CHAPTER 3

A NEW APPROACH TO LAND READJUSTMENT

3.1 Introduction

In the previous chapter, the land readjustment method was outlined with its characteristics, procedures, issues and potential use for urban land development. It is concluded that land readjustment is a powerful land management tool which provides great opportunities for local authorities when public and private land is needed for urbanisation.

In this chapter, considering the current status of land readjustment, issues and the solutions are specifically defined from the technical point of view. In order to improve the benefits obtained from a land readjustment process, a new approach is proposed and discussed. Based on the objectives of this research, a value-based urban land readjustment model was designed and developed.

The proposed model analyses each geographical unit of a land parcel with respect to some selected substantial and insubstantial land valuation factors. Each of these factors is mathematically expressed, and the *nominal asset values* for the parcels are determined with the combination of these factors. It has to be mentioned that, in this model, the term of *value* is used as a single unit figure which represents a land parcel's worth when compared with others. Therefore, the meaning of value is a numerical parameter of each land parcel rather than a real-market value. To determine this parameter, some land valuation factors which may affect the total perceived value of a land parcel are spatially examined. In order to accomplish the required analysis procedures, the spatial analysis capabilities of a GIS are used during the model development.

3.2 Requirements to improve land readjustment process

As pointed out by Doebele (1986), land readjustment is a complex management tool with economic, physical, social and planning dimensions. Not only the local government authorities but also private bodies are involved in a land readjustment project. Therefore, the interests in land readjustment are very broad. To clarify the research objectives, the requirements in the technical level are only considered during the study. Consequently, the study concentration was particularly focused on the following three requirements;

(1) Land valuation
(2) Decision making
(3) Information management

These requirements are examined individually. Then the solutions to them are tackled and provided within a single model.

3.2.1 Land valuation

The nature of land readjustment constrains the cadastral parcels to transform to new site lots. Hence, within a land readjustment project area, not only existing cadastral boundaries are changed but also the economic values of the parcels. From the economic point of view, these changes very much affect the landowners, land value profiles for the owners can be different before and after the project. Especially, after full implementation of the new plan, the land market-values increase greatly within the project region so that landowners can obtain new and different benefits from the project.

In general, the land valuation issue appears after the project. Most of the objections come from landowners about land valuation. They claim that equitable benefits are not obtained after the project. This is due in part to the fact that, during the project the planners have difficulty to estimate and distribute the benefits which a land-use plan may bring. Land market-values are usually used to evaluate these benefits.

However, in some countries, different approaches have been practised to deal with the land evaluation procedures. In Australia, for example, the land valuation board is established to determine the market value of the land parcels. After the project, a cash adjustment procedure is applied among the involved land owners. In Germany, annual real-market indexes are considered before and after the project. If the land values are quite homogenous in the project area then the values are ignored during the project. In the Japanese approach, land is evaluated in accordance with the site utilities. Land values are calculated using the index applying the same standard before and after the project. However, in Turkey, land evaluation is not considered during the any steps of the process.

In general, lack of information, funds, shortage of technical and administrative personnel delay implementation of the needed large scale land valuation activities. However, the determination of a land parcel value depends on a number of physical and economic characteristics which must be taken into consideration very carefully in a land valuation procedure. Some of these characteristics are intrinsic to the land, others are external or environmental factors. These factors can be determined in an objective way but there is always a certain degree of subjectivity that is difficult to measure in the valuation process.

In order to provide a more objective land evaluation approach to land readjustment, dynamic land valuation analysis is required. This analysis must deal with some tangible and intangible characteristics of a land parcel during the process. Criteria including location, view, shape, topography, available utilities, proximity to commercial areas etc. should be defined in a mathematical way and involved in the calculation process.

3.2.2 Decision making

Basically, in a land readjustment process, the site blocks which are given by zoning plan are subdivided into the new suitable lots according to the details of the plan. Then, the cadastral parcels are reallocated within these site blocks. During the land reallocation process, some small land parcels can be assembled within a new parcel. This means, a land parcel including its property rights can be shared between more than one landowner. On the other hand, a large cadastral parcel can be divided into more than one parcel. This can occur because new lot dimensions are given by the zoning plan that must be followed during the land subdivision.

Land reallocation is therefore the most complex part of the whole process which is carried out by planners after the land subdivision. Due to a non-standardised procedure, the planners have great responsibility to make decision about land reallocation, because the location of present cadastral parcels are changed, landowners are moved to new locations by the planner's judgement only. Thus, a more effective decision-making process is required to establish a standardised procedure which can be a guide for planners. In the decision making process, the land conditions before and after the project should be evaluated. To provide an equitable approach for landowners, considering the evaluation results and land ownership details, an optimal land distribution algorithm should be designed.

3.2.3 Information management

The examination of required cadastral records, basic calculations, and spatial data manipulation are important tasks during the land readjustment process. Currently used procedures for these requirements are done with conventional manual methods which are time-consuming and error-prone. In the land readjustment process, spatial data handling is a difficult task which requires great responsibility and accuracy, because when any small mistake occurs whether technical or non-technical, it may cause repetition of the whole process. This can also produce some unnecessary duplications in project stages so that the expense of the project increases. Hence, information management is the other issue that affects the performance of land readjustment.

However, a more effective information management process is needed to improve the qualitative and quantitative capabilities of land readjustment. The whole technical procedures and data flow can be automated for more efficient data use. This also establishes a reference for an information management system such as a land information system. To provide an effective information management system, the use of current information technology is essential.

3.3 Development of a value-based land readjustment model

Based on the technical requirements of the current land readjustment process, a new approach to land readjustment was proposed. In this section, the conceptual development of a value-based land readjustment model is discussed.

3.3.1 The aim

In order to accomplish the defined requirements in section 3.2, a new model which is a nominal asset value-based land readjustment was aimed to be developed using the currently available information technology. The main objective of this model is to determine the *nominal asset value* of a land parcel before and after the project with selected land valuation factors, then give back a new parcel to the landowner with the same value as that owned before. In other words, a parallel condition between the land parcel value profiles before and after the project must be provided so that all landowners who are involved in the project are affected in the same way from the land-use plan (Figure 3.1).

In this approach, due to the difficulty of collecting real-market value data, numerical parameters are intended to be calculated and used of for each land parcel rather than using the real-market value. In order to determine these numerical parameters, each geographical unit of a land parcel is analysed for selected land valuation factors. A land parcel value can then determined as a single unit figure which represents all factors effecting the land parcel as compared to others.

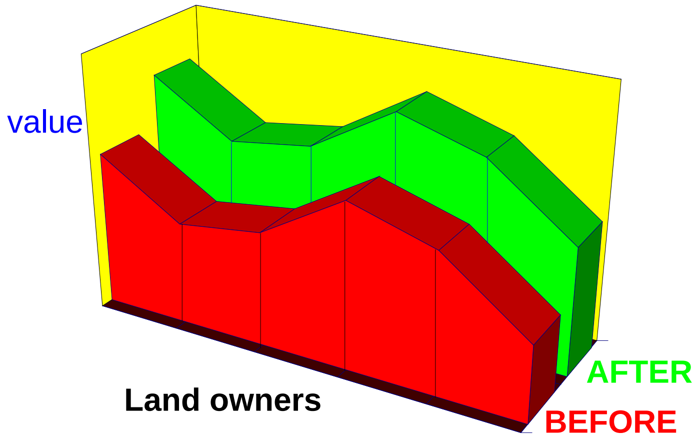


Figure 3.1 Land valuation profiles for landowners before and after project

The determination of a land parcel value with a selected valuation factors requires an effective computing environment which has the ability to make complex spatial analysis. Data collection, handling, manipulation, display and production of all necessary information should be done very quickly and accurately. Therefore, the use of some spatial analysis tools such as a GIS is essential.

3.3.2 Land valuation analysis

Land valuation is the process of assessing the characteristics of a given piece of land. The process may be described as a carefully considered estimate of the worth of landed property based on experience and judgement. However, the objective of land valuation is to determine value; a term generally prefaced by some description such as market value or benefit value (Dale and McLaughlin, 1988; Frizzel, 1979).

Land valuation is an essential process for the effective implementation of many development programmes and activities in a country. Land reform programmes, land and property taxation, land settlements and consolidation programmes, small and large land expropriations by governments and other public agencies, land use planning, land development projects, and private sales and purchases of land may be mentioned as fields and activities where land valuation may be needed (Henssen, 1990; Dale and McLaughlin, 1988; Walters, 1983). However, there are three generally recognised and widely used land valuation methods (Rees, 1988; Butler, 1987). These are:

(1) **The sales comparison method;** in which comparisons among recently sold properties are made. The procedure requires collection of all the available records of land sales in the area in recent years, making a scale by classifying them according to the characteristics of the land sold and comparing the land to be appraised with this scale.

