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# A GIS approach to shopping mall's real estate management

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**Key words**: GIS, Real Estate management, DCF

## SUMMARY

This paper, presents the use of Geographical Information Systems (GIS) in developing real estate management models for shopping malls and leisure centers. GIS applications in real estate management are used extensively by decision-makers and managers of real estate enterprises in their site selection for projects. Economists, geographers, surveyors, and developers recognize this powerful tool, which GIS offers in effective hypermarket management. It provides a means of managing land and property information digitally and in a geographical context, and allows for rapid access to information and a means of analyzing that information in a geographical context.

In this paper, geographic analysis, thematic cartography, real estate management and GIS are used in a proper and efficient way in order to develop a prototype model for the real estate management of shopping malls. This model combines a method of asset valuation, the discounted cash flow (or DCF) analysis, with the International Financial Reporting Standards (IFRS). Especially, the discounted cash flow approach, which is used to estimate the value of shopping malls, is the Internal Rate of Return (IRR), a discount rate that generates a zero net present value for a series of future cash flows. This essentially means that IRR is the rate of return that makes the sum of present value of future cash flows and the final market value of the investment (of the shopping mall) equal to its current market value. Moreover, the International Financial Reporting Standard, which is used, is the IAS 40 Investment Property, which is widely used in investment real estates, such as shopping malls that are acquired via property or financing hire aiming at the income of rents or the realization of capitalized surplus values. Furthermore, this method of valuation in order to be applied for estimating the value of leisure centers requires all the necessary financial and statistical data of commercial agreements that are developed in the commercial centers. The value of shopping malls is estimated with the use of selected model. The application of the evaluation method takes place initially at each shop of the shopping center, then at the area of use in which it belongs, afterwards at level, and finally, globally, the estimate of the total value of the commercial shop. Therefore analytic tables are presented and reference is made to comparative data, which concern the economic and commercial agreements, which are developed in the commercial shop,

concerning the area of use that each lessee belongs to and how this influences the rent that it overlaps, depending on the extent of the area, which is leased.

Taking the advantage of information technology, geographic information systems (GIS) enable the handling of both spatial and non-spatial data for constructing thematic maps depicting a variety of demographic information relating to population, housing, and economic activities. Its application on the technical area in the construction industry is evident, while its usefulness to the non-technical area (e.g., business, economics) is being explored. In view of the potentiality of the GIS, this model presents its utility for shopping mall location selection, which is one of the core business activities of developers for long-term capital investment. A GIS-based system uses electronic mapping technology in producing interactive multi-layer maps so that queries are set to find optimal solutions for problems. It combines spatial and non-spatial data to construct visualized information that can be easily analyzed by decision makers and that cannot be achieved in table or list forms. In the current paper, a project is demonstrated to create Geodatabases that include in detail, descriptive data for each commercial shop, which are useful and quite significant for the developers and managers of the commercial centers, in the frames of management features associated with household incomes, demand points, etc. Queries are then created leading to the production of thematic maps for finding solutions for several location problems such as: minimum distance, maximum demands coverage, maximum incomes coverage, and optimal center. More specifically, thematic maps can be used by the managers of shopping malls to monitor sales and the income rates as well as define which shops have a high yield and which a low yield according to the demographic basis of the sales.

This GIS approach to shopping mall real estate management was applied in “Mediterranean Cosmos”, the first and largest Shopping and Leisure Centre in Northern Greece, as well as one of the largest in South Eastern Europe.

In conclusion, this new real estate management model of shopping malls with the use of GIS, proved that GIS, used appropriately, could be an important aid and a very valuable analytical tool opening new prospects and horizons for its future. GIS in real estate management can help managers or leasing professionals understand a center more completely and formulate a more accurate picture of the expenses for the exploitation of a particular property of the shopping mall as well as detect the sales prices of the properties by analyzing the development plans and posing the priorities for development in the future, which constitutes a fundamental and vital factor for the successful operation of a shopping mall.

