Added values of Geographic Information Systems in the real estate life cycle

Michael Nadler & Christian von Malottki

(Prof. Dr. Michael Nadler, Assistant Professorship of Real Estate Development and Real Estate Finance at Technical University of Kaiserslautern, Dipl.-Ing. Christian von Malottki, International Research Training Group „Visualization of Large and Unstructured Data Sets“ at Technical University of Kaiserslautern, Erwin-Schrödinger-Straße, Building 56, Room 278/280, 67663 Kaiserslautern, Germany, Email: nadler@rhrk.uni-kl.de und malottki@rhrk.uni-kl.de; Website: www.uni-kl.de/real-estate)]

1 Abstract

In Geographic Information Systems (GIS), the collection, combination, analysis and visualization of spatial data is carried out in digital maps. Due to the significance of the location for this spatial data basis, a commercial use of GIS seems to be suitable for the real estate economy. In German practice however, this is only true for isolated, heterogeneous and individual applications with a low level of transparency. The practical problems nowadays result less from technology, but rather arise from availability and integration of data. For this reason, the possible use of GIS applications is evaluated on the basis of existing empirical analyses of the influence of spatial parameters for real estate decisions. Applications, target groups and requirements of property-related GIS are thereupon developed systematically - following the value-added chain in the life cycle of real estate. The range of applications reaches from value inquiries in the context of financing and portfolio decisions in the letting phases of real estate to the use in location and market analysis in the developmental stages of real estate. The latter is shown exemplarily with the modeling of a GIS to forecast the supply and demand of office property areas.

