A MATHEMATICAL MODEL PROPOSAL ON THE PARAMETERS OF URBAN TRANSFORMATION ZONING PRACTICES

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ABSTRACT

One of the most important problems encountered in urban transformation applications is to allow an understanding of urbanization in order to convince the inhabitants of the transformation zone and to increase the value of the land. In particular, it is a method used by politicians to save the day and get votes. These extra zoning increases lacking scientific foundation make the city's quality of life, transportation, air and water worse from day to day. For those who dream of living in the transformational areas, which are old, worn, not resistant to earthquake-resistant structures, and in the realm of implementation within the framework of international planning standards, these extreme zoning promises become a dystopian city at the end of all.

In this article, in the light of national and international standards and recommendations, zoning parameters (floor area ratio – FAR, building coverage ratio (BCR), construction area, car park, shelter, etc.), which is one of the major problems of the transformation areas, are formed by combining planning, architectural thinking and engineering parameters. It is attempted to bring a regulatory proposal to the Draft Urban Transformation Model (DUTM).

Keywords: Transformation, Mathematical Model, Zoning.

1. INTRODUCTION

Successful world examples of urban transformation practices that the city, low-income groups live under bad economic and physical conditions are as follows: Danbara, Solidere, Rio de Janeiro 55. At the same time, the transformation has been the implementation of projects that will contribute to the economic development of the city in the old empty port and industrial areas in the residential areas where the population is lost and social solidarity is lost (Ataöv and Oamay, 2007. In other words, in order to find a solution to the problems of the cities, it is a comprehensive activity in order to provide a fundamental solution to the social, physical, economic and environmental conditions of a region undergoing change (Thomas, 2003) Therefore, improving the living conditions without changing the demographic structure of a project area forms the basis of the transformational spirit. In this context, the structural and regional data of a place to be transformed should be examined in detail and the road map should be drawn accordingly. The analysis of the present situation in an area subject to transformation, the current situation analysis, the demographic and socio-economic structure of the region, geological and geotechnical analysis, earthquake risk, physical structure analysis (structure functions, floor quantities, building types, structure quality, density), property situation, upper scale planning and investment decisions, 1/5000 scale master plan, 1/1000 scale implementation zoning plan, transportation, technical infrastructure, expectations of the households, surveys which will take a picture of the current situation, the study sheets should be in the feasibility and research reports where the problems of the region will be detected in the future. These reports should therefore form the base of a mathematical model.

Mathematical modeling is the attempt to mathematically express the phenomena and relations between events in the most general meaning of mathematics. It is the process of revealing mathematical patterns in these events and phenomena (Verschaffel et al., 2002). The Draft Urban Transformation Model (DUTM) is a model in which all the parameters related to each other in a transformation area act together and give results.

In this study; it is tried to explain the methods of zoning in urban transformation regions by defining the relationship between the existing transformation region and the project transformation zone.

Based on the current practices and regulations, national and international boundary conditions have been read and a suggestion has been made on how to make zoning parameters in a transformation model.

2. ZONING PARAMETERS

As it is indicated in the zoning diagram in Fig. 1 for the zoning data, the current status database of the selected region was created when designing the model's writing and expression system. Within the framework of the urban transformation approach, an account and analysis method were developed within the framework of national, international and recommendation limit values.
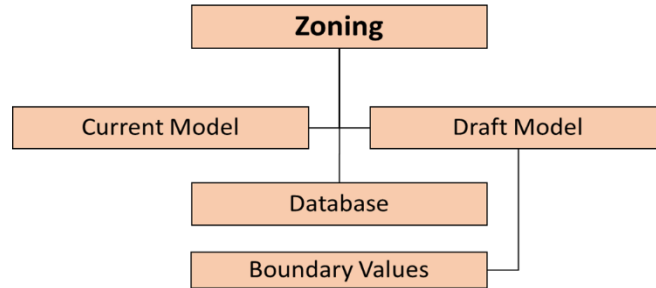

Fig. 1. Zoning diagram (Polat, 2017)

The aggregate data index of the group which is subject to the model is examined under the current and draft model headings as in Table 1.

