to examine a system.

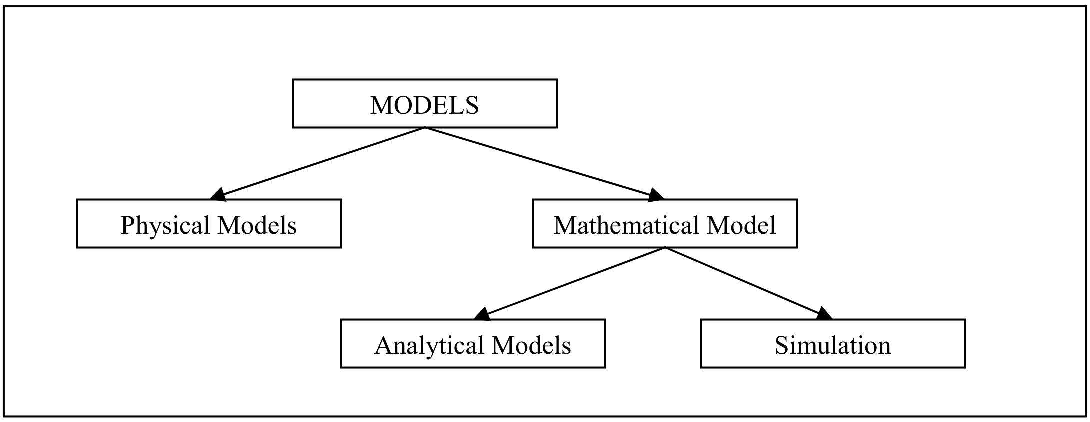

Figure 3.1. Model Classification (Kavcar 2004).

As seen in Figure 3.1, if it is decided to make a model of the system, there are two alternatives; a physical model or mathematical model. In mathematical models, the relations of the system are defined by mathematical formulas and if the analytical solution sub-header is selected, the model user can obtain an optimal result. Game theory is an example of it. However, this method cannot be applied every time. Because the data sets that used in the system cannot be convenient all the time. On the other hand, the simulation method is concerned with the behaviour of the system, not with optimal results (Berends and Romme 1999). In order to understand the content and to see the differences between them, it will be useful to examine the steps of analytical solutions and the simulation. The steps of solving a problem with analytical approach or simulation approach can be shown in Figure 3.2.

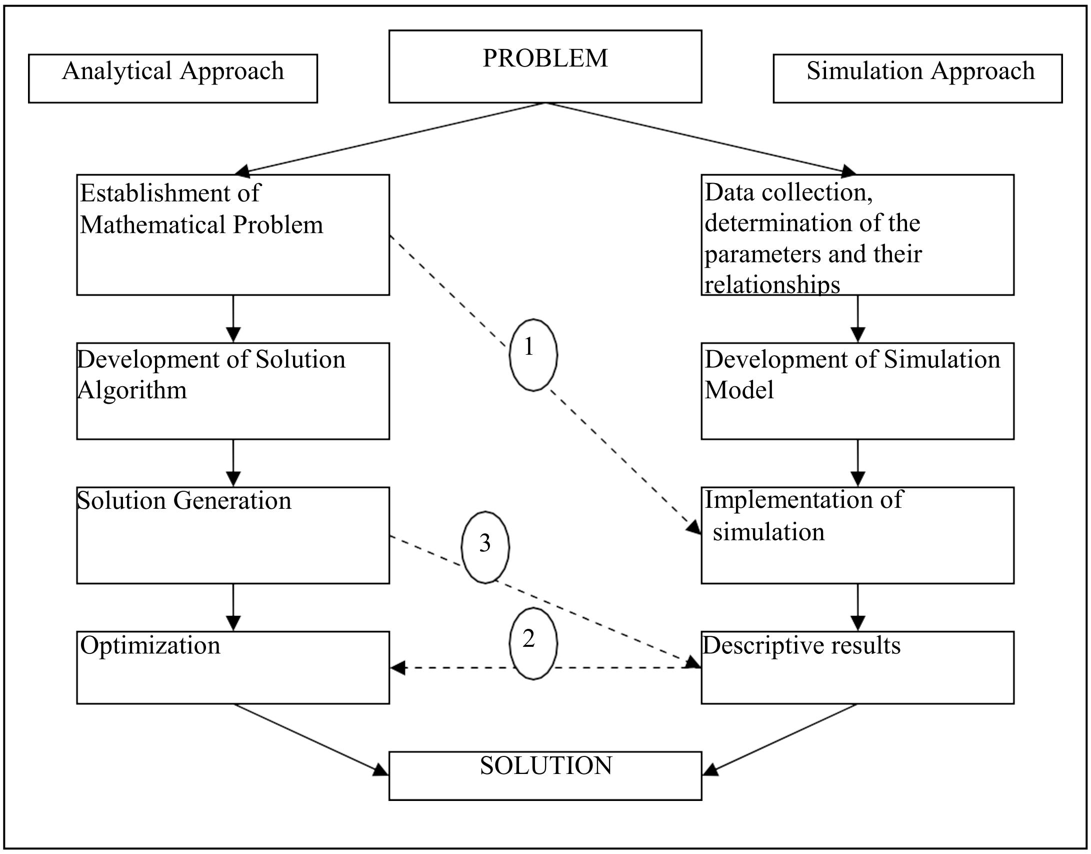

Figure 3.2 Model Steps

When we examine Figure 3.2; It can be seen that the simulation method can be used to generate a solution when a problem cannot soluble by the analytical approach (arrow 1). In other words, when the mathematical model cannot be implemented with the analytical approach, the simulation approach can be applied. Simulation is a descriptive modelling that establishes the relationships between dependent or independent variables in themselves, and also between each variable. Following the determination of the parameters and characteristics of the desired system, alternative decisions are applied in the model with the analysis approach based on probabilities, which is expressed as 'what-if' or 'if so'. Therefore, the output of the simulation method is always descriptive; these results can be used to achieve an optimal or near-optimal result and can be an input for analytical solutions (arrow 2). The reason for using the term ‘near-optimal’ is the results under the conditions defined in the simulation model does not guarantee optimality to cover all aspects of the system. After running the simulation, the most productive results can be determined as a result of the parameters used in the creation of the model. However, it may be possible that one of the neglected alternatives gives a better result in practice. Therefore, it is necessary to work precisely when selecting parameters and determining variable ranges.

Analytical models solve the problems with formulas and mathematical methods. Linear programming optimization methods consider only one objective function and try to minimize or maximize it. In some cases, secondary objectives are also important, and these methods may fail to achieve optimal results. Furthermore, in the modelling of random and dynamic systems, these methods may cause the analyst to use misleading data for random variables in the model. However, in a model which is made by using the simulation method, it is possible to consider many objective functions at the same time and analyze the changeable systems efficiently. Simulation models, unlike linear programming or decision analysis, are not built to find the optimal solution, they evaluate various alternatives and decisions are made by comparing these evaluation results (Kavcar 2004, Bierman et. al. 1986).

One of the important differences between the two approaches is the role of decision variables. In analytical models, these variables appear as outputs and form a set of results with the aim of minimizing or maximizing the objective function. In simulation models, variables are input and evaluate the objective function for a given set of values (Eppen et. al. 1993).

On the other hand, there are, of course, points where the analytical approach is superior to the simulation approach. One of them is to reveal the basic structure of the problem and allow the analysis of cause-effect relationships within the system. In spite of this superiority of the analytical approach, in some cases, it is not appropriate to use analytical approach to solve the problem and using the simulation approach is necessary in these cases. Kavcar (2004) states some of the situations where the simulation approach is required can be listed as follows;

- When the problem cannot be defined mathematically or functionally,
- When the system consists of too many random variables or complex parameters that the analytic approach cannot resolve,
- When there is not enough data to implement the analytical approach,
- In order to test the effects of alternatives on the system when it is desired to study with various variations, the simulation method can be used.

3.1.1. Advantages and Disadvantages of Simulation Method

Undoubtedly, the simulation method also has advantages and disadvantages. The advantages of the simulation method can be listed as follows;

- The simulation method is a flexible solution and can be modified when needed.
- Most of the complex, real-world systems with stochastic components cannot be accurately expressed by analytical models (Law and Kelton 1982). The simplification required for analytical solutions to complex problems significantly affects the results of the analysis (Stevenson 2002). However, these conditions and constraints which cannot be examined in another method can be modelled by the simulation method. Furthermore, the simulation method can reflect the complexity of the system without losing its simplicity.
- Time-based systems may require to time-processed solutions. In these cases, the simulation approach can provide complete control over time. Because the model can be flexed as desired according to the time parameter (Erkut 1992). Thus, the system can be analyzed in a very short time by time-processed simulation method while the results will be obtained after a long time in real life.
- Modelling of what-if scenarios enables decision-makers to evaluate different alternatives. In this way, the system can be examined in depth according based on demands.
- The simulation process is repetitive and often reveals important information and new perspectives (Habchi and Berchet 2003). New views and strategies can be easily implemented on the model without changing the current system.
- With the simulation method, more control and benefit can be achieved by experimenting on the model of the system than the system itself (Law and Kelton 1982).