2 Fundamentals and recent progress of geographic information systems

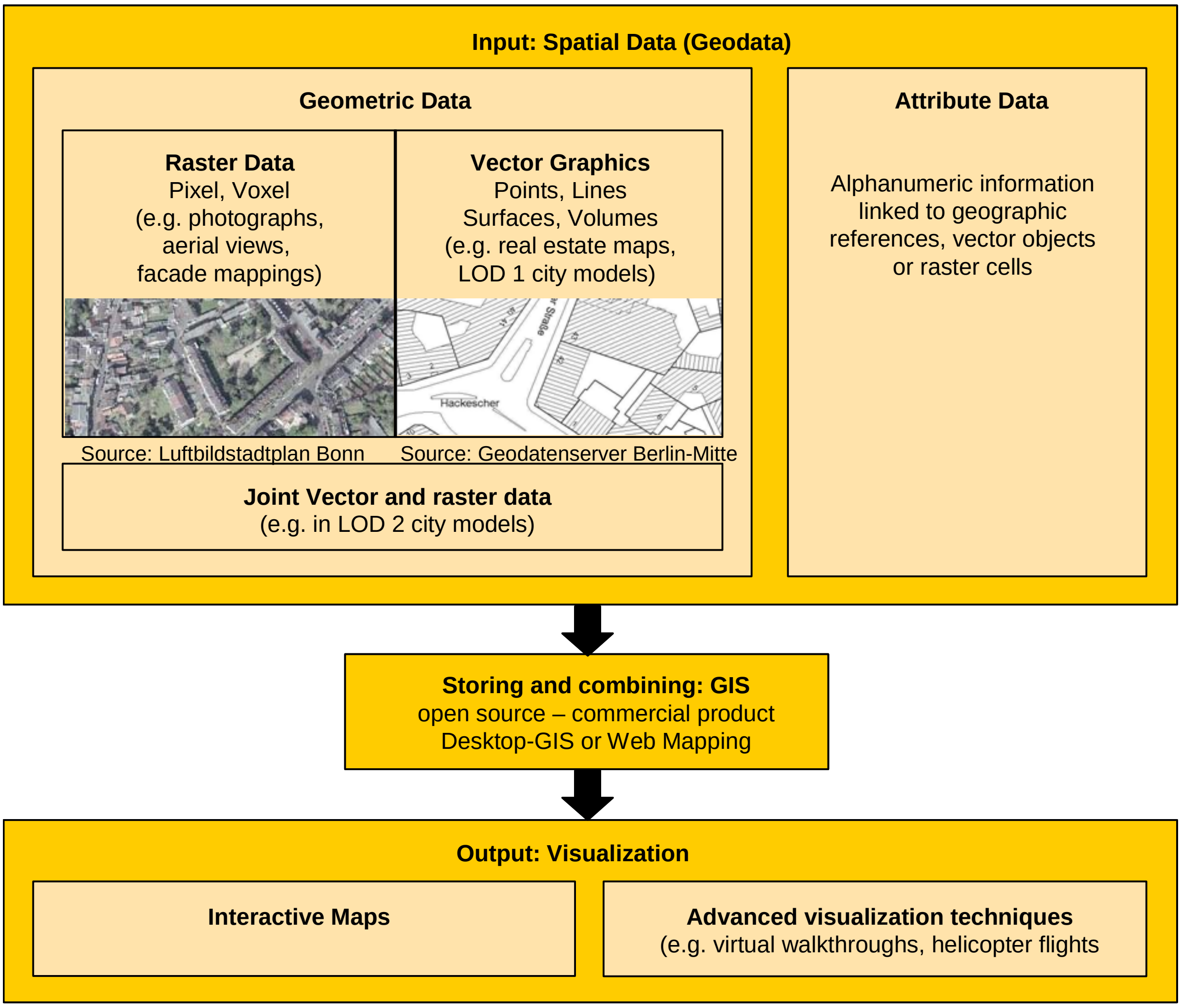
2.1 Defining GIS elements

A Geographic Information System is defined as a computer software package, which stores and combines spatial data, consisting of geometries (vector data, raster data) and alphanumerical attribute data. The latter is joined or related to vector objects, raster cells or geographic references (coordinates). Geographic information systems allow data base queries either by spatial or by attribute criteria. The system is for example able to calculate the number of inhabitants in a five-minute driving-time around a new supermarket or it can list all competing markets within a certain area including all characteristics. The other way round, it can display all markets selected by specific criteria in a map. In the first case, the output is a simple table, in the latter case, it is a visualization (defined as a representation of data in a viewable medium or format). GIS is useful for a variety of public tasks and economic sectors with a spatial component.

The implementation of a GIS system requires hardware, software (the GIS itself) and data. The hardware produces the least costs and problems because of the broad diffusion of desktop GIS programs. The software can be one part of a variety of standard software packages.[1] This variety led to the implementation of standards (especially of the Open Geospatial Consortium), which allow the exchange of data between the different software products. Further developments are to expect from Open Source GIS software[2], which today still lacks usability. The acquisition and integration of the spatial data in the software is the most complex and costly problem. Fitting to the requirements of the real estate industry, we will display the components of spatial data processing exemplarily on the building level in Germany:

[1] Common systems (without guaranty for completeness) are: ArcView, Smallworld, PC Map, SICAD, Map Info For a market overview see www.geoinformatik.uni-rostock.de/produkte.asp or BUHMANN / WIESEL (2004).

[2] The most common system is GRASS GIS, for a product overwiew see www.opensourcegis.org .



Ill. 1: Components of data processing in GIS

2.2 The Base: Geometries

In Germany, the main source for building related spatial data is the vector data of the public surveying administration – which is digitally available almost for the entire country as vector data in the digital land survey register (‘Automatisierte Liegenschaftskarte, ALK’). It is also possible to obtain only building outlines. The high price level without significant volume discounts still avoids a private use of this vector data for large areas.

