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# Multi-Objective Analysis of Housing Transformation in Istanbul

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**ABSTRACT**
The rapid growth of Istanbul has resulted in many housing problems in the periphery due to the development of squatter housing and the decline of districts in the historical center for various reasons. This paper presents a generalized evaluation model on housing transformation projects to examine the most productive use of land based on several objectives. The analysis takes multiple alternatives into consideration for each housing transformation project. The problem is solved separately according to each alternative by taking into consideration weighted objectives, thus revealing the most efficient alternative land use model with the maximum efficiency from among the calculated alternative activities by adding the effects of the targets. The findings obtained within the scope of the study should guide the development of more efficient decisions regarding housing transformation projects. The article proposes further extensions of the model to include the interactions among housing transformation projects and the use of new planning techniques.

**Keywords:** Urban transformation, land use model, urban planning, Istanbul

### Introduction

The rapid growth of Istanbul's population has caused the development of squatter homes in poor urban living conditions on the periphery of the city and the decline of central historical districts as a result of their populations moving to recently developed modern housing projects (Dokmeci et al., 1996) and the city's multicenter development (Dokmeci & Berkoz, 1994). This situation has created the need to transform both of these housing areas. In fact, many successful housing transformation projects have occurred in the historical urban center of Istanbul (Ozus & Dokmeci, 2005; Dokmeci & Ciraci, 1999; Ergun, 2004; Dokmeci et al., 2007; Kolcu & Dokmeci, 2013). Recently, an excellent paper by Kilinc and Turk (2022) investigated 17,369 local housing transformation projects throughout all of Istanbul. As these projects need to be evaluated, the present paper proposes a multi-objective analysis decision model by taking into consideration alternative solutions on housing transformation projects with respect to different objectives.

Multi-objective analyses of urban land-use projects started in the 1960s. One of the earliest studies on this subject was done by Dokmeci et al. (1993). This article presented a land use model for determining the most efficient use of land in line with two main objectives: (1) maximizing returns and (2) minimizing weighted distances between different types of land use units. The article showed the most efficient alternative land use model with the maximum efficiency from among the calculated alternative activities by adding the effects of the targets. Later on, Marquez and Maneepala (1996) conducted another paper on multi-objective analyses. Their article presented an objective model for planning urban lands integrated with public services. The model also facilitated scenarios for land planning and distribution of technical infrastructure areas, such as electricity, sewerage, and gas.

In addition, Hanink and Cromley (1998) presented a paper regarding the insufficiency of market value. Moreover, Feng and Lin (1999) developed the sketch layout model (SLM), which consists of a tool, multi-objective programming, and a genetic algorithm, to facilitate city planners' development of alternative scenarios. Ligmann-Zielinska et al. (2008) presented a comprehensive model on this subject, with their paper presenting a new spatial multi-objective optimization model using a constant based on the level of neighborhood development density, something that was lacking in previous models. The multi-objective optimization model minimizes conflicting targets such as creating open spaces in residential areas, determining zoning rights in vacant plots, and transportation costs. Discussing the planning decisions and their results by developing different perspectives has enabled the development of more accurate land use decisions (Turk & Celik, 2013). Their article aimed to analyze the effects of different

perspectives on optimum land use decisions analytically and empirically using the generalized land use model Hannink and Cromley (1998) had developed, which integrates a geographic information system (GIS) with multi-criteria decision-making techniques. Xu and Yan's (2021) study developed an integrated model based on transit-oriented development (TOD) theory that simultaneously optimizes land use and transportation in the new development areas in China. Their study illustrated that the most advanced techniques in land-use planning in the world were only being used in China, which conducts tremendous urbanization and transformation projects.

A review of the literature reveals that multi-objective urban planning analyses are greatly improved by increasing the number of objectives that are taken into consideration, as well as the number of techniques that are used. However, this method has not been used for local housing transformation projects. Thus, the present study illustrates how to apply multi-objective analyses in local housing transformation projects in Istanbul, a very crucial task considering the danger from earthquakes that is expected in the near future.

The paper is organized as follows. The first section explains the development of multi-objective techniques in urban planning. The second section presents developmental information about population and housing growth in Istanbul, as well as the recent local housing transformation projects. The third section explains the multi-objective evaluation of housing transformation projects, and the final section is devoted to the conclusion and suggestions for further research.

**Background**

Using transformation to improve the issues related to the living quality of housing projects in Istanbul is quite important, due to Istanbul's long historical background, natural beauty, and status as Türkiye's socioeconomic and cultural center. In fact, several attempts have been made for this purpose over time.

After the 1950s, the rapid growth of the population, urbanization, modernization, and industrialization in Istanbul caused various housing problems in different parts of the city. On one hand, a third of Istanbul's urban areas had been covered by squatter housing without the necessary infrastructure and services. On the other hand, historical neighborhoods started to lose their inhabitants to modern housing projects with better living quality along the city's periphery, such as in Atakoy and Ataşehir. Another reason for the housing decline in the old city center involved the multi-center development of Istanbul following the construction of the Bosporus bridges and the peripheral highways (Dokmeci & Berkoz, 1994).