## 1. INTRODUCTION

The basic aim of this paper is the design of a geographical system that provides all the benefits of geoinformatics on issues and projects relative to hypermarket valuation and management as shown on Figure 1.

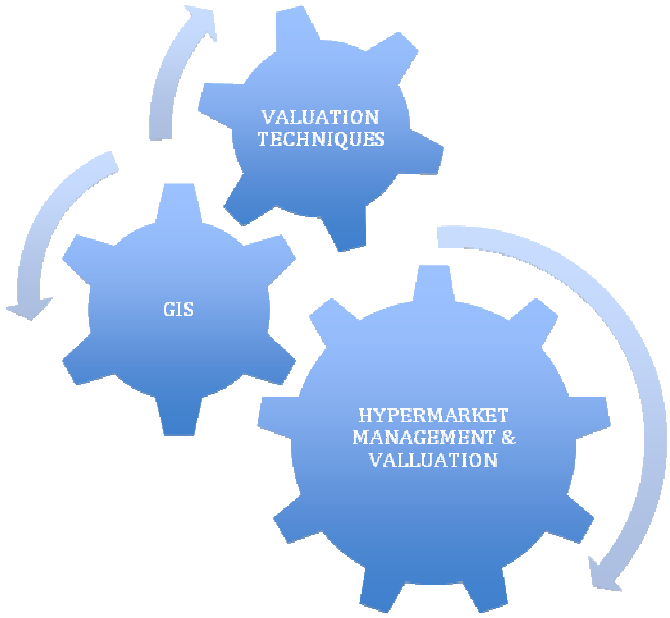



*Figure 1: The basic aim of the project.*

Geographic thinking and a geo-cartographic approach are the basic tools of the methodology on valuation and management of shopping malls.

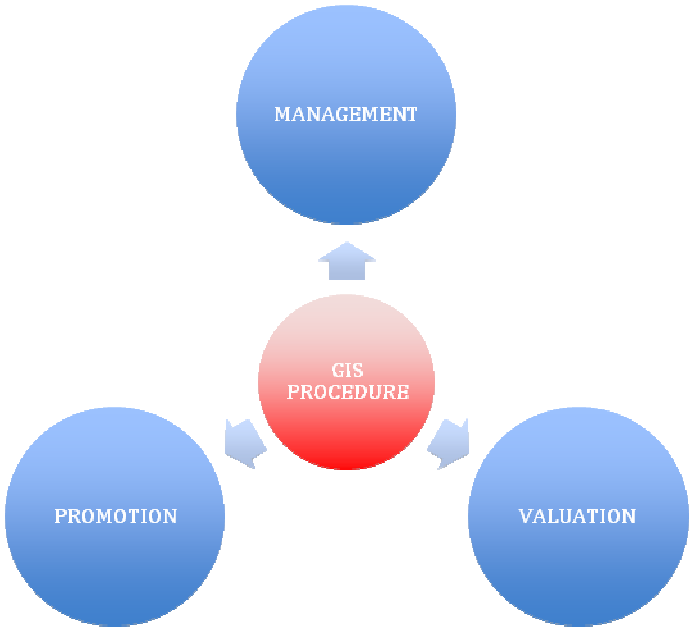



*Figure 2: Advantages of the methodology*

The main advantages of the GIS-Valuation procedure can be found on a design of a tool of management, promotion and accurate valuation of a shopping mall.