- The simulation method can be used both as an analysis tool to determine the effect of possible changes on the existing system and as a design tool to determine the performance of a newly created system under changing conditions (Banks et. al. 1996).
- The information obtained during the simulation process can be an important resource for improving the system. Furthermore, the simulation method can be used as a learning base to strengthen analytical solutions (Banks et. al 1996).
- New system designs, plans and targets can be tested on the simulation model without spending cash resources. This feature is of great importance. Because once decisions are made and actions are taken, changes and corrections can cost much more than expected, and also can cause irremediable results (Banks 1998).
- A simulation is a tool that allows decision-makers to deeply understand the behaviour of the system and to concentrate on key points (Fowler 2003).

Although it has many advantages, the simulation method has its disadvantages too. These disadvantages can be listed as follows;

- Developing an efficient simulation model can be more costly and time-consuming, especially when the system becomes more complex. Reducing expenditures of model and analysis may cause inadequate results.
- Simulation models are not sufficient in optimization like they are efficient in comparing specific alternatives (Law 1982). There is no guarantee of producing optimal results, it is a kind of trial and error method. Decision-makers should set out all conditions and constraints for alternatives they aim to try.
- Each simulation model is unique. Generally, solutions and inferences cannot be used to solve other problems. Because a simulation model has been created according to the system to be examined and cannot be transformed for another problem, remodelling is required if necessary.
- The stochastic structure of the simulation method is a set of statistical analyzes requiring multiple repetitions. Errors in modelling and analysis of findings may lead to inaccurate results.
- It is impossible to obtain all alternatives by simulation. Therefore, there is no way to know whether the best result is generated from the chosen alternatives or whether a better result could emerge from non-simulated alternatives (Lapin 1994).

3.1.2. Simulation method modelling process

Simulation is a modelling technique that enables users to monitor the cause-effect relationships in the system and the behaviour of real results under different variations (Murphy and Perera 2001). Simulation technique is a methodology for analysing problems rather than a theory.

The simulation development process involves the formation of a suitable model, determination of parameters and their interval scales, running the simulation and then evaluation of the results. The steps of the simulation process are shown in Figure 3.3 below.

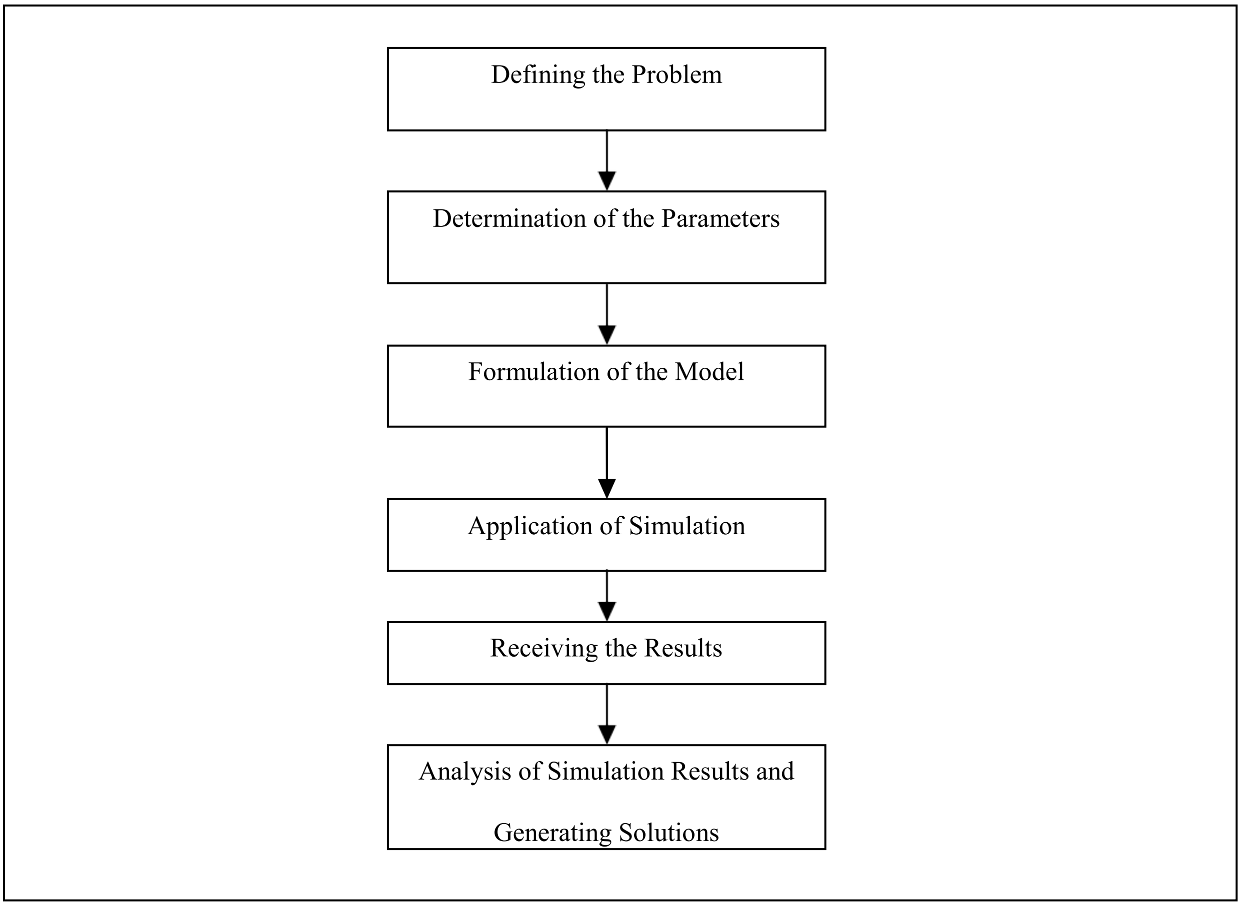

Figure 3.3 Simulation Steps

In the first stage, the problem should be defined and the frame of it should be drawn. The characteristics of the system to be modelled, its parameters and their relations with each other will be determined based on the problem. Accurately identified problem provides successful simulation implementations. In order to make a productive definition, the data related to the system elements should be collected and examined and converted into the form (values) that can be used in the model. While collecting the data, it is necessary to pay attention to whether the simulation analysis reflects the reality and distributions of variability.

The second step is to determine the parameters to be used based on the dataset. At this stage, it is crucial to analyze the dataset carefully and to decide which parameters fit better to solve the problem. Afterwards, the relationship between the selected parameters should be established. Then, it is possible to proceed to the next step.

The third stage is to formulate and validate the model. At this stage, the identified problems and the decisions are foreseen for achieving the objectives for their solution are evaluated. Then a model is formulated to represent the system. The formulated model may consist of mathematical or logical expressions. These expressions may vary depending on the system under investigation. But it needs to represent the model. At this point, the model does not have to determine or express the functioning of the whole system. Since the model is developed for a specific purpose, it can only be formulated for this purpose. Then, it should be assessed whether the data are properly included in the model and whether the model represents the problem identified in the system.

The fourth stage is the application of simulation. Simulation is run as much as desired and the result set is created to evaluate the alternatives. The success in the implementation phase is directly related to the decisions taken in the previous steps. If the model user has been in the installation process of the model and could comprehend the structure, the possibility of good practice will be increased (Banks et. al. 1996).

The data in the result set is evaluated in the fifth step. If the model generates efficient results for the solution of the problem and if it is assured that all the conditions are taken into consideration, then it is possible to take decisions based on these results. In the decision stage, the results are evaluated and analyzed. Decisions are taken for optimising the system and then they are reflected into it.

A simulation model consists of components, variables, relationships, assumptions and constraints (Erkut 1992). Simply components are the parts that make up the system. Variables are the elements that allow us to determine the responses of the model despite the change of these values by assigning random values. Relations refer to the connections between model elements. Assumptions are the acceptances deemed necessary to solve the model. Constraints are limitations in variables. Erkut (1992) summarizes a successful simulation model as;

- Can be understood by users,
- Can provide meaningful results,
- Easy to operate and control,
- Should be updateable or adaptable (Erkut 1992).