(2) **The income capitalisation method;** that entails estimating the presents worth of future income expected from the land. This method takes into consideration the annual net income of the land. The estimated net income is capitalised, at an accepted interest rate, to give the capital value of the land.

(3) **The replacement cost method;** where the value of the land is first estimated separately, the current cost of constructing the buildings and other improvements is added, and then depreciation of the improvements is subtracted.

Selection of a land valuation method may not depend only on the availability or lack of the necessary data which are specially required for each method, but also on the purpose of valuation. With valuation for land reform purposes, market prices may not always be taken as a basis for evaluation because they may be inflated. Neither may capitalised value of potential income be a suitable method, either because the landowners will be better off than they were before or the new owners will be receiving over-priced land with this type of valuation. In this situation a combination of the three methods may be taken as a basis for valuation. More details about land valuation techniques can be found in Baum and Sams (1990), Dale and McLaughlin (1988), Rees (1988), Butler (1987).

The land valuation process plays an important role in the success of any land readjustment project. Yet, different approaches have been practised. In some countries, market value is used during the projects because of the data availability. Sometimes the data may not be available. In this case, depending on the valuation technique, the collection of data can delay the project. After the project, some objections may also arise from landowners questioning the determined value. They claim that the determined value does not represent the real worth of their land. Nevertheless, one of the difficulties is to estimate future values after the project. Due to the new developments, land speculations on market prices may occur during the project time and this also causes problems obtaining accurate market value data.

In reality, it is almost impossible to determine the exact value of a land parcel. However, a sufficient estimation can be done by analysing a certain amount of land characteristics in an objective way. In this research, rather than dealing with the real-market prices, the qualitative and quantitative characteristics of individual land parcels have been examined. To determine the value of a land parcel, some land valuation criteria are selected and formulated so that parcel values are assigned by the numerical parameters rather than real-market values. These parameters are derived from a combination of the selected land valuation factors which can be spatially analysed.

3.3.2.1 Classification of land valuation factors

In order to make an adequate value estimation for a land parcel, there are many tangible and intangible land valuation factors that should be taken into account during the valuation process. The determination and classification of these valuation factors is difficult, because the characteristics of these factors can be objective and subjective, changing according to a person's desires. Therefore, the number of land valuation factors cannot be limited but at least some of the land valuation factors are considered and analysed with respect to the past land readjustment implementations and the procedures of property appraisals.

Before the determination of specific factors, the global land valuation criteria for establishing the comparability of land parcels must be outlined.

3.3.2.1.1 Use of the land parcel

The most obvious land characteristic for purposes of comparison is its present use. Classification according to use is essential because the motives of buyer and seller of residential properties are different from those of investors in commercial, industrial and rural properties. In the case of a land readjustment, land-use is mainly considered for residential purposes. Especially, before the implementation of a land readjustment project, where different types of land use can exist but after the project most of the new land parcels are produced for residential use.

3.3.2.1.2 Characteristics of neighbourhood

The characteristics of a neighbourhood in which land parcels are situated is also important. A neighbourhood is a district of a municipality that serves a particular purpose. The type and size of a neighbourhood is largely determined by its location in relation to other districts in the municipality. The majority of land in a neighbourhood is subject to the same economic forces and most land values rise or fall together. Any neighbourhood, whether residential, commercial, industrial or rural can be analysed on the basis of three factors:

(i) Physical environment; Physical environment of a neighbourhood is the result of both natural conditions and human activities. The natural conditions most significant for neighbourhood development in urban areas are topography and load-bearing qualities of the soil. Human activities are also an important influence on the physical environment of a neighbourhood. The location of the neighbourhood in relation to the business, social and other forms of activity throughout the municipality is one of the most significant characteristics. The influence of human activity is also reflected by the type and architectural style of buildings, service, development, the adequacy of public facilities and the degree to which nuisances as well as health and safety hazards are present.

(ii) Government regulations: Municipal government is the most interested and most active of all levels of government in encouraging efficient development of neighbourhoods. In order to implement their development policies, municipal councils use legislation such as zoning and sanitary regulations, planning by-laws, and subdivision controls. If this legislation is carefully prepared, and efficiently administered, and reflects economic and environmental conditions as these are interpreted by residents and investors in the neighbourhood, development in that neighbourhood will be encouraged. On the other hand, if the legislation is poorly drafted or administered, or if it ignores underlying conditions, development can be seriously hindered.

(iii) Personal characteristics of the owners and residents: These considerations are essentially subjective as they relate to human attitudes, outlooks and prospects. The attitudes of neighbourhood residents towards law and order, towards maintaining their property, towards the future of the neighbourhood, as well as towards their neighbours can have important influence on neighbourhood development. These attitudes are not usually reflected directly in sales but they do impress would be investors and in that way influence development.

3.3.2.1.3 Location of the property

The importance of the various locational characteristics of a property is largely influenced by the use of the property, but there are other factors that apply to all land use. Access to transportation facilities, for example, is always an important influence on property values although the types of facilities that are important vary according to the use of the property. Quantity and quality of municipal services are also important. While every property requires at least a minimum level of municipal services, its use will determine the services required as well as what constitutes a minimum level.

Some location characteristics that affect the value of a residential land parcel may be given as follows:

- Access to major sources of employment,
- Access to major shopping and service areas,
- Access to neighbourhood shopping and service stores,
- Access to schools and religious places,
- Access to parks and recreational areas,
- Distance from sources of safety and health hazards,
- Distance from nuisances such as noise and smoke.

3.3.2.1.4 Site

With regard to urban land the most important site consideration is its suitability for its present use and its adaptability to some other use. The factors that may be examined when analysing the site are:

- Terrain, or topography of the site,
- Load-bearing qualities of the soil,
- Shape and dimensions,
- Landscaping,
- Street frontage,
- Size or area,
- Homogeneity with other sites in the neighbourhood.

3.3.2.2 Factor selection

The above classification gives a global view about the land valuation factors that may be considered during the valuation process. However, a better estimation of a land parcel's value requires more specific valuation factors. Some land valuation factors have been adopted to land-related works by many investigators (Nelson *et.al.*, 1992; Mackmin, 1989; Myhrberg; 1987; Chang, 1986; NRC, 1983). Based on this research and the global overview of value classification in section 3.3.2.1, some land valuation factors may be considered in a land readjustment process. These factors are listed in Table 3.1.

1. Topography	21. Access to railroad
2. Shape (narrow, large, etc.)	22. Access to waterway
3. Current usable area	23. Nearby nuisances
4. Size	24. Nearby healthy services
5. View	25. Noise
6. Landscaping	26. Smoke
7. Wind	27. Natural vegetation
8. Environment	28. Water use
9. Soil condition	29. Sewerage
10. Paid tax	30. Drainage
11. Current sale price	31. Available utilities
12. Distance to shopping areas	32. Basic municipal services
13. Distance to recreational areas	33. Building
14. Distance to play garden	34. Street frontage
15. Distance to parking facilities	35. Corner location
16. Distance to school	36. Location in a a site block
17. Distance to religious areas	37. Permitted number of floors
18. Distance to city centre	38. Permitted usable construction area
19. Access to street	39. Load-bearing utilities
20. Access to highway	40. Type of permitted building style

Table 3.1 Factors that may effect a land parcel value

In a land readjustment process, the main consideration in the selection of land valuation factors is based on the land itself. In other words, rather than assessing the buildings or other established constructions, the land parcel's surfaces are only considered. The current buildings are not considered because they are not subject to transfer to any location by the project. In Turkey, for example, the legal and physical positions of the existence buildings are maintained by the cadastral and land readjustment legislations. Only the cadastral parcel boundaries are replaced by the process. This means that the location of the land parcel is the only one that is subject to change. In this case, the current economical merits which depend on the parcel location are shifted and affected directly from the project. Therefore, in the selection of land valuation factors, a factor which would be affected by a change in location should be evaluated.

The required information about land valuation factors may be collected directly by a site survey or indirectly from external sources, but usually both methods are involved. Some of the sources of information include land registration offices (ownership documents), planning offices (building permits, zoning, services), and survey and mapping organisations (aerial photographs, topographic and other maps, survey plans). In this study, necessary information for a case study is mainly derived from cadastral, zoning and thematic maps.