Table 1. Zoning data index (Polat, 2017)

N.	Current (C)	Draft (D)
1	Current gross residential building area (m²)	Draft population (person)
2	Coefficient of decrease in non-floor areas ratio	Draft residential population (%)
3	Current net residential building area (m²)	Draft residential population (person)
4	Current gross commercial building area (m²)	Draft net residential construction area per person (m² / person)
5	Current net commercial building area (m²)	Draft net residential building area (m²)
6	Current gross residential + commercial building area (m²)	Draft commercial population (%)
7	Current net residential +commercial building area (m²)	Draft commercial population (person)
8	Current net building area (m²)	Draft net commercial construction area per person (m² / person)
9	Current population (person)	Draft net commercial building area (m²)
10	Current net residential construction area per person (m² / person)	Draft residential + commercial population (%)
11	Current residential population (person)	Draft residential + commercial population (person)
12	Current net commercial construction area per person (m² / person)	Draft net residential + commercial construction area per person (m² / person)
13	Current commercial population (person)	Draft net residential + commercial building area (m²)
14	Current net residential + commercial construction area per person (m² / person)	Draft residential development area (m²)
15	Current residential + commercial population (person)	Draft residential FAR (coefficient)
16	Current total net construction area per person (m² / person)	Draft commercial development area (m²)
17	Current residential (zoned) area (m²)	Draft commercial FAR (coefficient)
18	Current residential FAR(Real)	Draft residential + commercial development area (m²)
19	Current commercial (zoned) area (m²)	Draft residential + commercial FAR (coefficient)
20	Current commercial FAR(Real)	Draft coefficient of increase in aboveground construction
21	Current residential + commercial (zoned) area (m²)	Draft residential increase area in aboveground (m²)
22	Current residential+ commercial FAR(Real)	Draft commercial increase area in aboveground (m²)
23	Current total FAR(Real)	Draft residential + commercial increase area in aboveground (m²)
24	Current residential building coverage area (m²)	Draft coefficient of increase in underground construction
25	Current residential BCR(Real)	Draft residential increase area in underground (m²)
26	Current commercial building coverage area (m²)	Draft commercial increase area in underground (m²)
27	Current commercial BCR(Real)	Draft residential + commercial increase area in underground (m²)
28	Current residential + commercial building coverage area (m²)	Draft total gross area of construction (m²)
29	Current residential + commercial BCR(Real)	Draft total net area of construction (m²)
30	Current total BCR(Real)	Draft gross/net construction area coefficient

31	Current residential parking lot (quantity)	Draft residential BCR
32	Current residential parking lot ratio (quantity/m²)	Draft residential building coverage area (m²)
33	Current commercial parking lot (quantity)	Draft commercial BCR
34	Current commercial parking lot ratio (quantity/m²)	Draft commercial building coverage area (m²)
35	Current residential + commercial parking lot (quantity)	Draft residential + commercial BCR
36	Current residential + commercial parking lot ratio (quantity/m²)	Draft residential + commercial building coverage area (m²)
37	Current total parking lot (quantity)	Draft residential floor quantities
38	-	Draft commercial floor quantities
39	-	Draft residential + commercial floor quantities
40	-	Draft residential average floor height (m)
41	-	Draft residential Hmax (m)
42	-	Draft commercial average floor height (m)
43	-	Draft commercial Hmax (m)
44	-	Draft residential + commercial average floor height (m)
45	-	Draft residential + commercial Hmax (m)
46	-	Draft residential parking lot coefficient (1/m²)
47	-	Draft residential parking lot quantity
48	-	Draft commercial parking lot coefficient (1/m²)
49	-	Draft commercial parking lot quantity
50	-	Draft residential + commercial parking lot coefficient (1/m²)
51	-	Draft residential + commercial parking lot quantity
52	-	Draft unit parking lot construction area (m²)
53	-	Draft total parking lot construction area (m²)
54	-	Draft shelter area per person (m² / person)
55	-	Draft shelter construction area (m²)
56	-	Draft other underground area coefficient (%)
57	-	Draft other underground area (m²)
58	-	Draft underground total area (m²)
59	-	Draft total increase area in underground (m²)
60	-	Draft usage of construction underground (%)

In the zoning database section of the current model, the data obtained from the feasibility studies of the region to be transformed are shown in the variable input column and the data that the variable inputs (VI) establish mathematically with each other in the dependent input (DI) column and the calculation and analysis results are shown in the output (O) column (Table 2).

According to this;
• 37 current types,
• 16 variable inputs (obtained from feasibility studies),
• 6 dependent inputs (determined by the relationship between variable inputs),
• 15 output data (as a result of the equation factors in the parameters section) are obtained.