3.1.3. Time advance in simulation method

It is necessary to run the model and monitor the responses by advancement the time in simulation applications. The concept of time advance determines the time repeat range of the results and will be ended at the desired time. There are two methods used for time advancement (Kavcar 2004);

- Changeable time advance method
- Constant time advance method

The start time is set to zero in the changeable time advance method. The possible realization times of the results are determined. The simulation is applied until the end of the last possible result is achieved. Simulation results are examined and checked whether the required results are obtained. If not, the simulation is rearranged and this process is continued until the predetermined stop condition is met.

In the constant time advance method, the model is operated with a stable increase (i.e. minute, hour, day, week, month, year). The simulation model is applied until the specified time that is determined at the model establishment. Then the results are examined.

The constant time advance method is used when the events are in order or when the number of possible events is high. The changeable time advance method is preferred if the number of events occurring within the specified time interval is small. The constant time advance method is used in this study.

3.1.4. Generating random numbers

Simulation methods produce random numbers and test the events that take place in the simulation. Simulation methods produce random numbers and test the events that take place in the simulation. The first and most basic random number generator is the middle-square method by von Neumann (1946) (Milner 1985). This approach allows us to create a series of random numbers by picking a four-digit starting value, taking its square, then using the middle for digits of the result as the input for the next iteration (Yalta and Schreiber 2012).

The second method is the linear congruence generator. Successive random numbers are generated logically. The next number in this sequence is formed by a linear formula. Another generating method is the fractional parts. Unlike the linear congruence method, it generates values between 0-1 range with a formula (Milner 1985). Generally, this generator is used by scientific computers and present mixed-up and exhaustive results. Therefore it is very rarely preferred for practical short-term analysis. There are other classes of random number generators such as multiple recursive generators, Fibonacci generators, feedback shift register generators, subtract with borrow generators, inversive generators and so on. There are also individual specifications and behaviour based on the choice of parameters within each group. As the generator become more complex, their structures will be increasingly difficult to analyze theoretically (Yalta and Schreiber 2012).

Milner (1985) emphasizes that the random number generation is a crucial topic in computer science and the investigation into the randomness. These products are used in practical statistical test and represent large volumes of real data. A mathematical method is required when it is desired to generate specifically random numbers.

However, Milner (1985) states that computers cannot generate random numbers. When we consider the technology in the 1980s, this situation makes sense. Fortunately, owing to current technology, random numbers can be generated with computer software. Random numbers are one of the basic inputs of simulations and can be applied easily in software programs. The user needs a random number generator which has a sufficiently random nature and can be updated easily. Simple random number generators methods mostly produce nonnegative integers and directly representable in the computer (Gentle 2003). Microsoft Excel contains a pseudo-random number generator feature which was tested for sufficiency (Subhash and Beaudet 2000). In this study, the pseudo-random feature of Excel is used. Pseudorandom numbers are deterministic and they look like generated randomly (Gentle 2003). That is, it can be defined as randomly assigned numbers without any formula.

According to Ripley (1990), a good random number generator should be;

- easily repeatable based on a starting point
- has a long period
- the numbers reflect distribution very well
- results are independent in a reasonable amount of dimensions.

3.2. Monte Carlo Simulation Method

Monte Carlo simulation method is a quantitative technique used in many types of decision analysis models. This method came to the fore in the early 1960s (Hertz 1964) as a tool to predict risk in capital markets and employs probability distributions' spread and skewness in the model uncertainty from various resources (Loizou and French 2012).

Monte Carlo Simulation method tries to provide a solution with using hypothetic examples of repetition to the problems which contain probability and cannot define with a specific formula (Sarıaslan, 1986). The Monte Carlo Simulation method is named based after the city of Monte Carlo, which is popular with its casinos. The most important aspect of this simulation is the chance and it can be applied only if it has a process of random components (Stevenson 2002). If there is a random component, it is more appropriate to make predictions of probability by considering uncertainties rather than running to optimal results. Monte Carlo Simulation is perhaps one of the easiest application in probability analysis (Elkjaer 2000). The important features of the Monte Carlo simulation are containing random constrained samples and intending to understand the behaviour of the system rather than the optimal result. The stages of the model to be created to represent the system with the Monte Carlo Simulation method is shown in figure 3.4.

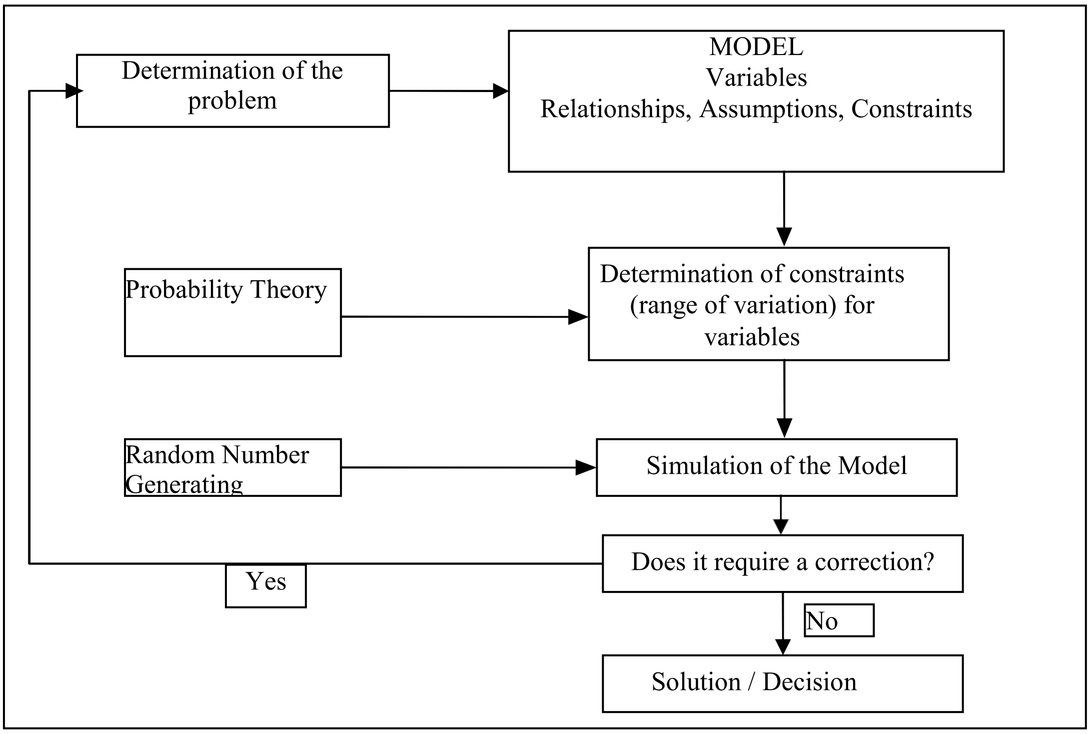

Figure 3.4 Monte Carlo Simulation Steps

The model steps shown in Figure 3.4 are described below:

- The variables and parameters of the model are defined based on the problem.
- The constraints are defined by determining the probability range of each variable in the model.
- Historical data can be used to define constraints. Restriction interval is determined by users based on the purpose of the study.
- Random numbers are generated at specified intervals to use in the model.
- The model is run with the generated random numbers, and results are obtained.
- The results are analyzed and the decisions are made.

Adding to these main steps, Lorance and Robert (1999) state that before running the simulation, the model generates a single result known as the deterministic result. This result is also known as the base estimation before adding the contingency.

First, key parameters are identified and then changed simultaneously within set ranges. If the set range is too narrow, it will underestimate the variation (extreme values has low probabilities) in a basic method. If the set range is extensive, it will overestimate the variation (extreme values has equal probabilities) (Balcombe and Smith 2007). The comprehensive analysis may contain different probability distributions for key parameters and allows for correlations between them. The specification of parameter probability distributions relies on either relevant time-series data either or expert opinion (Savvides 1994). The users should concentrate on the probability of missing expected returns at the evaluate phase of the model. In other words, these results provide important information, but the question of whether this probability is acceptable or excessive remains to the practitioner’s judgement (Gimpelevich 2011). It should not be forgotten that the simulation process contains the risk of the 'human' element in both the decision-making and analyzing stages (Loizou and French 2012).

Simulation can be done by computer or manually. However, if a lot of data is used in the simulation and a lot of repetition is desired, it will be more convenient to work on a computer. The main reason for using the Monte Carlo Simulation method in this study is that there are many independent parameters in the spatial planning stage and these parameters have a wide range. This method provides us to understand the system behaviour by running the model as the desired number of repetitions and the opportunity to make decisions accordingly. Especially in upper-scale plans, it can be difficult to make predictions and assumptions about the future. However, it is possible to obtain more comprehensive results with simulating many possibilities such as the utilization of historical data, the demand analysis of the real estate market, as well as the demographic examinations and projection predictions like in the traditional planning methods.