3.3.2.3 Determination of a land parcel value

The number of land valuation factors is uncertain. Therefore, the precise value for a land unit cannot be determined easily. Consequently, the purpose of the land valuation process in a land readjustment is to estimate the nominal asset value with the combination of the selected valuation factors. To determine the significance of these factors for a land parcel, they need to be expressed mathematically so that the effect of each valuation factor can be determined for the complete land parcel.

To formulate the land valuation procedure for a land readjustment, the main aim of this approach can be expressed by the following equation [3.1].

$$\sum_{i=1}^{n} V_{(BEFORE)\,i} = \sum_{j=1}^{m} V_{(AFTER)\,j} \qquad [3.1]$$

where;

n = *Total number of cadastral parcels*
m = *Total number of new parcels*

According to the equation [3.1], total nominal asset values before and after must be equal so that all land owners within the project area are affected in the same way by the project. To provide the equation [3.1], the required value for both sides of the equation is then determined by the equation [3.2]. This formula represents the total value for a single land parcel. The variable (**f**) in this formula represents each individualy selected factor's value. These factors may affect the total value of a parcel in different ways. Therefore, each of these factors should be considered with some weights. The determination of weights is explained after the calculation of factor value, in section 3.3.2.3.3.

In this study, to determine the factor values, it was assumed that each factor value could have a maximum value of 100 for a fully developed land unit.

Thus, each selected factor is evaluated out of 100 percent (Figure 3.2). Consequently, the considered land valuation factors and formulation of theses factors are detailed in the following section.

$$V_i = AREA_i * \sum_{j=1}^{k} (f_{ji} * w_j) \qquad [3.2]$$

V : Total nominal asset value of a land parcel
Area : Land parcel size
f : Factor value
w : Factor weight

n: Total number of old parcels
m: Total number of new produced parcels
k: Total number of factors

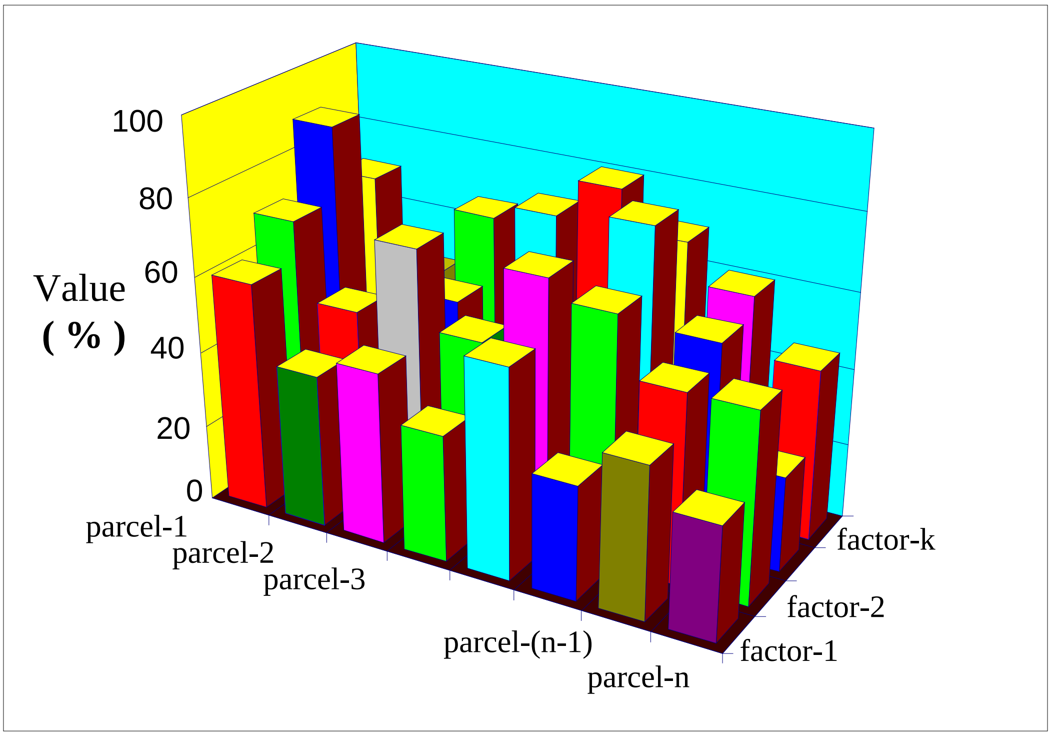


Figure 3.2 The conceptual view of land valuation factor assessment

3.3.2.3.1 Formulation of the land valuation factors

(a) Topography

Topography refers to natural contours of the land. As expressed by McRae and Burnham (1981); and Mackmin (1989), it is a significant element for the suitability of land, especially for residential purposes. Since the rough terrain may increase construction costs, flat or very nearly flat land is most desirable for more economical land use. Thus, it assumes that there is a reverse ratio between topographic value and slope level of the land. To determine the topographical factor value, the average slope of a land parcel is considered. However, the factor value for topography can be determined by the following formula:

$$v = 100 - S\% \qquad [3.3]$$

where;
v = The factor value of a parcel's topography
S% = Average slope percentage of the parcel

(b) Land parcel shape

The shape factor recognises that the geometrical form of a land parcel influences the cost of construction per square meter of floor area. Therefore, a parcel with rectangular shape is advantageous for construction design. The position and the number of lot corners effects the homogeneity and use of a land parcel respectively broken lot sides create an irregular parcel shape.

In the real-market, a regular parcel shape has a significant value (Mackmin, 1989). Therefore, shape can be considered as a land valuation factor. To determine this factor value, the number of the lot corners is examined. In the calculation of the value of shape, it assumes that there is an inverse relationship between the number of lot corners and the value. In the calculation of the shape factor, it was accepted that a parcel with 4 corners reflects a regular parcel shape. The shape factor however may be formulated as follow:

$$v = \frac{4}{n} * 100 \qquad [3.4]$$

where;

v = Factor value for the shape of a land parcel

n = The sum of a parcel's corners { if n < 4 then n=4 }

If two corners of a parcel are very close to each other, one of them can be ignored because the lenght of the side may be insignificant on the parcel shape. Therefore, during the factor's value determination, a tolerance distance is considered and the corners within this given tolerance distance are ignored. Some examples for the lot corner are given in Figure 3.3.

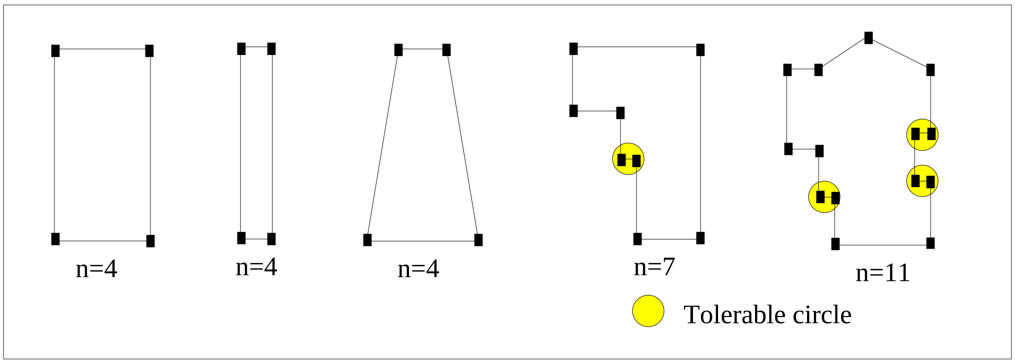


Figure 3.3 The examples for the different land parcel shapes

(c) Street frontage

Street frontage may be considered as the direct accessibility of a land parcel to a street. More accessibility provides more advantages for a parcel (Frizzel, 1979; Mackmin, 1989). Based on this, the parcel widths which face towards a street can be taken into consideration during the valuation process. To determine this factor's effect on the total value of a land parcel, the sum of the width of street frontages are compared with the total length of the parcel. The factor value can be expressed by the following equation:

$$v = \frac{\sum S}{\sum L} \qquad [3.5]$$

where;

v = Factor value of street frontage

ΣS = The sum of the length of street frontages of a parcel

ΣL = The total length of land parcel's perimeter

(d) Permitted number of floors:

In a parcel-based land development procedure, the zoning plan mostly regulates the construction dimensions, such as maximum construction area, maximum number of floors by given data, etc. In a land readjustment project area, these given dimensions may be different from parcel to parcel because of the planning design. For a new land parcel, these dimensions are important because they may directly affect the land usage. The permitted number of floors is however very significant for land holders. An extra floor for example provides more economical benefits to the parcel. Therefore, as a factor, the permitted number of floors should be considered during the land valuation process. The following equation can be used to determined the effect of this factor.