Several studies have analyzed the transformation of historical areas. One of these studies (Bardo& Dokmeci, 1992) investigated inhabitants' satisfaction with their neighborhoods in both historical and modern establishments. Their study's results revealed 95% of residents in modern housing projects to be satisfied with their neighborhoods, while only 75% of the residents were satisfied in the historical neighborhoods. Dokmeci et al. (1996) provided a comprehensive study on this subject. Another study by Dokmeci and Berkoz (2000) revealed that modern housing projects in Kadikoy, Sariyer, and Bakirkoy attracted residents more than the other districts of Istanbul, with squatter areas such as Gaziosmanpasa being the least preferred residential areas.

One of the earliest works on the transformation of historical districts started in Beyoglu, as illustrated by Dokmeci and Ciraci (1990) and Giritlioglu et al. (1993). Dokmeci et al. (2007) presented a study on the restoration of buildings in Beyoglu, which resulted in functional changes and increased land values. Ergun (1994) and Ergun and Dundar (1994) provided comprehensive studies on the transformation of Istanbul. Kolcu and Dokmeci (2013) investigated another analysis of the factors influencing land-use transformation in the historical city center.

In fact, Dokmeci and Erdogan (2021) illustrated how a tremendous need exists for land-use transformation in squatter housing areas, which are under-valued with respect to the rest of the city. Their article examined the distribution of housing prices in Istanbul at the neighborhood scale and compared the increases in housing prices over the last 20 years proportionally. According to the findings from their study, although the number of houses along coastal areas was determined to have increased, the house prices, which are higher than in other parts of the city, remained the same. In addition, high property values were decentralized toward the city periphery. The main reasons for this situation were found to be the formation of new sub-centers in parallel with the development of transportation opportunities, the attractiveness of the suburban lifestyle, and foreign capital investments accompanying the effects of globalization. However, the change in property values were also able to be explained as the increase in inequality between the quality of housing owned by low- and high-income groups. Furthermore, their research findings revealed the urban transformation practices implemented in the squatter housing areas, the revitalization of the dilapidated areas in the city center, and the increase in the number of neighborhoods developed under the control of the plans to have also caused an increase in housing prices at the metropolitan level. 17,369 housing transformation projects were erected between 2009 and 2018 in Istanbul, with Kilinc and Turk (2022) and Tarakci and Turk (2022) having provided comprehensive analyses of these projects from a value capture perspective. Developing evaluation techniques for these projects is important.

**Multi-Objective Analysis of Housing Transformation Projects at the Metropolitan Level in Istanbul**

Housing transformation projects are based on multi-objectives with respect to their location within the city, socioeconomic and political conditions, aesthetic evaluations (Rezafar & Turk, 2018; 2021), and their own characteristics. Kilinc and Turk (2021, 2022) broadly investigated these housing transformation projects and illustrated their multi-objective characteristics. As a result, the conditions of these projects reveal the need to exist for a decision method based on multi-objectives. Dokmeci et al. (1993) has already used this method for determining efficient land use based on maximization of returns and minimization of transportation costs. The formulation of the model is given below:

$$E_{(a)} = \Sigma_{k=1}^{n} U_k e_{k(a)} \tag{1}$$

where $E_{(a)}$ is the effectiveness of alternative $a$, $U_k$ is the weight of objective $k$, $e_{k(a)}$ is the efficiency of alternative $a$ in terms of objective $k$.

According to this model, for each housing transformation project, several alternatives are taken into consideration. The effectiveness of each alternative is calculated by summing up the weighted efficiencies of each objective with respect to this specific alternative. Finally, the alternative that has the maximum effectiveness is chosen as the best solution to be taken into consideration for the specific housing transformation project. Several other methods are also found that can be applied to arrive at a satisfactory solution for multi-objective programming problems (Nijkamp & Rietveld, 1981).

### Conclusion

Istanbul urgently needs to improve the quality of life in the haphazardly developed squatter housing areas and in the historical districts that have declined and to improve the quality of buildings in the face of an increasing earthquake risk. In fact, 17,369 housing transformation projects have occurred in different parts of the city with various deficiencies. Because these projects are based on multi-objectives involving socioeconomics, politics, and aesthetics according to their location and characteristics, the present paper proposes a multi-objective decision model for determining the most efficient housing transformation design. According to this model, several alternatives should be taken into consideration for the benefit of the different social groups subject to public benefits. The effectiveness of each alternative is calculated by summing up the efficiencies with respect to each objective. Finally, the alternative with the highest effectiveness is chosen as the best solution for the housing transformation project under consideration. This decision model eliminates problems that occur such as contradicting objectives and decision makers having different opinions. This model can also be useful in other areas of urban planning, such as transportation, facility planning, urban service systems, and real estate.

Further expansion of the model can be developed by taking into consideration the interactions among housing transformation projects with regard to economic and social aspects using artificial intelligence techniques.

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