4. CASE STUDY

4.1. Why Istanbul?

Istanbul is the 14th largest metropolis with a population of 14,967,667 on the world's most populous cities list (World Population Review 2019). Istanbul is located in Asia and Europe continents with its 39 municipalities. The population density of the city is 2,741 people / km².

It can be said that Istanbul is Turkey's economic capital. Most of the massive economic investments are being made in Istanbul and as a result of these, continuous population growth can be observed. In recent years, large projects have been developed by the government and many projects that will affect the city's texture and future structure are also on the agenda. These investments directly affect the spatial development of Istanbul. The two of these projects, the most important ones, are the New Airport project and Canal Istanbul projects. Despite the negative environmental impact assessment (EIA) report of the New Airport project, developed in the northern forests of Istanbul, the project was approved by the government and many forest areas were destroyed during construction. The project has been partially completed and remaining construction will continue until 2023. The largest airport, Atatürk airport, in the city, was closed after the opening of New Airport of Istanbul. This project development process is thought to be a good example of uncontrolled growth mentioned in the previous sections. Northern Forest Defense, a nongovernmental organization, Istanbul Airport Environmental Impact Assessment (EIA) report stated that 2.5 million trees will be cut, but the 13 million trees have been cut by the calculation of satellite images announced (KOS Medya 2019). With the destruction in this region, it is thought that the region will gradually be allowed for reconstruction and the city will lose a significant amount of green space.

The Canal Istanbul project is currently under development and a canal is planned to provide an alternative vessel crossing to the Bosphorus. The applicability of the project is doubtful. In addition to these two projects, Istanbul City Hospital, Istanbul City Square and Basaksehir Botanic Park projects are other projects that attract attention despite their small scale. Construction of some projects has started and some of them are still under development. However, the most important feature of all these projects is the growth direction. With the thousands year of history, Istanbul always grows on the east and west. With these projects, the city has a northward growth rather than linear growth. Consequently, the density of the building increases and the green areas are greatly reduced. It is inevitable to make new spatial plans to compensate for this situation.

Despite the second-oldest metro line in the world, the Tunnel Metro, is in Istanbul, the city lags behind in terms of underground transportation. Metro lines have been started to be built in recent years and construction is ongoing. Currently, there are 7 active metro lines in the city. There will be 14 metro lines when the ongoing projects are completed. In addition to these metro lines, as mentioned above, there is a suburban line suitable for the horizontal growth of the city. This line connects the most extreme points of the city by passing under the strait. Total line length is 76km (Metro Istanbul 2019). Although all these activities are carried out to improve the quality of life of the city and to facilitate transportation, it also increases the load of the city. The connection of the existing lands with the transportation networks or the distance with the big projects on the agenda will create an increase in land value and also will lead to new housing and commercial developments.

In line with the aim and motivation of this study, it was intended to draw attention to the importance of planning, especially considering the new growth targets of the city. In this context, it is aimed to calculate the current stock for housing function to create more productive regions with high quality of life, to bring a different perspective to the field of planning and real estate development and improve future projections by analyzing many parameters.

As stated in Section 2.5, Environmental Plan is the main upper-scale plan in Turkey at the urban scale. The Ministry of Environment and Urbanization, which has the authority to prepare 1/100.000 scale Environmental Plan for Istanbul, has delegated its authority to Istanbul Metropolitan Municipality. Upon this authority, Istanbul Metropolitan Planning Center(MPC) was established by Metropolitan Municipality. The Istanbul Environmental Plan was started in 2005 and completed in 2006. Many academicians and experienced professionals have been involved in the process by MPC. However, as a result of the objections to the plan, the plan was cancelled and a new Environmental Plan was prepared in 2009 by the Istanbul Metropolitan Municipality Directorate of City Planning.

The main goal of the Environmental Plan is a comprehensive structural transformation in Istanbul. With this transformation, it is aimed to gain a globally strengthened city status that fits with the identity of the city, emphasizes the advantages in cultural and tourism fields, improves the quality of life with the principles of sustainability, strengthens its economic structure (Istanbul Environmental Plan 2009). Residential related strategies based on targets are listed below;

1. Preventing the spread of central business districts to residential areas.
2. Preserving the texture, function and features of historical houses and housing areas.
3. Developing new residential areas out of greenfield, water catchment areas, agricultural areas and geologically inconvenient areas.
4. Providing the social dimension to the physical transformation process (urban renewal) of residential areas.
5. Generating solutions to reduce traffic in commuting.
6. Creating qualified housing and social environment opportunities for attracting the high-educated population to the city.
7. Providing the required restructuring to improve the quality of life with a sustainable urban approach.

There are many differences in implementations compared to the targets and strategies partaking in the Environmental Plan. Nowadays, residential and central business areas are intertwined and required green areas, especially in living spaces, could not be created. It is difficult to achieve this goal in a multicenter metropolis like Istanbul. Because there are many central business districts in the city. It is thought that decision-makers cannot set realistic targets and this leads to messy and ugly urbanization. On the other hand, the historical buildings were not paid sufficient attention to restoring, even some of them were demolished and multi-storey mixed-use projects were developed instead.

All the major projects above-mentioned were developed after this environmental plan and there is a violation of the foreseen strategies. As mentioned before, there is a big decrease in the green areas and the new projects are still being developed. In this study, the uncontrollability of this planning implementation is questioned. As a result, a comprehensive analysis is tried to be presented based on numerical data.

In line with the objectives of increasing the quality of urban life and providing social dimensions, Law No. 6306 on the Transformation of Areas under Disaster Risk has been enacted. The demolition of many risky structures had started and the city became a big building site with this law. This reduced the quality of living spaces, increased air and noise pollution, and brought many accidents with the excavation trucks coming down to the city centre. As Istanbul is an earthquake zone, construction quality and supervision have been increased with this law. However, it is thought the implementations have failed in terms of preserving and improving spatial quality. The floor area ratio (FAR) was changed and some of the plots have been granted very high construction rights with the misuse of power. The regular planning system should not have this kind of implementations. Unfortunately, the equal land use of regulatory systems mentioned by Evans (2004) and the 'good city' concept of Fainstein (2010) and Steel and Ruming (2002) could not be established.

Currently, there is an economic crisis in Turkey. According to the May 2019 report of the Turkey Statistical Institute, the official unemployment rate is 12.8%. This ratio is 12.4% among university graduates. Demand for mortgages loan has declined as interest rates are very high. As a result, a significant decrease is observed in the sales of houses (old or new). This increase in unemployment and the decrease in job opportunities affect the business life in Istanbul, which is the commercial centre of the country. Hence, it is pointless to draw attention of high-educated people to the city. This situation shows us the targets in the Environmental Plan are failed. It can be said that the government has only taken radical and useful steps towards transportation in line with these objectives. The aim of this study is to improve long-term environmental plans with detailed analysis.

4.2.Data

Istanbul is the most vibrant city for the housing market in Turkey with its dense population. Istanbul, with its dense population, is the most active city in the housing sector. In this study, only secondary data sets are used from various sources. Data sets are interpreted when necessary. The interpretations and assumptions based on them are explained in the following sections.

According to the Istanbul Environmental Plan prepared in 2009, there is a total housing stock of 124,718,536.4sqm as of that year. In return, as of the year 2009, a total of 3,483,758 housing units are located. As mentioned earlier, Istanbul, which is the economic centre of the country, is the province with the highest number of companies according to Turkish Statistical Institute (TURKSTAT) and Istanbul Chamber of Commerce data. Therefore, in order to live in better living conditions, especially financially, to find more job alternatives and to continue their careers in big companies, many white-collar (university graduate employees) prefer to work in Istanbul even if they have not studied in Istanbul. Likewise, the city is a centre of attraction with many factories and therefore with the need for unskilled employees. Such reasons increase the demand for housing. Therefore, the highest average housing unit prices in the country are observed in this city. It is inevitable that efficient planning is necessary for the city with such high demand.

Within the scope of this study, the current housing stock in Istanbul is discussed and the required residential stock is calculated by the Monte Carlo Simulation with 15 years projection. Numerical and time-spanning data is needed for all parameters to run the model. The outstanding features of Monte Carlo Simulation are the applicability of variations and analyzing the historical data efficiently. The data based on the aim and research question of this study are listed as follows;

- Population
- Average size of households
- Average living space per person

In general, it can be thought that the demand for housing can be vary depending on the population. This is not the only parameter. Besides, the standard living space per person should not be forgotten. Likewise, the average living space per person according to new trends in the market should be taken into consideration. Because market-based data reflects the demand of the market. Finally, the average house size and the total required housing stock can be calculated, together with data on how many people living in a house on average. As the minimal stock is calculated within the scope of this study, other reasons (house sales price, rent price, transactions with investment purposes, etc.) are excluded. The accommodation opportunity has to be provided for every citizen in social states. Other residential transactions are completely shaping the activity in the market and cannot be related to the stock requirement. The following sections explain the details of the parameters and data from recent years.