$$\mathbf{v = (F_{\mathit{i}} * 10)} \quad [3.6]$$

where;

v = Factor value for the permitted number of floors

F = Permitted number of floor given for a parcel *i*

(In this equation, it assumes that the maximum floor number is 10)

(e) Permitted construction areas

Similar to the permitted number of floors, the construction area is another factor that comes with the zoning plan. Particularly, the permitted building dimensions on the ground are given by the plan. In generally, these dimensions are given as a percentage of the total parcel area that can be used by landowners. This factor can be expressed by the following equation:

$$\mathbf{v = C_{\mathit{i}} * 100} \quad [3.7]$$

where;

v = The factor value for permitted construction area

C = The construction coefficient for parcel *i*

(f) Location within site block

The location within a site block is another important attribute for a land parcel. Due to their open face to different streets, corner lots are being more serviceable and valuable than the mid-block lots (Chang, 1986; Mackay, 1968). It assumes that when the parcel is far off from the block centre the factor value increases (Figure 3.4). Yet, to determine the significance of the location within the block, the distance from the block centre to the corner lot is considered. However, the factor value can be expressed by the following equation:

$$v = \frac{PD_i}{MD_j} * 100 \qquad [3.8]$$

where;

v = The factor value for the location within a block

PD = The distance from the centre of parcel *i* to the centre of a site block *j*

MD = The maximum distance from the centre of site block *j* to the centre of a corner lot in the same block

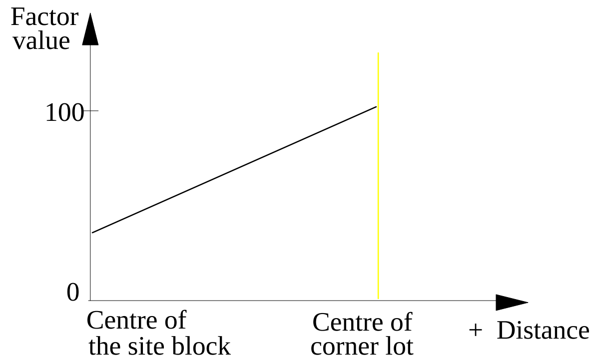


Figure 3.4 The relationship of factor value and a parcel location within a site block

(g) Soil condition

Soil condition is generally considered in the classification of agricultural land for farming purposes. In the case of land readjustment, the soil condition can be considered as a load-bearing characteristic of a site lot. The load-bearing quality of the soil is an important feature that the construction cost of the parcel is influenced. To determine the load-bearing quality of a land parcel, geological ground analysis is needed. Solid or marshy soil may increase the expense of any building plans (Baum and Sams, 1990). However, to represent the factor value, the following soil types and values can be considered during the valuation process.

Ground type Value

Rocky	10
Gravel	25
Mud	50
Clay	75
Loam	100

(h) <u>Current usable area</u>

The factor of current usable area may be considered as a physical characteristics of the land itself on the ground rather than the planning aspect of it. With respect to the physical attributes of the land, there may be some natural restrictions that limit the appropriate use of individual parcels. These natural restrictions such as rocky, marshy, downfall areas are considered as a disservicable areas of a land parcel. It is presumed that more usable areas may have a positive influence on the value. Yet, the factor value can be determined by the following equation.

$$v = \left(1 - \frac{NU_i}{PA_i}\right) * 100 \qquad [3.9]$$

where;

v = The factor value for current usable area

NU = The total non-usable area of land parcel *i*

PA = The total area of land parcel *i*

(i) <u>Supplied municipal services</u>

Whilst some land parcels have the basic services the others may not have. Therefore, the served parcels have advantages over the unserved parcels. At the same time, a land parcel may not be fully supplied. Hence, currently supplied services should be considered individually for each land parcel. The existence of the basic services such as sewerage, electricity, water supply, telephone, gas, cable may be examined to determine the factor value. The following equation can represent the factor value.

$$v = \frac{S}{N} * 100 \qquad [3.10]$$

where;

v = The factor value for the supplied basic services

S = The total number of services which a land parcel has

N = The maximum number of considerable services

In this study, the below items were taken into account as the basic services. According to the list N is 6 in the equation [3.10].

Services
(1) Electricity
(2) Sewerage
(3) Telephone
(4) Water supply
(5) Gas
(6) Cable

(j) Available utilities

A land parcel may have some intrinsic utilities that affect the parcel value. Such utilities are wall, water foundation, existing plants, vegetation etc. The availability of these utilities provides a tangible economical value for the parcel. However, the assessment of these utilities requires a careful examination. In this study, such utilities are individually assessed out of 100 with respect to their qualitative and quantitative characteristics. The following equation then can be used to represent the factor value.

$$\mathbf{v} = \frac{1}{n} \sum_{j=1}^{n} G_j \qquad [3.11]$$

where;

v = The factor value for available utilities

G = The assessment value of the utility *j* out of 100

n = The maximum number of considered utilities

Some of the availability utilities which were considered during the study are given as follows. According to the list *n=6* in the equation [3.11].

(1) Tree
(2) Pool
(3) Private road
(4) Garage
(5) Water foundation
(6) Current plants

(k) Environment

Research (Li and Brown, 1980; Nelson *et.al.*, 1992) routinely finds that environmental features can increase land value if they are viewed as attractive or desirable, and they can reduce land value if they are viewed undesirable.

The determination of an environmental effect on a land parcel value is a very complex task. Because many subjective and objective criteria are involved which are very difficult to classify. Both the physical and social conditions influence the landowners feelings and developments (Mackmin, 1989). To determine the factor value, the environmental features may be examined by considering the present living standards and paid-tax prices.

Some known regions within the project area or other developed parts of the city may also be considered as a reference for the environmental assessment. Based on this, an assessment map is prepared and the regions with different attributes are evaluated out of 100 (Figure 3.5). For the factor analysis, a land parcel is overlaid on the assessment map and corresponding value is determined by the following equation.

$$v = \frac{\sum_{k=1}^{m} (a_k * p)}{A} \qquad [3.12]$$

where;

v = The factor value for environment

A = The total area of the land parcel

a = The corresponded parcel area of a particular environmental region

m = The number of parcel portions which are divided by environmental regions when overlaid on the land parcel

p = The value of an environmental polygon which corresponds to the parcel

$\{ \sum_{k=1}^{m} a_k = A = \text{The parcel area} \}$

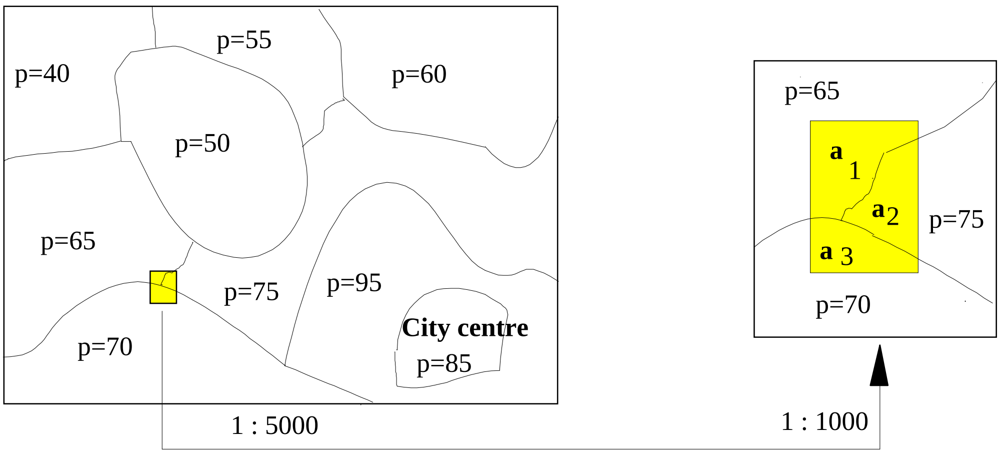
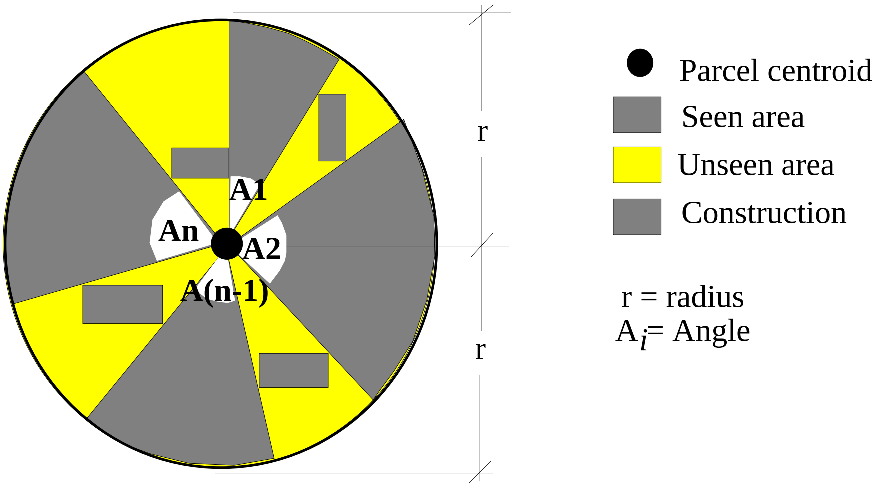