## 2. GIS FOR REAL ESTATE

For real estate, **location** is one land characteristic of high importance for economic analysis. As a matter of fact, location is the crucial spatial attribute on which estimation and analysis of land value can be transformed and create different types of study. Prior to GIS period, the location determinant impact on land values was difficult to be succeeded due to the existing accuracy levels on positioning. Nowadays, GIS offers techniques in tens to facilitate the analytic spatial reasoning (Arbia, 1989; Tomlin, 1990; Huxhold, 1991; Star and Estes, 1990). Today also, the cost of a GIS system, the revolution on computer technology, the availability of digital maps and geographic data on internet, the business applications promotion through GIS (Fryrear et al, 2001) are the critical factors for the increased use of GIS in real estate market. Location is a parameter of high importance even when the economic analysis involves the location of a hypermarket and even more when the discussion is the location in a hypermarket.

GIS can also play an important role in real estate research (Rodriguez et al, 1994). For instance, in the areas of spatial interaction models (Haynes and Fotheringham, 1984) and spatial diffusion models (Morrill, Gaile and Thrall, 1988), GIS is of great importance for formulating accurate spatial models. Spatial interaction models, which can also referred to as gravity models, forecast traffic models, investment analysis and shopping centre revenue and should be used to identify optimal site locations. Clapp and Rodriguez (1995) also show the importance and improvement of the real estate market analysis using GIS.

Thrall in his works (Thrall, 1984–1988), contains many relevant works that bridge the gap between geography, real estate and urban economic disciplines. Other literature covers such topics as central place theory (King, 1984), point pattern analysis (Boots and Getas, 1988), and spatial autocorrelation (Odland, 1988). Point pattern analysis is of interest in that most real estate research does not require the specification of precise boundaries surrounding a parcel. As such, the precise location of a parcel is represented by only a single point contained somewhere within the boundaries of that parcel of land. Nevertheless, given that each location on the surface of the earth is influenced by other locations, econometric analysis must be concerned not only with the possible errors introduced by the problem of time autocorrelation but must also address the errors that can be introduced by the problem of spatial autocorrelation. The real estate literature has not yet dealt adequately with these issues.

### 2.1. THE IMPORTANCE OF GIS

All geographers take into consideration a number of basic views when they perform spatial analysis. The lack of geographic thinking can lead to problems when analysis is taking place. Many non-geographers, who work in real estate market, are capable of avoiding mistakes by taking into consideration some necessary geographic tools.

Geographic scale, absolute and relative locations, Geocoding, characteristics of continuous and non-continuous space, spatial autocorrelation, geographic accessibility, proportional and absolute geographic measurements, geographic surveying are some of the tools that real estate analysis must always consider.

For instance, geographic scale can be a common error in data analysis. There is always a basic consideration that GIS produce successful new datasets if data are collected in high resolution. For example, statistical census collections are able to provide data for households' income by census tract because the information exists due to households. When real estate analysts are working with data and creating new datasets (Shilton and Stanley, 1995; Bible and Hsieh, 1996) sometimes they confuse geographic scale of the existing data and at the same time are proposing solutions on higher resolution even though initial data are collected in lower resolution levels. The analysis on geographic scale and geographic position shows up a dependency, which is known as the "modifiable area data problem" (Arbia, 1989).

Is space continuous for all geographic phenomena? Although in physical geography many phenomena are considered and treated as continuous –for example elevation is a continuous phenomenon which alters from place to place in smaller or bigger changes- the situation is slightly more problematic when it comes to land values. All locations do not have land values. Even though a contour program in GIS maps surfaces giving a value everywhere, apparently there is not good accuracy in such a mapping. On the contrary when contours of land values are illustrated, this does not mean that land value is a continuous phenomenon. For instance, there are no values in the centre of a lake or along a river. Although algorithms creating surfaces are mainly based on mapping surfaces from spatially continuous measurements, common real estate characteristics are discrete phenomena. Real estate analysts can make use of software to create maps of land values but they must always consider how results can be interpreted and used.

Another fundamental problem is spatial autocorrelation. In this case, values of 2006, for instance, must occur before values of 2007 in the relevant used model and therefore the neighborhoods are expected to have more similar values than distant estates. Spatial autocorrelation is a well-recognized problem by geographers (Norcliffe, 1977; Silk, 1979; Cliffe and Ord, 1981; Goodchild, 1986; Odland, 1988; Anselin, 1988; Cressi, 1991). A few methods are capable of detecting spatial autocorrelation as well as other procedures are used to correct spatial autocorrelation.