4.2.1. Population

According to TURKSTAT's Address Based Population Registration System, population data of country, regions, provinces, districts and villages are published annually. The people living at any address are recorded in this system. In more detail, an address code is defined for each unit. Then, the information of the people that are residing at that address is kept digitally. And the census is performed accordingly. In some cases, even if housing is owned, it may be no one defined in this address. For example, foreign investors bought lots of houses in recent years and they only use houses during holidays. It is not possible to be registered in this address in such cases. TURKSTAT doesn't take them into the account for the census. Therefore, such housing purchases are not important while determining the housing stock. To give another example; if a house rented, tenant's records are kept in the system and the census is made accordingly. In other words, the owner cannot be included in the census if he/she is not living in this address. Within the scope of this study, the population of Istanbul from 2008 to 2018 and its increase by years are taken as a parameter of this simulation. Figure 4.1 shows the population and population change of Istanbul by years.

Year	Population	Increase Rate
2008	12,697,164	
2009	12,915,158	1.72%
2010	13,255,685	2.64%
2011	13,624,240	2.78%
2012	13,854,740	1.69%
2013	14,160,467	2.21%
2014	14,377,018	1.53%
2015	14,657,434	1.95%
2016	14,804,116	1.00%
2017	15,029,231	1.52%
2018	15,067,724	0.26%

Figure 4.1 Population Data (TURKSTAT)

As can be seen in figure 4.1, Istanbul's 2018 year-end population is 15.067.724 according to TURKSTAT data. In 2018, the number of leaving inhabitants' ratio was -13.9% with 210,321 people, -0,4% with 5972 people in 2017 and -4,8% with 71,307 people in 2016. While Istanbul has always been an immigrant-receiving city throughout its history, it has been losing inhabitants regularly for the last three years (TURKSTAT 2019). 2008 data is not used in the study and added to the table to calculate the population increase in 2009. The lowest population growth in the 10-year period is observed in 2018 and this shows the economic situation of the city and the country. The average 10-year population growth in Istanbul is

1,73%. In line with these data, it is possible to say that the population has grown constantly in this city. Urban functions should be able to respond to this increase.

4.2.2. Average size of households

The average household size refers to the average number of people living in a household. The average size of households in cities is published by TURKSTAT annually. The last 10-year period's average household size and its change in Istanbul and Turkey are shown in figure 4.2.

Years	Turkey Average	Increase Rate	Istanbul Average	Increase Rate
2008	4,0		3,80	
2009	4,0	-0,00%	3,80	0,00%
2010	3,84	-4,09%	3,70	-2,63%
2011	3,76	-1,96%	3,63	-1,89%
2012	3,69	-1,82%	3,57	-1,65%
2013	3,63	-1,73%	3,53	-1,12%
2014	3,57	-1,53%	3,51	-0,57%
2015	3,52	-1,47%	3,48	-0,85%
2016	3,48	-1,07%	3,46	-0,57%
2017	3,45	-1,09%	3,44	-0,58%
2018	3,41	-0,99%	3,39	-1,45%

Figure 4.2 Average Household Size and Its Increase (TURKSTAT)

According to figure 4.2, the average household size increase rate for the 10-year period is -1.57% for Turkey, while it is -1.12% in Istanbul. The reason for this decline is the change in trends in the country. For instance, even if young people are studying or working in the same city with their family, they move their own home. Some of them move to other cities for studying at the university. Adding to this, there is a notable brain drain to the out of the country. It can be observed that the average household size decreases gradually in Istanbul and Turkey. The difference, which is 0.2, between Turkey and Istanbul 10 years ago has decreased over time and balanced at the end of 2018. The reason for the difference in 2008 is rural and undeveloped parts of the country where the average household size of seven. In this study, both the last average household size observed in 2018 and the increase rates according to years are used. Although the average household size will not reach zero, it is assumed that it will continue to decrease in the 15-year projection.

4.2.3. Average living space per person

The standards for the construction of buildings in Turkey are determined by Planned Area Development Regulations (2017). The aim is defined by the first article of this regulation. Accordingly, the purpose of the regulation; to determine procedures and principles about the plan, technical, health and sustainable environmental conditions and structure and construction in accordance with the design and inspection. Standards and conditions to be followed for each type of buildings (i.e. factory, office, residence etc.) are explained with this regulation. For instance, the minimum qualifications and minimum sizes required in an apartment are summarized in figure 4.3 below.

Qualification	Size (sqm)
1 living room	12
1 bedroom	9
1 Kitchen	3,3
1 Bathroom	3
1 Toilet	1,2

Figure 4.3 Minimum Qualification and Minimum Size per an Apartment

According to figure 4.3 above, it is not possible to build an apartment to be less than 28.5sqm. However, there is no definition of how many people can stay in this apartment. In addition, the regulation does not specify the required minimum living space per person. The minimum housing area to be provided per person is stated as 25sqm in the Istanbul Environmental Planning report. It is stated in the same plan report that there are 3,483,758 houses in Istanbul. 65% of these houses are located on the European side and 35% are located on the Asian side. However, the examination is made at the Metropolitan level and the details of the municipality are not considered separately within the scope of this study. Other points that draw attention in the report; average housing area per person is 35.8 sqm and the total housing construction area of the city is 124,718,536.4sqm. These figures are from 2009. When considering the average household size at this year, which is 3.8, the average apartment size is observed as 136sqm. Unfortunately, such data for 2018 could not be reached. Instead, Turkey Furniture Manufacturers Association (TFMA)'s research is considered which is prepared in 2018. According to TFMA, the average housing size in Turkey is 114sqm at the end of 2018. The average household size is 3.4 in 2018 in Turkey. In accordance with this data the housing area per person is calculated as 33.5sqm. Since there is no such data about Istanbul, Turkey average is used for Istanbul in the study. According to the 2009 data in Istanbul, the housing area per person, which is 35.8 sqm, has decreased by 6.4% in the last ten years and observed as 33.5sqm. As a result, the average housing area per person based on the market is 33.5sqm and it should not be less than 25 sqm according to the standards in Turkey. It is assumed that the decrease in living space per person will be continued. Therefore, the 6.4% decrease in the 10-year period is spread into the general. Thus, the variable range is assumed between 5.6% and 7.2%.

4.3.Application of Monte Carlo Simulation

Monte Carlo Simulation method is used to determine the required residential stock that will be needed in Istanbul in the near future. There are several reasons why residential function is preferred. First of all, accommodation is the basic human need which should be provided by the state. Housing investment is the main real estate investment tool which has a decisive role in terms of the dynamics of urban development. The last point is the news about the newly built unsold apartments in the market. Because of these reasons, it is questioned how housing planning is done and how can it be developed.

Data starting from 2008 to 2018 are used in this study. Due to the lack of information in databases, some parameters are taken from 2009. And also some of them are calculated manually because of the lack of records. According to TURKSTAT data, there are three parameters which are thought to determine the housing stock. These parameters and the variable range of them form the basis of the study. As stated in section 3.1.4, randomly generated numbers in this range are used in the simulation to estimate future housing stock of Istanbul for 2033. Monte Carlo Simulation is run in Microsoft Excel. The defined formulas within the software itself are sufficient for this kind of simulation. The time advancing function is created for 15 years period. Then the system is repeated 1000 times with Monte Carlo Simulation.

4.3.1. Running the Monte Carlo Simulation

Data related to the market mentioned in section 4.2 was used during the evaluation of the current situation in the housing stock, and also stock planning for the following years. As a result of the evaluation of the market; population, living space per person and average household size were used to understand the housing sector and stock. The variable range of these data between 2008 and 2018 is analyzed.

As it can be seen in figure 4.1, the population tends to increase continuously, barely a 0.26% increase in 2018 is remarkable. Although the population raise an upward trend in recent years, the reason for the decrease in 2018 is related to economic uncertainties in Istanbul and Turkey. As stated in section 4.2.1, Istanbul has been losing inhabitants for the last 3 years and the causer of population growth is new births. The highest population increase in the last ten years is observed in 2011 with 2.78%. In 2010, the population growth was 2.64%. Since the population growth has been observed below 2% since 2013, it is assumed that it will continue in the future similarly. These values (increase rates in 2010 and 2011) are accepted as extreme values. Therefore, the 2013 increase is taken as the basis of maximum value, which is 2.21%. When these values are excluded from the calculation, it is seen that the average population growth depreciates by 15% and the average annual population increase is 1.48% for ten years period. There is also extreme average household increase rate which is observed in 2010 with -2,63%. This value is 50% higher than the latter. It is assumed that -1,89% increase rate (increase in 2011) should be maximum value to reach more efficient results. When using the random number generation method specified in section 3.1.4, narrowing the range of variables will also reduce the standard deviation of the calculation. Firstly, a 15-year time flow is prepared. During this process, random numbers were generated in the variable range. Figure 4.4 and 4.5 illustrates details of the time flow.