Figure 3.5 An environment assessment of land parcel

(l) View

When a land parcel is surrounded by some trees, buildings, or any other tall construction, the view from the parcel may not be possible. This can be considered as a disadvantage for the parcel because landscape benefits may not be enjoyed. A view of the landscape has always been an attractive characteristics for a parcel. Hence, the view has to be taken into account during the land assessment (Price, 1978; Mackmin, 1989). To determine the factor value, the sighting from parcel to around is analysed (Figure 3.6).



$$\text{Factor value} = \frac{\text{Total area of unseen areas}}{\pi r^2} * 100$$

Figure 3.6 The view analysis for a land parcel

(m) <u>Access to street</u>

Sometimes a land parcel is fully surrounded by the other land parcels and the directly connecting road is closed. In another words, a land parcel cannot directly link to any public road. This condition particularly appears for undeveloped cadastral parcels, and the only connection to street can be provided through the other parcels. A lack of direct access to a street may have a negative influence on the total value of a land parcel. Therefore, access to streets needs to be examined as well. In the factor valuation process, if a land parcel has direct access to a street, the factor value can be considered as 100, otherwise it is null (Figure 3.7).

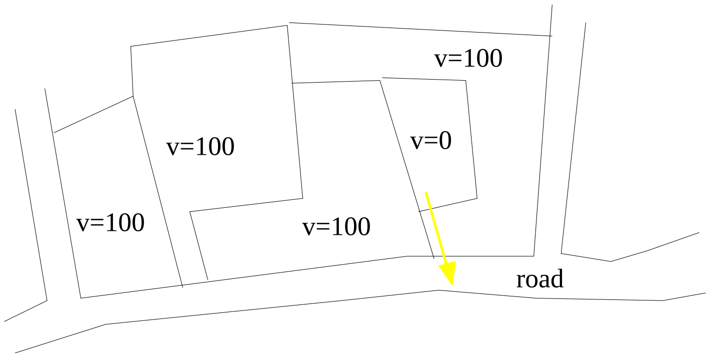


Figure 3.7 A land parcel access to street

v = 0 { if there is not a direct access to street }
v = 100 { if there is a direct access to street }

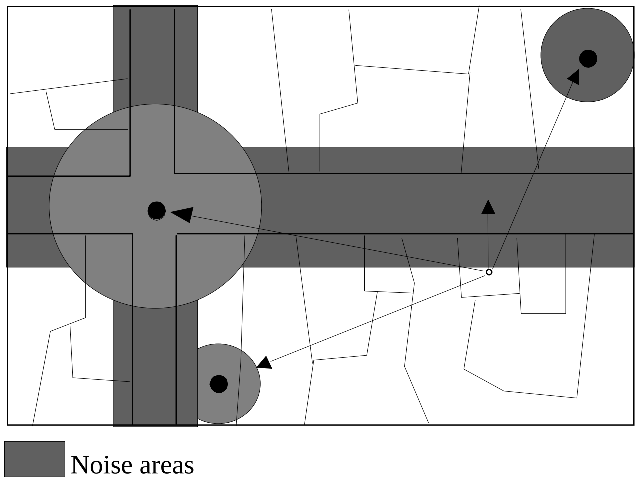
(n) Proximity to noise

The effects of noise on land prices have been studied by Walters (1975) and Nelson, *et.al.*, (1992). These studies showed that any noise from commercial or industrial activities have an adverse effect upon the values of a residential parcel. Hence, there is a inverse ratio between the value and the amount of noise.

There is a natural quantitative measure of noise used by physicists. It is the energy content of a noise emission (Walters, 1975). But such a measure is very difficult to incorporate in the case of a land valuation process. However, the proximity of a land parcel to noise areas, such as entertainment places, main roads, road junctions, airport, railroads, can be examined. To do this, some buffer zones of a specified radius can be created around the noise resources then the parcel distance to the zones considered (Figure 3.8).

(o) Proximity to nuisance

The distance to nuisance places is also important. As in the noise factor, it assumes that there is a inverse ratio between the value and proximity to nuisance areas. So, the examination of nuisance factor may be considered as the determination of the noise factor. In the calculation of the factor value, first, the nuisance areas should be decided on a map. Then, the determination of value is carried out like the noise analysis.



Distance (meter)	Value
000-024	1
025-049	5
050-074	10
075-099	20
100-124	30
125-149	40
150-174	50
175-199	60
200-249	70
250-299	80
300-400	90
400->	100

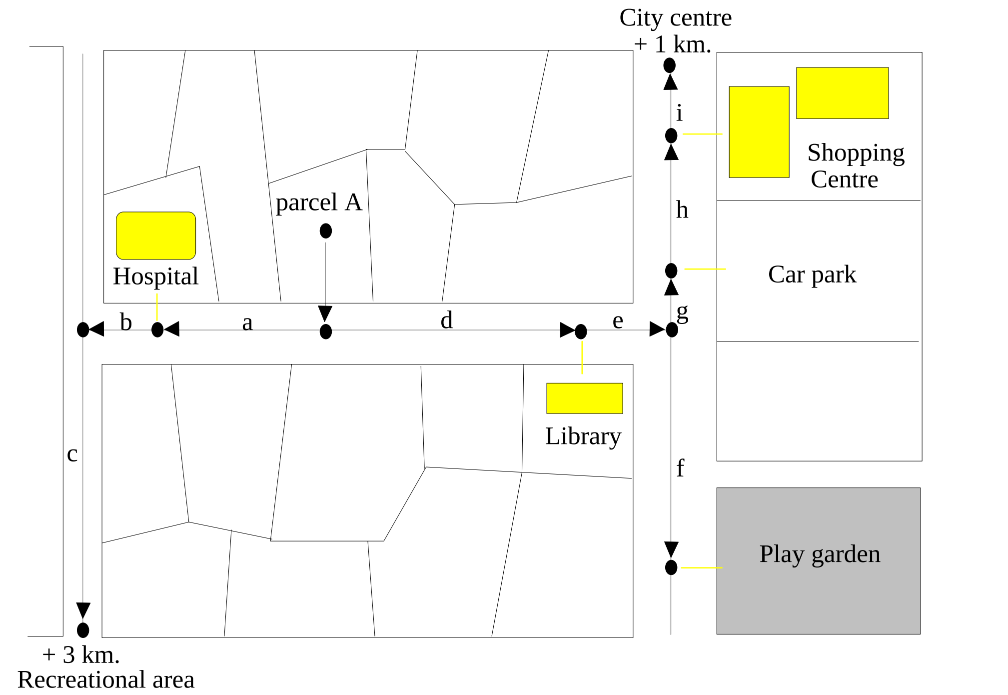
Figure 3.8 Noise and nuisance analysis

(p) <u>Distance to shopping area, health services, educational places, play gardens, recreational areas, religious places, city centre, car parking, fire and police stations</u>

These are some other important criteria that may effect a land parcel value. But, proximity to one or other may give rise to higher or lower relative values depending upon desirability or otherwise of being close to such a feature. So, as expressed Ravenscroft (1992) and Mackmin (1989), it is really difficult to decide of what type of feature may have advantages or disadvantages on a land parcel value.

However, in this study, it presumed that when the distance from a land parcel to the mentioned places increases then the land value decreases. Hence, there is an inverse relationship between value and distance from the above places.

These factors are examined individually and the factor value is determined by particular proximity ranges (Figure 3.9).



Distance (meter)	Value
000-024	100
025-049	90
050-074	80
075-099	70
100-124	60
125-149	50
150-174	40
175-199	30
200-249	20
250-299	10
300-400	5
400->	1

The distance of parcel A to hospital = a

The distance of parcel A to recreational area = a + b + c + 3 km.