Measuring externality in real estate analysis is difficult. For instance, migration in western Thessaloniki, Greece gave increase on land values during the last years. Suspend of migration and arrival of new habitats has already stopped the increase of values and at the same time reduced the demand for new houses. General theory of land values and uses would suggest that the general trajectory of land values would be downward in areas impacted by negative externalities (Thrall, 1982, 1988).

One of the most common errors in real estate analysis is distance measurement between two points of interest. The distance measured in many GIS programs is the so called as the crow flies method of measurement. It is a straight line between two points in the map. This can be a mistake in real estate analysis where accessibility is a

basic analysis factor in many cases. Geocoding is a powerful tool, which can properly assist the real estate analysts and valuators. Collection of real estate data can be of great accuracy, in a really fast way, with the use of Geocoding tools.

The phenomenon of "ground truth" is a critical problem for real estate analysts. It is never obsolete to visit locations and study the way the model in paper describes reality in space. The data analysis must always be ground truth.

## 3. VALUATION OF A HYPER MARKET

In real estate society it is widely acceptable that the selection of a valuation method depends on two things, both of which are equally important. The first is the analytical review of valuation models, exploring the relationships between them and exposing what each of them makes. The second is to evaluate the data (economic, demographic, statistic) that are available for use in the valuation model. Moreover, there is a significant relationship between the choice of the valuation model and the available data.

Considering that the valuation object of the paper are hypermarkets, there is a number of standard approaches to valuing such centers, most of which are based on turnover and location. The shopping mall is an asset, which represents a stream of future cash flows to its owners, and the reliability of these cash flows determines the ultimate value of the centre. Thinking that a shopping mall is an income producing and investment property, it is easily understandable that the available data for valuation are economic (monthly leasing) and statistic, which concern the commercial deals and tenancy which are developed in the commercial center between the tenants and the management of the commercial center. To apply the available data correctly, the discounted cash flow (or DCF) analysis and the International Financial Reporting Standards (IFRS) was applied.

Especially, this real estate management model combines a method of asset valuation of cash flow (or DCF) analysis, the Internal Rate of Return (IRR) and the IAS 40 Investment Property of the International Financial Reporting Standards (IFRS).

In general, Internal Rate of Return (IRR) is a discount rate that generates a zero net present value for a series of future cash flows. This essentially means that IRR is the rate of return that makes the sum of present value of future cash flows and the final market value of the investment (of the shopping mall) equal to its current market value. In simple words, the Internal rate of return calculates the rate at which the investment made will generate cash flows. Given a collection of pairs (time, cash flows) involved in a project, the internal rate of return follows from the net present value as a function of the rate of return. A rate of return for which this function is zero is an internal rate of return.

Thus, in the case of cash flows at whole numbers of years, to find the internal rate of return, find the value(s) of *r* that satisfies the following equation:

$$C = \frac{A_1}{(1+r)} + \frac{A_2}{(1+r)^2} + \ldots + \frac{A_n}{(1+r)^n} + \frac{S}{(1+r)^n}$$

C : The initial expense or the capital that is required for the realization

$A_1, A_2, \ldots, A_n$: Cash flows, that is earnings after taxes and repayments are calculated, which are expected to come from the investment in the years 1, 2, …n which is their life expectancy.

r: (internal rate of return), that is the figure which equates the cash flows which are expected to come from the investment with the cash expenses which are required for the realization of the investment.

n: The expected financial life of the investment of the shopping mall

Furthermore, the IAS 40 Investment Property is generally used to prescribe the accounting treatment for investment property and related disclosure requirements. According to this Standard, the current DCF model is a fair value model, under which an investment property such as shopping malls is measured, after initial measurement, at fair value with changes in fair value recognized in profit or loss. More specifically, the fair value of investment property is the price at which the property could be exchanged between knowledgeable, willing parties in an arm's length transaction.