	2018	2019	2020	2021	2022	2023	2024	2025
	0	1	2	3	4	5	6	7
Population Increase Rate	0	0,64%	0,40%	1,36%	1,22%	0,41%	0,65%	0,70%
Population	15.067.724	15.164.157	15.224.814	15.431.872	15.620.140	15.684.183	15.786.130	15.896.633
Average Household Size Increase Rate		-1,07%	-0,96%	-1,44%	-0,93%	-0,23%	-0,33%	-0,45%
Average Household Size (sqm)	3,39	3,35	3,32	3,27	3,24	3,24	3,23	3,21
Average Living Space Increase Rate		-0,57%	-0,64%	-0,70%	-0,70%	-0,67%	-0,68%	-0,61%
Living Space Per Person (sqm)	33,50	33,31	33,10	32,86	32,63	32,42	32,20	32,00
Average House Size (sqm)	113,57	111,71	109,93	107,59	105,84	104,89	103,83	102,74
Total Housing Unit	4.444.756	4.521.584	4.583.673	4.713.891	4.816.191	4.847.086	4.894.745	4.951.289
Total Required Housing Construction Area (sqm)	504.768.754	505.103.678	503.878.499	507.156.128	509.750.028	508.410.675	508.235.680	508.671.391

Figure 4.4 15 years time flow (2019-2025)

	2026	2027	2028	2029	2030	2031	2032	2033
	8	9	10	11	12	13	14	15
Population Increase Rate	1,14%	1,03%	1,29%	0,89%	1,39%	1,62%	1,70%	1,43%
Population	16.077.855	16.243.457	16.452.997	16.599.429	16.830.161	17.102.809	17.393.557	17.642.285
Average Household Size Increase Rate	0	-1,65%	-1,61%	-1,20%	-0,81%	-0,42%	-1,72%	-0,50%
Average Household Size (sqm)	3,21	3,16	3,11	3,07	3,04	3,03	2,98	2,96
Average Living Space Increase Rate	-0,58%	-0,56%	-0,68%	-0,59%	-0,64%	-0,60%	-0,70%	-0,71%
Living Space Per Person (sqm)	31,81	31,63	31,42	31,23	31,03	30,85	30,63	30,41
Average House Size (sqm)	102,14	99,89	97,61	95,87	94,49	93,53	91,28	90,17
Total Housing Unit	5.007.733	5.144.192	5.295.815	5.407.842	5.527.786	5.641.028	5.837.328	5.950.554
Total Required Housing Construction Area (sqm)	511.486.317	513.860.800	516.950.275	518.473.981	522.316.413	527.593.271	532.806.420	536.588.530

Figure 4.5 15 years time flow (2025 – 2033)

According to figure 4.4 and 4.5, the year of start is set as 2018, and calculations are made until the end of 2033. While preparing the time flow, numbers were generated, as defined in section 3.1.4, at the specified interval for each year by using the features (with RANDBETWEEN() formula) of Microsoft Excel. First, this formula was applied to the population increase rate. As stated before, the extreme values were subtracted and the variable range is limited between 0.26% and 2.21%. Subsequently, the randomly generated increase rates were added to the population of the previous year. Increase rates of the average household size were calculated with the same method between -1.89% and 0.00% and were added to the average household size of the previous year. Finally, the increase rate of the living space per person was calculated by the random number generation function. The assumptions on the variable range of these rates are explained in the data section. Random numbers between -7.2% and -5.6% were generated. Then the increase rates were added to the previous years' value. The required housing stock formula for each year is shown below.

Required Housing Stock = (Estimated Population/ Estimated Average Household Size)

According to this formula, the number of dwellings to be located in Istanbul is calculated separately for each year. Then, the total construction area was calculated according to the required housing stock. First, the average apartment area was calculated. The average household size and the average living space per person are multiplied to calculate the average apartment area.

As a result; there should be 5,950,554 housing units for 2033 with a one-time random number generation and a single calculation of 15-year time period. Total housing construction area to be formed in line with market dynamics is 536,588,530sqm. This study focuses on the number of required housing. The forecast for the total construction area is not as important as the total house number. Because market dynamics are changeable. But this time-flow allows implementing market trends easily.

However, these figures are not useful since they are obtained by considering the parameters over a single value. Therefore, the system was run 1,000 times to calculate required housing stock with Monte Carlo Simulation method. In other words, the sample interval was extended over 1,000 random results and more efficient results were obtained. Figure 4.6 and 4.7 below show these results.

1-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	401-450	451-500
5.471.902	5.703.544	5.764.129	5.800.665	5.826.627	5.854.177	5.877.343	5.900.041	5.922.715	5.940.344
5.476.422	5.704.983	5.764.299	5.801.534	5.826.785	5.854.659	5.877.538	5.900.417	5.923.525	5.940.508
5.535.866	5.705.047	5.764.584	5.801.828	5.827.030	5.854.986	5.878.482	5.900.829	5.924.852	5.941.262
5.551.517	5.706.173	5.766.477	5.804.130	5.827.130	5.855.848	5.878.969	5.900.852	5.924.878	5.942.100
5.583.658	5.710.351	5.767.609	5.804.155	5.827.425	5.856.177	5.878.993	5.901.025	5.925.572	5.942.350
5.585.402	5.712.294	5.768.097	5.804.249	5.827.807	5.856.178	5.879.047	5.901.720	5.925.591	5.942.483
5.589.424	5.714.305	5.770.174	5.806.107	5.828.970	5.857.022	5.879.070	5.902.341	5.925.967	5.942.594
5.590.496	5.715.234	5.770.332	5.806.290	5.829.108	5.858.242	5.879.306	5.902.622	5.927.403	5.943.092
5.591.900	5.719.155	5.770.399	5.806.886	5.829.633	5.860.989	5.880.160	5.903.651	5.928.192	5.943.674
5.593.659	5.720.568	5.771.542	5.807.560	5.830.372	5.861.434	5.880.568	5.903.913	5.928.387	5.943.951
5.596.737	5.724.798	5.773.220	5.807.562	5.830.957	5.862.064	5.881.132	5.904.033	5.928.574	5.944.159
5.598.212	5.726.705	5.773.423	5.807.985	5.831.433	5.862.696	5.881.532	5.904.061	5.929.625	5.944.346
5.608.328	5.726.899	5.774.572	5.808.005	5.832.168	5.862.952	5.882.299	5.904.854	5.930.408	5.944.650
5.609.703	5.728.279	5.774.980	5.808.471	5.833.234	5.864.007	5.883.468	5.905.615	5.930.424	5.946.216
5.611.903	5.729.071	5.775.216	5.808.738	5.833.717	5.864.183	5.884.265	5.906.063	5.930.528	5.946.532
5.620.202	5.729.597	5.776.228	5.809.071	5.834.381	5.864.904	5.884.377	5.906.548	5.930.674	5.946.656
5.623.166	5.731.032	5.777.778	5.809.192	5.834.616	5.865.371	5.884.588	5.906.562	5.930.691	5.946.854
5.627.513	5.731.457	5.778.073	5.810.296	5.834.774	5.865.375	5.884.649	5.906.741	5.930.810	5.946.864
5.631.404	5.732.023	5.778.120	5.810.339	5.834.918	5.865.837	5.884.743	5.907.521	5.930.878	5.948.783
5.631.996	5.732.771	5.778.548	5.811.215	5.835.021	5.865.974	5.884.884	5.907.637	5.931.158	5.949.023
5.633.013	5.733.888	5.778.746	5.811.260	5.835.525	5.866.011	5.885.312	5.908.017	5.931.562	5.949.654
5.634.201	5.734.654	5.779.075	5.811.754	5.837.740	5.866.403	5.885.743	5.908.061	5.931.730	5.949.910
5.637.031	5.734.776	5.780.900	5.811.897	5.838.633	5.867.227	5.886.413	5.909.250	5.931.750	5.949.959
5.640.596	5.735.020	5.781.345	5.812.121	5.838.767	5.867.587	5.886.562	5.909.612	5.931.777	5.950.396
5.642.756	5.735.586	5.781.860	5.812.592	5.839.118	5.867.840	5.887.400	5.910.121	5.931.943	5.950.468
5.645.318	5.737.529	5.784.280	5.814.814	5.839.828	5.869.025	5.887.624	5.910.242	5.932.112	5.950.809
5.645.967	5.737.673	5.784.428	5.815.109	5.841.104	5.869.203	5.888.716	5.910.514	5.932.160	5.950.899
5.646.873	5.738.287	5.785.826	5.815.376	5.841.886	5.869.639	5.888.838	5.910.943	5.932.643	5.950.976
5.648.314	5.738.555	5.785.926	5.815.737	5.842.229	5.869.979	5.889.045	5.910.984	5.933.065	5.951.016
5.648.534	5.739.663	5.786.481	5.816.850	5.843.281	5.870.804	5.889.235	5.911.444	5.933.109	5.951.069
5.648.660	5.740.051	5.786.861	5.816.907	5.843.336	5.871.177	5.889.494	5.911.627	5.934.083	5.951.503
5.651.217	5.740.563	5.787.368	5.816.977	5.843.350	5.871.281	5.890.105	5.911.865	5.934.530	5.951.562
5.658.626	5.743.409	5.787.563	5.818.090	5.843.868	5.871.315	5.890.128	5.911.903	5.935.770	5.952.719
5.660.850	5.744.689	5.787.783	5.818.096	5.844.135	5.872.121	5.890.615	5.913.502	5.936.544	5.952.775