The distance of parcel A to car park = d + e + g

The distance of parcel A to city centre = d + e + g + h + i + 1 km.

Figure 3. 9 Determination of proximity factors

For the calculation of the factor value, first, a street network is created. This network represents the road connections of land parcels and public areas or other public buildings. Street axes and lengths from the centre of land parcels to the street axis are considered as linkage routes to the selected places. Then, the shortest path from parcel to the sites are calculated with respect to road segments.

(q) Access to highway, railroad and waterway

The distance from parcel to the entrance of highways, railroads and waterway points are also significant features for a land parcel. It is assumed that there is a regular ratio between the land nominal asset value and the distance from parcel to the connection nodes of main transportation networks. For the value determination, access to highway, railroad and waterway are examined individually as three separate factors. To do this, network analysis is required along the main streets. The shortest paths from parcel to main junctions are considered. A factor value is determined similar in Figure 3.9.

3.3.2.3.2 Calculation of the value parameters

Following the land valuation factor analysis, the total value of a parcel is determined using equation [3.2]. This equation applies to all land parcels within the project area. These are the current cadastral parcels and the produced site lots. In a land readjustment process, there are two main distinction stages that must be realised while performing the land valuation analysis. These stages are;

(1) Pre-project stage (Before) which represents the current land parcels and land-use condition. The land parcels are the cadastral or old parcels which are subject to land development process. These are the only parcels that are totally affected by the project. They are also considered as the original input parcels of a land readjustment project (Figure 3.10). In this stage, all land parcels are evaluated and classified by their existing suitability without referring to the urban land scheme.

(2) Post-project stage (After) which represents the new site lots. These lots are created according to the detailed urban planning programme. The zoning plans which have been designed by the town planners are used as a base map (Figure 3.11). These maps basically provide the planned roads, streets, residential areas and other public and private places. The creation of new land parcels within the given site blocks are left for land surveyors. The lot dimensions such as minimum construction area, depth, street-frontage are given by the plan to perform the land subdivision. It is important that these given data should be followed during the creation of new land parcels. Therefore, in the post project stage, based on the zoning data all given site blocks are carefully subdivided into the new suitable lots. These created new lots are considered as the output parcels of the project. After the completion of the project, these new lots are demarcated in the field and legally registered. However, in the post-project stage of land readjustment, the new lots are created evaluated with respect to the planning details as if these lots were fully developed.

The land valuation process is carried out differently in both these stages. Considering the suitable land valuation factors, first, the parcel values are calculated. Then, using the equation [3.2], the total value of the project area is determined for the both stages by following equations;

$$\Sigma \mathbf{V}_{(\text{before})} = \mathbf{V}_{1} + \mathbf{V}_{2} + \ldots\ldots + \mathbf{V}_{n} \qquad [3.13]$$

$$\Sigma \mathbf{V}_{(\text{after})} = \mathbf{V}_{1} + \mathbf{V}_{2} + \mathbf{V}_{3} + \ldots\ldots + \mathbf{V}_{m} \qquad [3.14]$$

where; n = The total number of cadastral parcels (input parcels)

m = The total number of produced site lots (output parcel)

Figure 3.10 A sample of cadastral map

Figure 3.11 A sample of zoning map

It has to be noticed here that, except for a very extreme condition, the results of these two equations mathematically will not be same, because the total number of land parcels before and after is different, as will be the number of their selected factors too. However, to prove the main equation [3.1], a scale coefficient is required to be applied the individual parcels. This coefficient can be determined as follows:

$$z = \frac{\sum V_{before}}{\sum V_{after}} \qquad [3.15]$$

The scale coefficient [3.15] is multiplied by the new parcel's parameters to determine the final valuation parameters. Then, these determined parameters are considered during the land distribution. As a result, the total value of land parcels will be exactly the same before and after while the total number of the parcels is different. In another words, land valuation profiles before the project will be same after the project.

3.3.2.3.3 Determination of the weights

The weight determination for the land valuation factors is important in a value-based land readjustment process, because each land valuation factor does not have the same effect on the total perceived value of a land parcel. For example, proximity to city centre may have a different effect to the topography. Sometimes, a valuation factor such as the permitted number of floors may not be significant before the project, but it may be very significant after the project. Hence, during the factor selection, the project stages should also be considered.

To give a priority to the factors in accordance with their importance, the selected valuation factors should be assigned usimg some weight parameters. However, the determination of these weights is complicated and difficult because they are changeable from person to person. For the implementation of the proposed model, it was thought that a number of land valuation factors could be evaluated with the aid of a survey study. Based on the list in Table 3.1, the possible land valuation factors that may be subject to change when a land readjustment project is applied, were considered.

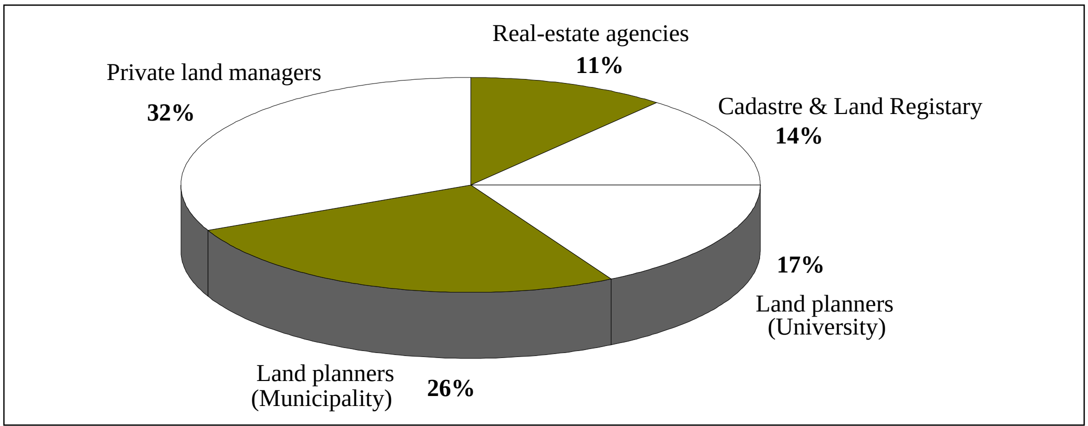


Figure 3.12 The distribution of the responded questionnaire forms

(a) The survey study

For the evaluation of the selected land valuation factors, a survey was carried out in Turkey. The main aim of this survey was to find out the mean values of the given factors then use these mean values as the factor weights in the equation [3.2]. For this purpose, a questionnaire form was prepared and sent to 302 people in Turkey (Table 3.2). But only 202 questionnaire forms have been responded. For this survey, the professional people who are from the government branches, universities and private sectors which are actively involved in land management processes were selected (Figure 3.12). Landowners were not involved in the survey because it was thought that they would consider only their own individual land position, so that they may not make an objective evaluation.

Table 3.2 The questionnaire form

The purpose of this Questionnaire is to determine and give priority to the selected land valuation factors and their effects on total land parcel value.

"Because of a land position, every land parcel has some tangible and intangible criteria which affect the total perceived value of a land parcel."

Suppose that you are looking for a land parcel on which to build a new house. Please assess the following factors in accordance to their importance to parcel value. Each of these factors should, individually, be marked out of 100%
(100 = very high, 1 = very low, 0 = No idea).

Grade(%)	Selected Land Valuation Factors
1________	ENVIRONMENT [living conditions within the parcel district]
2________	SUPPLIED BASIC SERVICES [electricity, water, telephone, cable, sewer, bus stop, etc.]
3________	LANDSCAPE, VIEW [parcel position determines amount and quality of view]
4________	DISTANCE FROM NUISANCES
5________	LAND PARCEL SHAPE [number of corners, long, narrow, large, regular or irregular conditions]
6________	DISTANCE FROM NOISE (from heavy traffic, airport, plants, entertainment area etc.]
7________	AVAILABLE UTILITIES [currently available capital resources such as timber, garage, wall, fence etc.]
8________	PERMITTED BUILDING CONSTRUCTION SIZE [in accordance with zoning plan limitations]
9________	ACCESS TO STREET
10________	CURRENTLY USABLE AREA
11________	STREET FRONTAGE [number of sides which are facing street]
12________	PERMITTED NUMBER OF FLOORS [in accordance with zoning plan limitations]
13________	DISTANCE TO CITY CENTRE
14________	SOIL CONDITION [the characteristic of soil that allows to economical load-bearing]
15________	DISTANCE TO SHOPPING CENTRE
16________	DISTANCE TO HEALTH SERVICES
17________	PARCEL LOCATION WITHIN SITE BLOCK [parcel located on corner or centre of the site block]
18________	TOPOGRAPHY [slope percentages, flat or rough surface]
19________	DISTANCE TO EDUCATIONAL CENTRES [school, library]
20________	ACCESS TO HIGHWAY
21________	DISTANCE TO RECREATIONAL AREA
22________	DISTANCE TO CAR PARKING AREA
23________	DISTANCE TO POLICE STATION
24________	DISTANCE TO PLAY GARDEN
25________	DISTANCE TO FIRE STATION
26________	DISTANCE TO RELIGIOUS PLACE
27________	ACCESS TO RAILWAY
28________	ACCESS TO WATERWAY

(b) Analysis of the survey data

The survey data were analysed for statistical significance. For this purpose the *RELIABILITY* analysis was applied to the data which are given in Appendix B. Winer (1962) indicates that the *reliability* of the results is conceived of as that part which is due to permanent systematic effects, and therefore persists from sample to sample, as distinct from error effects which vary from one sample to another.