Even though the country-wide 2D-digitalization of the land survey register is not yet completed, the first metropolises and tourist destinations started with the realization of the third dimension in GIS. As a result of the large quantity of data required, typical 3D-models of entire cities reach only a so called ‘level of detail 1 (LOD 1)’. This a block model generated from a base polyline and height information.[3]

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[3] The initiative for a geodata infrastructure in North Rhine-Westphalia, Special Interest Group 3D (SIG 3D), calls a single regional terrain model LOD 0 and a block model with a base polyline and

The second group of geometric data is raster data. The public administration and commercial geodata brokers offer topographical raster maps or aerial views at much lower rates than vector data. Small areas can also be copied from free internet sources.[4] The first step into the third dimension consists in oblique aerial views with an alterable viewing angle or in simple photographs which are geo-referenced and can be combined to slide-show-based walk-throughs or integrated in maps.[5]

The combination of 3D raster and vector data leads to the generation of city models with façade images mapped on the vector geometries (LOD 2). This process is actually very expensive due to its complex automation.[6] Consequently, until today the cities have limited themselves to important (central) areas. Given the multifunctional use of 3D-city models, it is to be expected that this type of geodata base will constantly drop in price making it affordable for uses in the real estate industry.

Munich (3dGeo GmbH and Remote Sensing Solutions GmbH)	Within the circular expressway 55,000 buildings with roofs and facades
Wiesbaden (GTA)	Whole city as blocks, city center with detailed cubatures and (less buildings) with facades
Düsseldorf (CPA Geoinformation)	LOD 2 in the inner city area, LOD 1 based on number of floors in the whole city
Köln (GraphiX)	City center and adjacent areas with roof details, smaller zones with facades
Bochum (Aerowest)	3D-model as base for a racing game connecting the different zones of urban development
Hamburg (GIStech GmbH)	120.000 buildings with roofs and exact height, the rest are blocks with heights calculated by the number of floors
Berlin (3dGeo GmbH, Distribution by www.geotainment.de)	Inner City with 26.000 buildings containing facades and roofs
Stuttgart	Whole city as blocks, roof details for ca. 60 % of the municipality

Tab. 1: German Cities working on 3D city models

In 3D we see efforts to create a new standard for city models (*city gml*) and to improve its interoperability. But the import of recently created formats exceeds the resources of a standard GIS system. Apart from 2D standards the end customer, e.g. the real state industry, will furthermore be reliant on special GIS providers.

height information LOD 1. The height information could be drawn from laser scanning, stereo photographs or from a floor level database and estimated floor level heights.

4 Check for example Google Earth / Google Maps, the Homepage of the German Yellow Pages or interactive offers from surveying administrations (www.geodaten.bayern.de/).

5 See www.ld7.de for the city of Landau. The Germany-wide project DeskCityServer has ended with the bankruptcy of the company.

6 The so called LOD 2 requires not only photographs of the façade but also additional information of the cubature (especially roofs etc.). STÄDTETAG NORDRHEIN-WESTFALEN (2004) gives an overview of the state-of-the-art technique.

A further detailing of city models is actually a dream of the future.[7] The resulting data masses seem not to be manageable – not considering the necessary effort to hold the database up to date. The actual discussion is therefore about creating interfaces with architectural CAD programs, that are able to work and construct traditionally in three dimensions. Supported by this kind of program, it is possible to model and to visualize single buildings and their directly adjacent surroundings before the construction phase. If it is - one day - possible to apply digitally for a building permit, it will be reasonable to integrate this data directly in the model.

2.3 Joining attribute data

The integration of the digital land survey register (ALK) and the digital land register (‘Automatisiertes Liegenschaftsbuch, ALB’) in a joint land information system (ALKIS) is in Germany still under construction. It will link cadastral attribute data (plot numbers, owner information etc.) with the geometric base, theoretically allowing a start with integrated GIS data.