5.667.635	5.745.262	5.789.033	5.818.783	5.844.169	5.872.292	5.890.654	5.914.188	5.936.858	5.952.834
5.670.208	5.746.987	5.789.112	5.819.654	5.844.300	5.872.304	5.890.666	5.914.202	5.937.131	5.952.874
5.672.038	5.749.271	5.790.369	5.819.847	5.845.192	5.873.000	5.891.409	5.914.589	5.937.237	5.952.877
5.672.790	5.749.276	5.790.425	5.819.865	5.847.044	5.873.037	5.891.799	5.915.480	5.937.388	5.953.185
5.675.135	5.753.334	5.791.978	5.820.161	5.847.274	5.873.493	5.892.075	5.916.213	5.937.624	5.953.460
5.683.910	5.753.838	5.792.663	5.820.446	5.848.584	5.873.598	5.892.668	5.916.363	5.937.844	5.953.679
5.686.754	5.754.541	5.792.779	5.821.455	5.848.882	5.873.698	5.893.730	5.917.578	5.937.961	5.953.721
5.686.779	5.757.602	5.792.894	5.822.098	5.849.270	5.873.852	5.894.434	5.917.690	5.938.009	5.953.961
5.687.159	5.757.905	5.793.015	5.822.166	5.850.245	5.874.353	5.895.372	5.918.907	5.938.356	5.954.548
5.688.401	5.758.332	5.793.673	5.822.563	5.850.867	5.874.579	5.895.898	5.919.209	5.938.483	5.954.590
5.689.770	5.760.980	5.796.600	5.823.059	5.850.940	5.874.705	5.896.273	5.919.534	5.938.696	5.955.483
5.693.545	5.762.288	5.797.631	5.824.976	5.851.235	5.874.762	5.896.290	5.920.162	5.939.527	5.956.185
5.694.557	5.762.382	5.798.573	5.825.155	5.851.417	5.875.348	5.898.809	5.920.279	5.939.609	5.956.482
5.695.966	5.762.920	5.798.790	5.825.570	5.852.224	5.875.869	5.899.195	5.921.082	5.939.669	5.957.061
5.698.112	5.763.509	5.798.935	5.826.583	5.853.510	5.876.201	5.899.387	5.922.490	5.939.968	5.957.125
5.699.985	5.764.059	5.800.112	5.826.588	5.854.053	5.876.813	5.899.873	5.922.496	5.940.302	5.957.666

Figure 4.6 Simulation Results (1 - 500)

501-550	551-600	601-650	651-700	701-750	751-800	801-850	851-900	901-950	951-1000
5.958.087	5.978.827	5.997.373	6.018.581	6.043.424	6.067.473	6.102.967	6.130.110	6.162.008	6.227.701
5.958.910	5.979.046	5.997.522	6.018.901	6.044.629	6.067.643	6.103.371	6.131.781	6.162.013	6.227.748
5.960.196	5.979.210	5.997.583	6.018.989	6.044.632	6.068.829	6.103.641	6.132.630	6.162.403	6.229.570
5.961.270	5.979.487	5.997.905	6.019.032	6.045.188	6.069.165	6.105.042	6.134.282	6.163.507	6.231.451
5.961.864	5.979.591	5.999.493	6.019.504	6.045.455	6.069.213	6.105.269	6.134.509	6.163.930	6.233.214
5.962.093	5.979.755	5.999.678	6.020.045	6.045.736	6.069.381	6.105.643	6.135.184	6.166.682	6.234.905
5.962.212	5.979.921	6.000.154	6.020.470	6.046.006	6.069.552	6.105.859	6.135.429	6.167.250	6.236.026
5.962.219	5.980.021	6.000.263	6.020.566	6.047.023	6.069.710	6.105.904	6.137.132	6.168.673	6.238.417
5.962.225	5.980.353	6.000.568	6.020.679	6.047.308	6.069.863	6.106.030	6.137.411	6.169.617	6.240.873
5.962.401	5.980.517	6.000.799	6.021.149	6.047.738	6.069.954	6.106.891	6.138.725	6.170.159	6.241.383
5.962.404	5.980.911	6.001.448	6.021.333	6.047.870	6.071.606	6.107.057	6.138.728	6.170.607	6.242.271
5.962.497	5.981.003	6.001.487	6.023.015	6.048.179	6.072.129	6.107.777	6.139.054	6.171.183	6.242.462
5.962.554	5.981.035	6.003.217	6.023.033	6.048.180	6.074.044	6.108.307	6.140.025	6.174.822	6.242.644
5.962.589	5.981.239	6.003.302	6.023.186	6.049.273	6.074.445	6.108.979	6.140.444	6.175.811	6.242.901
5.962.919	5.981.244	6.004.361	6.023.332	6.049.854	6.074.972	6.110.084	6.140.837	6.179.404	6.247.337
5.963.248	5.981.953	6.004.658	6.023.479	6.050.929	6.076.486	6.110.518	6.141.164	6.179.951	6.251.815
5.963.272	5.982.616	6.004.845	6.023.503	6.051.473	6.076.783	6.111.079	6.141.330	6.181.019	6.252.513
5.963.394	5.982.715	6.005.264	6.024.272	6.051.627	6.076.861	6.112.049	6.141.512	6.181.057	6.252.560
5.963.480	5.984.608	6.006.134	6.024.334	6.051.848	6.077.179	6.112.332	6.141.543	6.182.588	6.253.149
5.964.339	5.985.498	6.006.299	6.025.214	6.053.678	6.077.861	6.113.124	6.141.784	6.183.163	6.255.707
5.964.359	5.985.708	6.006.337	6.025.405	6.054.053	6.077.922	6.113.876	6.141.792	6.185.386	6.258.188
5.966.260	5.986.358	6.006.719	6.027.070	6.054.457	6.078.664	6.114.000	6.142.617	6.185.975	6.265.392
5.966.344	5.986.514	6.007.930	6.027.464	6.055.288	6.080.567	6.114.679	6.142.732	6.186.236	6.268.594
5.967.007	5.986.671	6.007.944	6.028.307	6.056.307	6.081.589	6.114.880	6.144.611	6.186.433	6.270.023
5.967.946	5.987.602	6.008.550	6.029.272	6.057.127	6.081.738	6.115.127	6.144.661	6.186.467	6.279.033
5.968.117	5.988.334	6.008.571	6.031.611	6.057.172	6.081.846	6.115.971	6.144.966	6.187.326	6.283.796
5.968.782	5.988.487	6.008.894	6.031.855	6.057.174	6.081.958	6.116.153	6.146.544	6.188.919	6.284.546
5.969.033	5.988.513	6.009.156	6.032.199	6.057.258	6.082.091	6.116.341	6.146.760	6.189.283	6.285.911
5.969.299	5.989.800	6.009.414	6.032.365	6.057.817	6.082.956	6.116.816	6.147.300	6.191.137	6.287.512
5.970.727	5.990.382	6.009.460	6.034.015	6.058.170	6.082.973	6.117.242	6.147.867	6.193.061	6.289.352
5.970.871	5.990.573	6.009.698	6.034.608	6.058.536	6.082.991	6.118.927	6.148.108	6.195.498	6.295.487
5.971.168	5.990.695	6.010.095	6.034.807	6.058.844	6.086.815	6.120.263	6.148.299	6.196.125	6.299.469
5.971.289	5.990.956	6.010.332	6.034.998	6.059.657	6.087.822	6.120.448	6.148.326	6.200.430	6.300.073
5.971.740	5.991.144	6.010.623	6.035.205	6.059.658	6.088.569	6.121.179	6.149.395	6.201.361	6.300.786