Table 2. Zoning data of the current model (Polat, 2017)

N.	Type	VI	DU	O
1	Current gross residential building area (m²)	x	-	-
2	Coefficient of decrease in non-floor areas ratio	x	-	-
3	Current net residential building area (m²)	-	-	x
4	Current gross commercial building area (m²)	x	-	-
5	Current net commercial building area (m²)	-	-	x
6	Current gross residential + commercial building area (m²)	x	-	-
7	Current net residential +commercial building area (m²)	-	-	x
8	Current net building area (m²)	-	x	-
9	Current population (person)	-	x	-
10	Current net residential construction area per person (m² / person)	-	-	x
11	Current residential population (person)	x	-	-
12	Current net commercial construction area per person (m² / person)	-	-	x
13	Current commercial population (person)	x	-	
14	Current net residential + commercial construction area per person (m² / person)	-	-	x

15	Current residential + commercial population (person)	x	-	-
16	Current total net construction area per person (m² / person)	-	x	-
17	Current residential (zoned) area (m²)	x	-	-
18	Current residential FAR$_{(Real)}$	-	-	x
19	Current commercial (zoned) area (m²)	x	-	-
20	Current commercial FAR$_{(Real)}$	-	-	x
21	Current residential + commercial (zoned) area (m²)	x	-	-
22	Current residential+ commercial FAR$_{(Real)}$	-	-	x
23	Current total FAR$_{(Real)}$	-	x	-
24	Current residential building coverage area (m²)	x	-	-
25	Current residential BCR$_{(Real)}$	-	-	x
26	Current commercial building coverage area (m²)	x	-	-
27	Current commercial BCR$_{(Real)}$	-	-	x
28	Current residential + commercial building coverage area (m²)	x	-	-
29	Current residential + commercial BCR$_{(Real)}$	-	-	x
30	Current total BCR$_{(Real)}$	-	x	-
31	Current residential parking lot (quantity)	x	-	-
32	Current residential parking lot ratio (quantity/m²)	-	-	x
33	Current commercial parking lot (quantity)	x	-	-
34	Current commercial parking lot ratio (quantity/m²)	-	-	x
35	Current residential + commercial parking lot (quantity)	x	-	-
36	Current residential + commercial parking lot ratio (quantity/m²)	-	-	x
37	Current total parking lot (quantity)	-	x	-

In the zoning database section of the model, the data determined according to the need of the region to be transformed is shown in the variable input (VI) column, in the legend (L) of the zoning column, the data that the variable input data have mathematically correlated with each other are shown in the dependent input (DI) column and the calculation and analysis results are shown in the output (O) column.

In addition, the values created from national and international criteria and recommendations, in which the adequacy of these outputs are determined, are in the boundary value column and the relationship between whether these outputs are within the limit value (LV) standards is found in the conditional (C) and appropriateness (A) columns (Table 3).

Table 3. Zoning data of the draft model (Polat, 2017)

N.	Type (D)	VI	L	DI	O	C	LV	A
1	Draft population (person)	-	-	x	-	-	-	-
2	Draft residential population (%)	x	x	-	-	-	-	-
3	Draft residential population (person)	-	-	-	x	x	x	x
4	Draft net residential construction area per person (m² / person)	x	-	-	-	-	-	-
5	Draft net residential building area (m²)	-	-	-	x	x	x	x
6	Draft commercial population (%)	x	x	-	-	-	-	-
7	Draft commercial population (person)	-	-	-	x	x	x	x
8	Draft net commercial construction area per person (m² / person)	x	-	-	-	-	-	-
9	Draft net commercial building area (m²)	-	-	-	x	x	x	x
10	Draft residential + commercial population (%)	x	x	-	-	-	-	-
11	Draft residential + commercial population (person)	-	-	-	x	x	x	x
12	Draft net residential + commercial construction area per person (m² / person)	x	-	-	-	-	-	-
13	Draft net residential + commercial building area (m²)	-	-	-	x	x	x	x
14	Draft total population (person)	-	-	x	-	-	-	-
15	Draft net total building area (m²)	-	-	x	-	-	-	-
16	Draft residential development area (m²)	-	-	x	-	-	-	-
17	Draft residential FAR (coefficient)	-	-	-	x	x	x	x
18	Draft commercial development area (m²)	-	-	x	-	-	-	-
19	Draft commercial FAR (coefficient)	-	-	-	x	x	x	x
20	Draft residential + commercial development area (m²)	-	-	x	-	-	-	-
21	Draft residential + commercial FAR (coefficient)	-	-	-	x	x	x	x
22	Draft total FAR (coefficient)	-	-	x	-	-	-	-
23	Draft coefficient of increase in aboveground construction	x	-	-	-	-	-	-
24	Draft residential increase area in aboveground (m²)	-	-	-	x	x	x	x
25	Draft commercial increase area in aboveground (m²)	-	-	-	x	x	x	x