To determine the influence of key variables on shopping centre value, as measured by IRR, this prototype model was applied, in "Mediterranean Cosmos", the first and largest Shopping and Leisure Centre in Northern Greece, as well as one of the largest in South Eastern Europe. This provides a base scenario against which comparisons can be made. The IRR is determined using a discount rate of 8% for future cash flows, which is a rate considered appropriate for shopping malls (Kiochos 2006). Also annual turnover fee is assumed to increase at 8%. The DCF model takes into account rental income, building operating costs and vacancy levels over a 6-year holding period (2006-2012). Annual income from each tenancy for the year 2006 was obtained from the respective tenancy schedules as at 31 December for each of these years. The anchor tenant pays a base rental plus a percentage rental based on turnover. The specialty store leases are generally either reviewed to market or CPI over varying time periods. Initially, the DCF model evaluates the total fair value of each shop of commercial center. In order to accomplish that, for each commercial shop of the shopping mall, the DCF model, estimates the reasonable price of the yearly tenancy (€ / $m^2$), and some other economic data, which concern each trade deal such as the surface that is leased, the re- establishment index, the pre-payment index and the exit performance. Then, the application of the evaluation method takes place at each shop of the shopping center, then at the area of use in which it belongs, afterwards at level, and finally, globally, the total fair value of the commercial shop is being evaluated.

More specifically, for every shop there is a card of the evaluation of the total value, which includes all the data that concern the trade deal, which is made between the administration of the commercial center and the tenant in question. Therefore analytic tables are presented and reference is made to comparative data, that concern the

economic and commercial agreements, which are developed in the commercial shop, concerning the area of use that each lessee belongs to and how this influences the rent that it overlaps, depending on the extent of the area which is leased. With this model the future earnings for every tenant- commercial center are estimated and at the same time the total reasonable value and the tenancy value (€ / $m^2$) are calculated through the DCF model. Simultaneously, the value of every zone of use of the commercial center, the value for every level of the commercial center and its total value are also calculated.

## 4. THE REAL ESTATE MANAGEMENT MODEL

Applying the DCF model successfully for the estimation of the value of commercial centers, there is a whole infrastructure available for the correct construction of the GIS system of the administration and management of shopping malls.

The current GIS-based system uses electronic mapping technology in producing interactive multi-layer maps so that queries are set to find optimal solutions for problems. It also improves the performance of mall management and calculates the performance capability of the shopping center at a number of spatial scales. This type of management system is developed thanks to the inherent spatial dynamics of GIS. It combines spatial and non-spatial data that concern the shopping mall so as to construct visual information that can be easily analyzed by decision makers and that cannot be achieved in table or list forms. Furthermore, this particular system of administration of commercial centers requires the creation of "Geodatabases" in order to estimate the competitive edge of the case mall within the retail environment. More specifically, in addition, these spatially-referenced data bases include in detail, descriptive data for each commercial shop, which are useful and quite significant for the developers and managers of the commercial centers, in the frames of management features associated with household incomes, demand points, etc.

Using the querying capabilities of GIS, queries are then created leading to the production of thematic maps for finding solutions for several location problems such as: minimum distance, maximum demands coverage, maximum income coverage, and optimal center. The spatial variations in tenant sales are being studied and evaluated. More specifically, thematic maps can be used by the managers of shopping malls to monitor sales and the income rates as well as define which shops have a high yield and which a low yield according to the demographic basis of the sales. The investors and the managers of shopping malls should be able to follow quickly the economic performance of the trade deals, which are developed, and the thematic maps offer the means to achieve this easily. The current GIS-based real estate management model helps the investors and the managers of the shopping malls to define the geographical reasons why some properties- shops may perform better or worse than expected. Here, the analysis concentrates on the sensitivity of tenant sales performance as regards their distance from mall promotions and tenant store expansion. For example, a shop may present declining financial rates because it is located in a position in the shopping mall, which is not easily accessible by the consumers. Alternatively, the decline in the available empty spaces in one zone of the shopping mall may lead to the increase in