5.972.187	5.991.728	6.010.677	6.035.339	6.059.981	6.088.936	6.121.309	6.150.934	6.205.333	6.307.019
5.972.915	5.991.736	6.011.043	6.035.981	6.060.976	6.088.972	6.123.608	6.152.784	6.206.469	6.310.260
5.973.165	5.992.074	6.011.128	6.037.104	6.061.375	6.090.787	6.124.081	6.153.012	6.209.001	6.314.475
5.973.254	5.992.977	6.011.711	6.037.381	6.062.208	6.091.751	6.124.976	6.153.563	6.210.454	6.316.942
5.973.262	5.993.094	6.011.835	6.038.138	6.062.551	6.091.935	6.125.220	6.153.718	6.210.696	6.329.514
5.973.422	5.993.193	6.011.843	6.038.316	6.062.746	6.092.474	6.125.529	6.154.118	6.215.892	6.339.486
5.973.948	5.993.534	6.012.648	6.039.033	6.063.077	6.093.658	6.126.059	6.155.523	6.216.675	6.348.984
5.974.965	5.994.082	6.012.666	6.039.796	6.063.489	6.093.834	6.126.227	6.156.144	6.219.844	6.351.307
5.974.990	5.994.302	6.013.768	6.040.341	6.063.943	6.095.386	6.127.164	6.157.005	6.220.436	6.355.546
5.975.241	5.994.525	6.014.102	6.041.250	6.064.161	6.097.137	6.127.177	6.157.030	6.221.088	6.358.904
5.975.516	5.995.239	6.014.402	6.041.406	6.064.324	6.097.444	6.127.212	6.157.724	6.221.507	6.370.944
5.975.824	5.995.343	6.014.883	6.042.133	6.065.421	6.099.970	6.127.338	6.158.380	6.221.684	6.384.359
5.976.589	5.995.561	6.016.765	6.042.153	6.065.997	6.100.274	6.128.933	6.159.032	6.223.960	6.390.336
5.977.213	5.996.250	6.017.041	6.042.340	6.066.132	6.101.246	6.129.418	6.160.424	6.224.360	6.401.552
5.977.548	5.996.412	6.017.823	6.043.162	6.066.355	6.101.769	6.129.452	6.161.808	6.226.083	6.408.367
5.977.980	5.997.367	6.017.917	6.043.169	6.066.963	6.102.015	6.129.965	6.161.955	6.226.432	6.434.798

Figure 4.7 Simulation Results (501 - 1000)

In figure 4.6 and 4.7, 1,000 results of the simulation are listed in ascending sort. These results were obtained by using Microsoft Excel's Data Table feature to enable the system to operate 1,000 times. Figure 4.8 below shows the minimum, maximum, mean, median, standard deviation and percentiles of these data.

Mean	5.961.541
Median	5.957.877
Min	5.471.902
Max	6.434.798
Standard Deviation	158.385
Percentile (5%)	5.703.366
Percentile (25%)	5.854.146

Figure 4.8 Key Indicators

As it can be seen from figure 4.8, the average of 1,000 results is 5,961,541 housing units. The minimum value with the result of the lowest increases is 5,471,902 and with the highest increases, the maximum value is 5,957,877. The standard deviation is very high with 158,385 units. This is the result of uncertain and uncontrolled growth observed in recent years which causes wide ranges. At this point, the notion of percentile helps us to interpret these results. The percentile divides a distribution into 100 equal parts and refers to ranges of 1%. The PERCENTILE.INC () formula of Microsoft Excel can be used to calculate percentiles. 5% and 75% percentiles were calculated to interpret the results more efficiently. There is a 95% chance that Istanbul will need more than 5,703,366 housing units at the end of 15 years if the variables continue as they sort as same in the last 10 years. If we go further, there is a 75% chance that Istanbul will need more than 5,854,146 housing units at the end of this period.

As stated in figure 4.4, there are approximately 4.4 million housing units in Istanbul by the end of 2018. It has been stated that there isn't any publishment for the total amount of houses in Istanbul in 2018. The total population is divided by 'total houses' while calculating the average household size. Due to the total houses number is not known, the process was considered in reverse. Thus the total population was divided by the average household size. Then, the approximate number of houses was found. As a result, when the percentiles and mean were taken into the account, it was concluded that there should be approximately 5.8 million houses in 2033. The current estimated housing stock (4,45 million) is approximately 1,400,000 below the average value resulting from the 15-year forecast made with the Monte Carlo Simulation. This projection provides the opportunity to re-evaluate results in the process (in this case 15 years period) and gives us the highest and lowest scenarios. These possibilities are very valuable for decision-makers. These results are open to development especially under the uncertainties and unstable economic growth. As a result of this analysis; it is considered to settle at least 5,850,000 housing units for a higher quality of life in the city, according to the key indicators shown in figure xxx. To sum it up, 1.45 million housing units will be needed in addition to the existing housing stock, and a total of approximately 5.85 million housing units should be available in Istanbul in 2033.

5. CONCLUSION

While plans increase the quality of life in the cities, they also direct investments in the real estate sector. Therefore, the decisions made during the planning stage are important for the whole group of people like inhabitants, sector professionals and investors. The timing of these decisions is just as important. In addition to the rational and economic efficiency of resource utilization, a comprehensive planning study based on analysis is required for the creation of a plan adopted by market actors and society. Particularly, as stated in section 2.3, successful and functional planning is possible when it meets with the demands of the market. At this point, it should be kept in mind that planning should always be in the public interest and the creation of cities with a high quality of life is the main objective.

Within the scope of this thesis, a new method proposal which takes into consideration the market demands and non-parametric data sets in the determination of the urban functions in the planning process is made. In this context, the residential function, which is the pioneer of urban settlement and development, is selected. Target year (2033) forecasts were made through parameters determined based on the characteristics of the housing function with the Monte Carlo Simulation. The values obtained as a result of the model are suitable for interpreting the current stock and foreseeing the future development in the housing market.

As stated before, the current housing stock was calculated 4,444,756 in Istanbul. There is no published information on the actual dwelling stock. It is only possible to make assumptions from the news. According to press reports on this issue, there are approximately 168,000 housing units that cannot be sold in total in Istanbul (CnnTurk 2018). This information confirms that TURKSTAT population projections are also an insufficient example of planning. When 2018 is considered in the population projection of TURKSTAT from 2017 to 2025, the estimated population is 15,254,331. However, the actual population is 15,067,724 in 2018. Approximately 200,000 difference has a direct impact on the housing sector and this figure illustrates how planning is important in terms of the relationship between planning and the market as indicated in section 2.3. In 2025, this difference gradually increases to about 800,000 people in time-flow shown in figure 4.5. If the decision-makers continue with this projection, Istanbul will encounter an inevitable building density and inefficient housing sector. It is also an indication that the public interest was left behind during planning. Especially considering the principle of 'creating nice places to live', it would be beneficial for the metropolitan municipality of Istanbul and the central government to review the policies and projects for the future and quality of life in the city.

Analyzes should always be kept up-to-date and needs should be well defined in planning studies. As it is reflected in the press, there is an excess of stock in the housing market as the result of insufficient restriction in this field. For future planning studies, this study can be evaluated and developed according to their needs. It hopefully will shed light to the planners, planning professionals, decision-makers and real estate developers in the market. As mentioned before, it is shown that base data sets can be created for decision-makers in the light of non-parametric statistical methods, and the possibilities can be predicted more comprehensively with the help of simulation methods. In particular, in all planning studies within the scope of the Istanbul Environmental Plan or in the lower scale planning to be carried out by the Istanbul Metropolitan Municipality, the stock requirement can be determined according to market demands by considering this analysis method.

This study may serve as a basis for international planning studies, especially in developing countries. It can be used for many different urban functions with changing parameters by the user. It should not be forgotten that the simulation is based on a study on data from previous years. Admittedly, uncontrolled growth in Istanbul and uncertainties stemming from the unstable economy have greatly reduced the quality of the results. To overcome the negative aspects, stable and longer period data sets are needed. Since there are no such problems in the countries that are growing in a more planned and controlled way, planning decisions can be made with more effective results while using this kind of analysis. Thus, more coherent base data sets can be created for socio-economic balance.

In addition to this, the transparency of regulatory plans is also important in terms of gaining public trust and open policy. Moreover, future private investments can be shaped accordingly, and spatial economic development can be provided more easily with open and trustful planning studies. As a result of this study, even if misuse of power cannot be prevented, it is valuable to establish a hierarchical relationship more healthily and to provide statistical and numerical data analyzes that everyone can accept. The most important contribution of the model to traditional regulatory planning methods is to integrate many non-parametric data into the system and to easily update and use them with considering the market demands.

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