26	Draft residential + commercial increase area in aboveground (m²)	-	-	-	x	x	x	x
27	Draft total increase area in aboveground (m²)	-	-	x	-	-	-	-
28	Draft coefficient of increase in underground construction	x	-	-	-	-	-	-
29	Draft residential increase area in underground (m²)	-	-	-	x	x	x	x
30	Draft commercial increase area in underground (m²)	-	-	-	x	x	x	x
31	Draft residential + commercial increase area in underground (m²)	-	-	-	x	x	x	x
32	Draft total gross area of construction (m²)	-	-	x	-	-	-	-
33	Draft total net area of construction (m²)	-	-	x	-	-	-	-
34	Draft gross/net construction area coefficient	-	-	-	x	x	x	x
35	Draft residential BCR	x	-	-	-	-	-	-
36	Draft residential building coverage area (m²)	-	-	-	x	x	x	x
37	Draft commercial BCR	x	-	-	-	-	-	-
38	Draft commercial building coverage area (m²)	-	-	-	x	x	x	x
39	Draft residential + commercial BCR	x	-	-	-	-	-	-
40	Draft residential + commercial building coverage area (m²)	-	-	-	x	x	x	x
41	Draft total building coverage area (m²)	-	-	x	-	-	-	-
42	Draft residential floor quantities	-	-	-	x	x	x	x
43	Draft commercial floor quantities	-	-	-	x	x	x	x
44	Draft residential + commercial floor quantities	-	-	-	x	x	x	x
45	Draft total average floor quantities	-	-	x	-	-	-	-
46	Draft residential average floor height (m)	x	-	-	-	-	-	-
47	Draft residential Hmax (m)	-	-	-	x	x	x	x
48	Draft commercial average floor height (m)	x	-	-	-	-	-	-
49	Draft commercial Hmax (m)	-	-	-	x	x	x	x
50	Draft residential + commercial average floor height (m)	x	-	-	-	-	-	-
51	Draft residential + commercial Hmax (m)	-	-	-	x	x	x	x
52	Draft residential parking lot coefficient (1/m²)	x	-	-	-	-	-	-
53	Draft residential parking lot quantity	-	-	-	x	x	x	x
54	Draft commercial parking lot coefficient (1/m²)	x	-	-	-	-	-	-
55	Draft commercial parking lot quantity	-	-	-	x	x	x	x
56	Draft residential + commercial parking lot coefficient (1/m²)	x	-	-	-	-	-	-
57	Draft residential + commercial parking lot quantity	-	-	-	x	x	x	x
58	Draft total parking lot quantity	-	-	x	-	-	-	-
59	Draft unit parking lot construction area (m²)	x	-	-	-	-	-	-
60	Draft total parking lot construction area (m²)	-	-	-	x	x	x	x
61	Draft shelter area per person (m² / person)	x	-	-	-	-	-	-
62	Draft shelter construction area (m²)	-	-	-	x	x	x	x
63	Draft other underground area coefficient (%)	x	-	-	-	-	-	-
64	Draft other underground area (m²)	-	-	-	x	x	x	x
65	Draft underground total area (m²)	-	-	x	-	-	-	-
66	Draft total increase area in underground (m²)	-	-	x	-	-	-	-
67	Draft usage of construction underground (%)	-	-	-	x	x	x	x

Here;

- 67 draft type,
- 20 variable inputs (assigned by the designer),
- 3 legend (1 variable, 2 dependent),
- 15 dependent inputs,
- 32 output data,
- 32 conditions (24 of them less than or equal (≤), 5 of them greater than or equal (≥) which determine the relationship between output, and boundary value;
- 32 limit values,
- 32 eligibility criteria (positive (√) or negative (x) status of the condition relationship between output and limit values are reflected in the database, negative (x) conditions are tried to be converted into positive (√) by means of variable inputs).

Table 4 contains the international (I) and national (N) value references of the input data of 20 types in the zoning database (FAR, BCR, parking lot, etc.) and the recommendations (S) of the DUTM (limit value) are included.