Using the SPSS-X statistical package, the reliability test was applied to the survey data. The reliability coefficient of the test was found as $\boldsymbol{\alpha=0.9398}$. This figure provides a significance value that the survey data are reliable to 94%. The interpretation of the reliability test can be given as follow:

> If the survey were to be repeated with the other people, but the same land valuation factors, the correlation between the mean rating obtained from the data sets on the same land valuation factors would be approximately 0.94.

The test results including statistical description of the data and frequency tables are given in Appendix B. However, Table 3.3 illustrates the mean values and the standard deviation of the land valuation factors. According to the survey results, the factors; *supplied municipal services, permitted number of floors, permitted construction area, view, environment, location within site block, and access to street* have been found as the most important factors on the total perceived value of a land parcel. On the other hand, the factors; *distance to fire station, police station, religious places, access to waterway, and railway* have been found as less important factors. The graph in Figure 3.13 however shows the mean value distributions for the land valuation factors.

Table 3.3 The basic statistical results of the survey data

ID	VARIABLE	MEAN	STD DEV	CASES
001	ENVIRON	75.2772	21.8266	202.0
002	MUNICIP	81.7277	20.0109	202.0
003	VIEWLCP	74.8713	24.4994	202.0
004	NUISANC	63.9307	29.3014	202.0
005	SHAPEFO	65.4505	27.7779	202.0
006	NOISEDI	61.5941	27.5331	202.0
007	UTILITI	54.4851	26.9712	202.0
008	PERMTAR	78.2673	19.5272	202.0
009	ACCSTRE	72.4901	27.3949	202.0
010	USABLEA	62.8218	29.5060	202.0
011	FRONTAG	69.0495	24.5137	202.0
012	PFLOORS	76.7079	23.5986	202.0
013	CITYCNT	67.7624	22.9855	202.0
014	SOILCON	56.6188	28.4313	202.0
015	SHOOPIN	58.9109	25.1636	202.0
016	HEALTHS	60.0347	25.0540	202.0
017	LOCATIO	72.8713	23.0990	202.0
018	TOPOGRH	56.8911	23.5836	202.0
019	SCHOOLD	61.4604	23.8196	202.0
020	HIGHWAY	57.3812	27.0906	202.0
021	RECREAT	56.1188	24.3712	202.0
022	PARKING	50.4109	24.8489	202.0
023	POLICED	39.7178	26.2168	202.0
024	PLAYGRD	50.3564	25.2939	202.0
025	FIRESTS	39.1089	26.6351	202.0
026	RELIGIO	44.5842	31.3219	202.0
027	RAILWAY	38.6683	26.4397	202.0
028	WATERWY	35.5446	27.6490	202.0

As mentioned above, the main aim of this survey was to obtain some figures that can be used as a factor's weight in the equation [3.2]. Based on the questionnaire results, the *weighted* mean values were used as the factor weights. The *weighted* mean values were determined because in this way the effects of the *"0"* values on the mean values can be ignored. For this, each data item was considered as its own weight. Finally, Table 3.4 illustrates the land valuation factors and their weights in a sequence form. These factors and the assigned weights were then used in the implementation part of this study, particularly in the land valuation analysis and the calculation of a parcel nominal asset value.

Figure 3.13 The graph of mean value..

Table 3.4 Land valuation factors and their weights

No	CODE	LAND VALUATION FACTOR	WEIGHT
1)	002	SUPPLIED BASIC SERVICES	86.60
2)	012	PERMITTED NUMBER OF FLOORS	83.93
3)	008	PERMITTED CONSTRUCTION AREA	83.12
4)	003	LANDSCAPE, VIEW	82.85
5)	009	ACCESS TO STREET	82.79
6)	001	ENVIRONMENT	81.57
7)	017	PARCEL LOCATION WITHIN BLOCK	80.16
8)	011	STREET FRONTAGE	77.71
9)	004	DISTANCE FROM NUISANCES	77.29
10)	005	LAND PARCEL SHAPE	77.18
11)	010	CURRENTLY USABLE AREA	76.61
12)	013	DISTANCE TO CITY CENTRE	75.52
13)	006	DISTANCE FROM NOISE	73.84
14)	014	SOIL CONDITION	70.82
15)	019	DISTANCE TO EDUCATIONAL CENTRES	70.65
16)	016	DISTANCE TO HEALTH SERVICES	70.44
17)	020	ACCESS TO HIGHWAY	70.11
18)	015	DISTANCE TO SHOPPING CENTRE	69.61
19)	007	AVAILABLE UTILITIES	67.77
20)	021	DISTANCE TO RECREATIONAL AREAS	66.65
21)	018	TOPOGRAPHY	66.62
22)	026	DISTANCE TO RELIGIOUS PLACE	66.48
23)	024	DISTANCE TO PLAY GARDEN	63.00
24)	022	DISTANCE TO CAR PARKING AREA	62.60
25)	025	DISTANCE TO FIRE STATION	57.16
26)	028	ACCESS TO WATERWAY	56.95
27)	023	DISTANCE TO POLICE STATION	56.94
28)	027	ACCESS TO RAILWAY	56.66

3.3.3 The process of decision making

Land distribution can be considered as a crucial phase of the entire land readjustment process. In this phase, the location and the boundaries of land parcels are changed and landowners are moved to the new locations. From the cadastral point of view, this is very important because current land rights are legally affected and exchanged by individuals.

The main purpose of this stage is to maintain the current property rights while reallocating the land parcels in the new locations. This may partly be achieved by giving back a new parcel in the same location, at least within the same block. Although the parcel location is maintained, the planning benefits may not be fully provided for a parcel with respect to the nominal asset value of land before and after the project. Therefore, not only the locational characteristics but the planning effects must be taken into account.

By the analysis of land valuation factors, the nominal asset values of parcels are determined both before and after the project. Based on these nominal asset values, the old and new conditions of a land parcel can be compared and the possible best location is decided for the parcel. So, land valuation analysis gives more objective criteria which greatly helps planners during land reallocation.

3.3.3.1 Land subdivision

In a land readjustment process, the existing cadastral parcels are considered as the input parcels. On the other hand, the zoning plan exists. This plan only shows the designed planning details such as main roads, street patterns, public-user areas, site blocks with the zoning codes. More importantly, the detailed subdivision layout scheme is not given by the plan. Thus, land subdivisions are fulfilled during the implementation with respect to site blocks and zoning codes. The main objective of land subdivision is however to produce new land parcels that will be used for land development.

In order to compare the land parcel conditions before and after, first site blocks are subdivided into suitable lots. These site lots must be created according to the zoning details. The created lots are considered as the developed land parcels. These parcels are mostly in a rectangular form that allow for more economical use of the land. After the project, these lots are legally registered so that they become the new cadastral parcels.

To estimate the land nominal asset values after the project, the availability of new site lots are very important to accomplish the land valuation analysis. Therefore, the land subdivision can be considered as the first requirement of the process. This process is followed by the land valuation analysis, so that land parcel values before and after are determined. Finally, land distribution is performed with respect to the results of the land valuation analysis.

3.3.3.2 Land distribution

Land distribution may be considered as the final stage of the land readjustment process. In this stage, the old cadastral parcels are reallocated into the new site lots. Based on the calculated land valuation parameters, land distribution is carried out and the old parcels are replaced with the new site lots. Due to the different lot sizes after the project, a cadastral parcel may be reallocated within various site lots. On the other hand, small cadastral parcels may be assembled within a site lot as well.