the income of a property that belongs to another zone. The maps of the specific GIS model allow the manager of the commercial centre to define and to discover these income relationships from a distance. Least but not last, the system examines the influence of various mall management "controllables" on individual tenant sales. Activities such as mall promotions, architectural modifications, and the locational impact of tenant changes on the performance of the shopping center will be included.

| **Code** | **1.168** |
|---|---|
| **Address** | Mediterranean Cosmos |

| | | | | | |
|---|---|---|---|---|---|
| | Plot | 250.000 sq.m. | | | |
| | Cover | 46.350 sq.m. | | | |

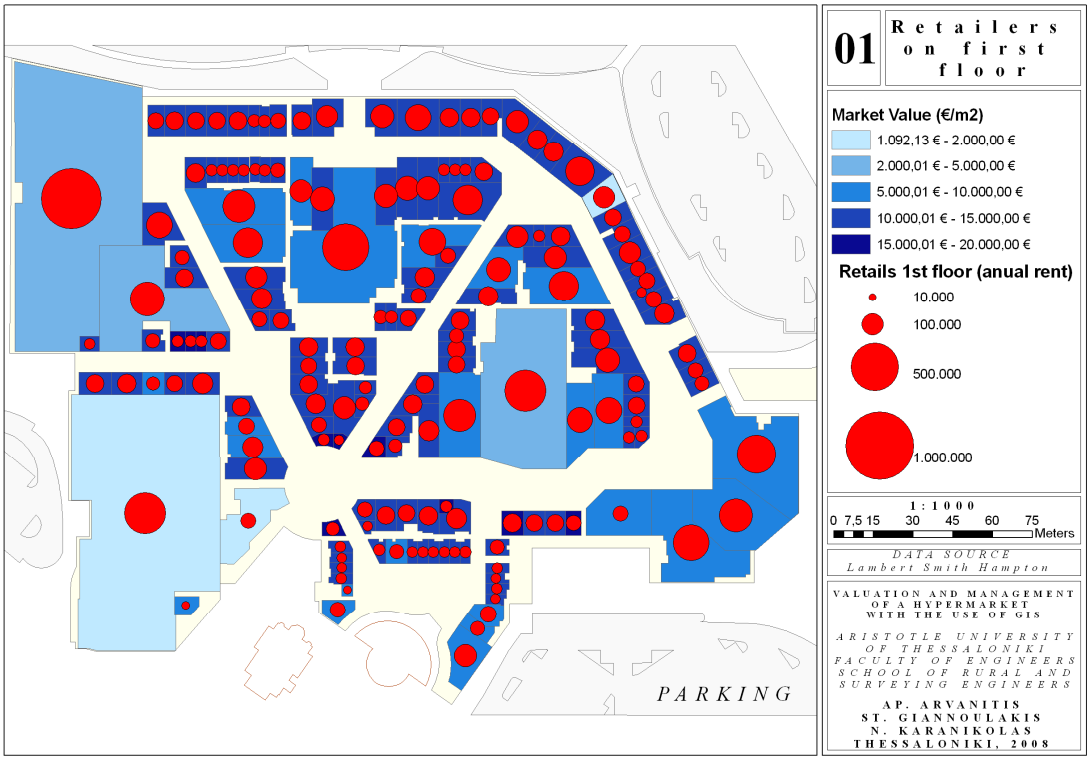
| | **LAYER** | **User** | **Uses-zone** | **Areas (square meters)** | | | **Year's Rent (€) 2007** |
|---|---|---|---|---|---|---|---|
| | | | | spare areas | rent areas | area | |
| | 1 | GOODYS | RESTAURANTS | 0,00 | 236,30 | 236,30 | 110.588,40 |
| | sum | | | 0,00 | 236,30 | 236,30 | 110.588,40 |