Table 4. Limit value references for input data (Polat, 2017)

N.	Type	I	N	S
1	Draft residential population (%)	-	-	√
2	Draft net residential construction area per person (m² / person)	-	√	√
3	Draft commercial population (%)	-	-	√
4	Draft net commercial construction area per person (m² / person)	√	√	√
5	Draft residential + commercial population (%)	-	-	√
6	Draft net residential + commercial construction area per person (m² / person)	-	-	√
7	Draft coefficient of increase in aboveground construction	-	√	√
8	Draft coefficient of increase in aboveground construction	-	√	√
9	Draft residential BCR	√	√	√
10	Draft commercial BCR	-	√	√
11	Draft residential + commercial BCR	-	√	√
12	Draft residential average floor height (m)	-	-	√
13	Draft commercial average floor height (m)	-	-	√
14	Draft residential + commercial average floor height (m)	-	-	√
15	Draft residential parking lot coefficient (1/m²)	√	√	√
16	Draft commercial parking lot coefficient (1/m²)	√	√	√
17	Draft residential + commercial parking lot coefficient (1/m²)	-	-	√
18	Draft unit parking lot construction area (m²)	√	√	√
19	Draft shelter area per person (m² / person)	-	√	√
20	Draft other underground area coefficient (%)	-	√	√

The output data, which are the results of the equations of each data in the draft model, were limited in the same context to the international and national standards and limiting conditions were proposed and recommendations were made (Table 5).

Table 5. Limit value references for output data (Polat, 2017)

N.	Type	I	N	S
1	Draft residential population (person)	-	-	√
2	Draft net residential building area (m²)	-	√	√
3	Draft commercial population (person)	-	-	√
4	Draft net commercial building area (m²)	√	√	√
5	Draft residential + commercial population (person)	-	-	√
6	Draft net residential + commercial building area (m²)	-	-	√
7	Draft residential FAR (coefficient)	√	√	√
8	Draft commercial FAR (coefficient)	-	√	√
9	Draft residential + commercial FAR (coefficient)	-	√	√
10	Draft residential increase area in aboveground (m²)	-	√	√
11	Draft commercial increase area in aboveground (m²)	-	√	√
12	Draft residential + commercial increase area in aboveground (m²)	-	√	√
13	Draft residential increase area in underground (m²)	-	√	√
14	Draft commercial increase area in underground (m²)	-	√	√
15	Draft residential + commercial increase area in underground (m²)	-	√	√
16	Draft gross/net construction area coefficient	-	√	√
17	Draft residential building coverage area (m²)	√	√	√

18	Draft commercial building coverage area (m²)	-	√	√
19	Draft residential + commercial building coverage area (m²)	-	√	√
20	Draft residential floor quantities	√	-	√
21	Draft commercial floor quantities	-	-	√
22	Draft residential + commercial floor quantities	-	-	√
23	Draft residential Hmax (m)	-	√	√
24	Draft commercial Hmax (m)	-	√	√
25	Draft residential + commercial Hmax (m)	-	√	√
26	Draft residential parking lot quantity	√	√	√
27	Draft commercial parking lot quantity	√	√	√
28	Draft residential + commercial parking lot quantity	-	-	√
29	Draft total parking lot construction area (m²)	√	√	√
30	Draft shelter construction area (m²)	-	√	√
31	Draft total increase area in underground (m²)	-	√	√
32	Draft usage of construction underground (%)	-	-	√

5. CONCLUSION AND EVALUATION

This article; in the light of national and international criteria and recommendations, in order to assist in a regional based planning study, the DUTM proposal is discussed in the context of zoning parameters (current and draft). According to this; the analysis is carried out via 307 parameters, including 104 types, 36 variable inputs, 21 dependent inputs, 47 outputs, 3 legend, 32 conditions, 32 limit values and 32 appropriateness criteria.

The Draft Urban Transformation Model (DUTM) tried to contribute to the accounts and assessments related to methods that should be followed in the new urban transformation studies planned or to be planned within the framework of the mathematical model designed for urban transformation applications.

4. REFERENCES

Ataöv, A. and Oamay, S. (2007). Türkiye'de Kentsel Dönüşüme Yönetsel Bir Yaklaşım. Middle East Technical University Journal of the Faculty of Architecture, Vol. 24, No. 2, pp.57-82.

Polat, H. I. (2017). Türkiye'de Kentsel Dönüşüm Uygulamaları İçin Matematiksel Bir Model Önerisi, (A Mathematical Model Suggestion for Urban Transformation in Turkey), PhD Thesis, Yıldız Technical University, Istanbul, Turkey.

Thomas, S. (2003). A Glossary of Regeneration and Local Economic Development. Manchester: Local Economic Strategy Center.

Verschaffel, L., Greer, B. and De Corte, E. (2002). "Everyday knowledge and mathematical modeling of school word problems." In Symbolizing, modeling and tool use in mathematics education, Springer Netherlands, pp. 257-276.