However, during the land distribution process there are two main cases that should be carefully examined in order to provide an optimum land distribution to landholders. These are;

<u>Case 1:</u> **If a cadastral parcel is larger than a new lot:**
In this case, the cadastral parcel is distributed to more then one parcel. But the distributed land portions may fit a few new lots, then the rest of it may not fit any new lot. As a result of this, the remaining land should be shared with other parcel or parcels (Figure 3.14).

<u>Case 2:</u> **If a cadastral parcel is smaller than a new lot:**
In this case, small size cadastral parcels are consolidated in a new lot. In accordance with their participant percentages, the new lot is shared by the landowners (Figure 3.14).

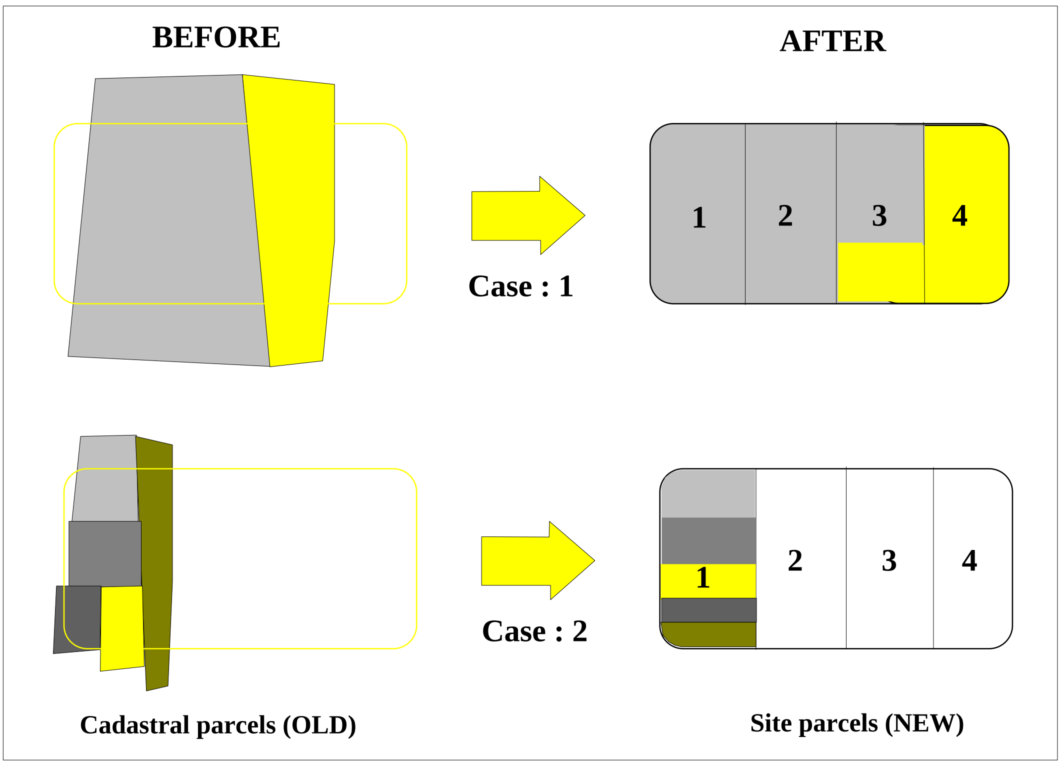


Figure 3.14 Two cases which occur during the land distribution

During the land distribution process, the original location of a cadastral parcel should be maintained as much as possible. This is very important for the landowners because they may not be happy when moved to other locations.

3.3.4 The procedure of information management

A value-based land readjustment process requires highly complex spatial analysis with textual and non-textual data. Following the entire process also requires effective information management in order to control the data input, output, manipulation and analysis. Therefore, the value-based land readjustment model would be a very complicated process if computing technology is not involved.

Today, some information technology such as a GIS or LIS provides a great opportunity to deal with such complex spatial data analysis requirement. However, to determine the ability of a GIS/ LIS and integration with a value-based land readjustment process, the concept and terminology of GIS and LIS are summarised in Chapter 4.

Nevertheless, there are three main information management processes for the value-based land readjustment process. These are data input, data analysis and data output.

3.3.4.1 Data input

All required spatial data are basically derived from the property, land-use, thematic and topographical maps. On the other hand textual data such as landowners names, shares, addresses, parcel ID's, details of property rights are obtained from the registration documents or other related texts. The zoning codes are also considered as textual data. Table 3.5 illustrates some this necessary textual and non-textual information.

Using information technology, the graphical data are first digitised from the existing maps. Following the digitising process, the graphical data and related descriptive information is linked via a database system. All data can then be stored in suitable formats for later use.

3.3.4.2 Data analysis

The land subdivision process is the first step of data analysis. Considering the digitised zoning plan and related zoning codes, a subdivision layout plan is produced. Basically, the site blocks are automatically subdivided into the new lots in the required dimensions.

Following the land subdivision, land valuation analysis is performed. This is the most complicated part which requires to deal with many spatial objects dealing within a geographical unit. With respect to the selected land valuation factors, some spatial analysis such as map overlaying, buffering, street network analysis, surface analysis, extraction of information for other use is essential.

After the analysis of land valuation factors, the land parcel values are determined individually for both before and after the project. These values are actually in numerical form and represent the total perceived value of a land parcel when compared to the others. The determined parameters are then used in the land distribution.

Table 3.5 The initial textual and non-textual information for land readjustment

<table>
<tr><th></th><th>TEXTUAL DATA</th><th>GRAPHICAL DATA</th></tr>
<tr><td>Cadastral</td><td>Land parcel IDs
Block IDs
Legal parcel size
Owner(s) name
Parcel address
Volume no.
Title number
Plan no
Registration date
Landowners shares
Map sheet no
City name
District name
Paid tax
Mortgages</td><td rowspan="3">Cadastral parcel boundaries
The boundary of project area
The outlines of site blocks
Buildings
Play gardens
Green areas
Planned buildings
Elevation contours
Main roads
Streets
Railways
Streams
Soil type
Sewers
Car parking
Nuisance areas
Public buildings
Recreational areas</td></tr>
<tr><td>Zoning</td><td>The plan no
Date of issued
Type of land -use
Site block ID
Permitted floors
Permitted area
The width of streets</td></tr>
<tr><td>Surveying</td><td>List of coordinates
Surveying plan no.
Date of surveying
Map ID</td></tr>
</table>

Land distribution performs the reallocation of the cadastral parcels within the site lots. An algorithm should be designed to provide an optimal solution to consolidate, divide, and redistribute the land parcels to minimise the number of shares within a single site lot.

3.3.4.3 Data output

Data output and presentation relates to the way the data should be displayed. The results of valuation analysis should also be reported to the users. However, all results both graphical and non-graphical, including land valuation maps with the 3-D visualisations, street networks, ownership records, land distribution tables are presented as both hard and soft copies for further use. An interactive environment can be created for more sophisticated query requirements as well.

3.4 Chapter summary

The technical issues of land readjustment process were defined and a new approach to solve these issues was discussed in this chapter. Three different issues have been classified. These are land valuation, decision making, and information management.

Land valuation is an important issue because during the implementation, some land valuation factors which may effect the total perceived value of a land parcel are ignored. Due to non-standardised procedures, the planners often have difficulty in making decisions about the land parcel locations. The landowners are at risk because different approaches provide different land locations to them. Therefore, inequitable land distribution can occur to the original landowners affecting their benefits from the project. Information management is another issue that affects the performance of land readjustment process. The process has not been integrated with the current information technology in sufficiently. Hence, the technological benefits have not been enjoyed.

In order to solve these issues a value-based approach to land readjustment was proposed. The main idea of this approach was to determine a land parcel value before and after the project with considerable land valuation factors, then give back a new parcel to each landowner with the same value as that owned before. To accomplish the idea, first the requirements for this approach were explained. Then, the possible land valuation factors were defined with their formulas and land valuation analysis was involved in the entire process.

In this approach, the term of *value* was used as a single numerical parameter which represents a land parcels nominal asset values when compared the others. A land parcel value has been determined mathematically with the combination of different land valuation factors. The land distribution process was based on the calculated unit parcel value. So, rather than using parcel area, the determined nominal asset values are distributed to landowners.

The value-based land readjustment process requires highly complex spatial analysis. An effective information management procedures are also required to control the data input, output, and manipulation.

Therefore, the use of information technology is essential. In order to understand the capability of information technology, some land-related information systems such as a GIS and LIS have to be examined. However, GIS and LIS are reviewed in the following chapter.