| **GOODYS** | | | **1** | | | **31/12/2006** | |
|---|---|---|---|---|---|---|---|
| | 1 | | Area sq. meters | | | 236,30 | |
| | | | Reasonable Rent Value € / sq.m. | | | 39,00 | |
| | | | Rate of Adjustment | | | 4,8% | |
| | | | Discounting rate | | | 8,0% | |
| | | | Efficiency Exit | | | 8,0% | |
| A/A | Period | | Months of Rent | Monthly Rent (€) | Sum of rents for period (€) | Years of Rent | Reasonable Value |
| | Start | End | | | | | |
| 1 | 1.1.2006 | 31.12.2006 | 12,00 | 9.215,70 | 110.588,40 | 1,00 | 102.396,67 |
| 2 | 1.1.2007 | 31.12.2007 | 12,00 | 9.658,05 | 115.896,64 | 2,00 | 99.362,69 |
| 3 | 1.1.2008 | 31.12.2008 | 12,00 | 10.121,64 | 121.459,68 | 3,00 | 96.418,61 |
| 4 | 1.1.2009 | 31.12.2009 | 12,00 | 10.607,48 | 127.289,75 | 4,00 | 93.561,76 |
| 5 | 1.1.2010 | 31.12.2010 | 12,00 | 11.116,64 | 133.399,65 | 5,00 | 90.789,56 |
| 6 | 1.1.2011 | 31.12.2011 | 12,00 | 11.650,24 | 139.802,84 | 6,00 | 88.099,50 |
| 7 | End of period | | - | | 139.802,84 | | 1.189.343,28 |
| | | | | SUM | | | 1.759.972,08 |
| | **Market Value** | | | | | | **1.760.000,00** |

*Table 1: Example of the valuation of a retail space.*

Also, knowing that the internationally acceptable term developer means every individual or legal entity, which aims at any form of development of any category of property, is easily conceivable why the specific Real Estate Management Model can turn out to be a very useful tool for the developers of shopping malls. It is generally accepted that in the real estate market the developers earn money-buying properties, which are devalued, they exploit them at a reasonable cost and they sell them at

market prices or above. Most developers find such properties on an independent basis.




*Map 1: Analysis of 1st floor.*

But the current GIS - based management model can improve the range and the adequacy of the research procedure. The thematic maps of the particular model can help developers understand better where and why there is an increase in the demand rate of the consumers of a commercial center. In deeper analysis, if there is available information on the recent commercial deals, the system of management can contribute to the definition of the zones of use where the property is devalued or overvalued. Moreover, the GIS maps, which are relevant to the zones of a commercial center, can help developers form a more specific picture of the expenses for the exploitation of a particular property. In addition, the developers of commercial centers can through this original model of administration use the GIS tools to detect the sale prices of the properties, to analyze development plans and to prioritize growth goals for the future.

## 5. CONCLUSIONS

The GIS methodology introduces innovative elements, which mainly make management of shopping malls easier and the production line more constructive. GIS systems are unchangeable while at the same time can be dynamic. This option gives the opportunity to change the shell and adapt the interface in actual user needs.

Furthermore, all GIS functionalities, like for instance, valuation, analysis etc. can help for a most accurate decision.

In conclusion, one question is posed. Until now, in the shopping center industry, GIS has been applied mainly to understanding and profiling trade areas and to connecting market coverage to mall advertising and promotion. Can now, this prototype system of real estate management with GIS be established in the administration of commercial centers as an original way? The future will tell. One thing is certain, though. It has all the prerequisites as it presents effectiveness, speed, direct communication and a friendly environment between each developer and owner of the commercial center.

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