Because of the large amount of data and its laborious generation, new inventions are generated a lot faster than their nationwide or citywide providing can be accomplished. The consequence is a huge variety of data formats. The German surveying administrations created their own format (*edbs*) years ago. The problem for users consists in the necessary conversion of the data in the actual formats of standard GIS systems (e.g. *shapefiles*). It can be carried out by the city administrations themselves, commercial converters or open source programs. As raster data is much cheaper than vector data (on the building level), it is an alternative to base the GIS on a raster map, geo-reference the alphanumerical address data, and link further attributes with the address data.

Further attribute data on the building level (e.g. vintage, number of floors, user) are – if at all existent – distributed in different formats and held by different institutions. While commercial data brokers dispose of a relatively small set of attributes, the extent of public data depends on the commitment of individual municipalities and their departments. In addition the real estate industry (estate agents, research companies, housing cooperatives, large land owners) is collecting its own data more or less systematically. For this target group the incorporation of own data plays the most important role when starting with GIS.

The data at a higher geographic level (e.g. on the level of blocks, streets, town districts, postal codes) is less difficult to obtain in an adequate quality. Socio-demographic parameters are available from data providers working in the field of mar-

[7] In the nomenclature of the cited SIG 3D a LOD 3 model comprises architectural details like windows and constructional details as vector data. LOD 4 offers an access to spectators to the inside of the building.

keting. Data of the road network is used for calculating real time driving (and walking) distances. Data from public sources (like social infrastructure) is very heterogeneous.

Yet there has not been established one integrative structure for the acquisition of data. In Germany the surveying administrations created only model projects for the standardization of data supply.[8] Commercial geodata brokers specialized in user-specific downloads of data accounting with a pay-per-click-system.

Apart from the – highly relevant – problems of data availability, the further analytical processing of the spatially referenced attribute data is an important research field. Econometric methods are used to prove the statistical significance of spatial data – the discipline is also called spatial econometrics and deals e.g. with spatial autocorrelation problems that can be observed by visualizing them in GIS systems.

Models in urban and regional economics always deal with spatial parameters. In dynamic modeling a temporal component is added and the state of an geometric object or a raster grid cell can change within different periods. If future results of the model are not determined and must be observed by experiments, we speak of simulations. GIS has two functions in spatial econometric modeling: On the one hand, it serves as an integrative database joining data from different spatial levels. On the other hand, it visualizes the result of modeling and simulation. The next step would be the full integration of modeling into the GIS program structure.[9]

2.4 Visualizations of outputs

As mentioned, visualization is a representation of data in a viewable medium or format. This broad definition incorporates at the same time the geometric and the attribute component. The original visualization tool in geography and urban planning is the map. Standard GIS systems improve mapping by providing interactivity, e.g. the user can turn on and off layers with additional information. Internet provides a new medium for visualization leading to interactive Web Mapping Services. In the third dimension an interactive visualization allows helicopter flights over 3D-city models or virtual walkthroughs. A further possibility is the connection of reality or real-time data and virtual data to an augmented reality, which can be perceived e.g. by head-mounted displays.

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8 An overview of projects for an integrated online-use of the geodata infrastructure in the different federal states is available (only in German) at https://projekte.eteam.verwalt-berlin.de/pub/bscw.cgi/d16460/gdi-berlin_aktivitaeten_anderer_bundeslaender.pdf. The federal administration is organized in an interdisciplinary working group (Interministerieller Ausschuss für das Geoinformationswesen – IMAGI) which is working on the construction of a geodata portal. A search engine for geodata is available (www.geomis.bund.de) but focussed mainly on the field of environmental planning and research.

9 See WADDELL / ULFARSSON 2004; 24

Actually when we talk about advanced visualization techniques it refers mainly to an improvement of the geometrical base. Due to the big effort of generating these improvements, the connection of geometries and alphanumerical attribute information gets slightly out of perspective. Even though there are huge efforts to standardize the 3D-models today, it has to be stated that the actual German city models are not 'intelligent'. Their digital geometric objects are not connected to the (partially available) attribute data at the building level (e.g. number of floors, tenant, building quality). This link promises some interesting trends for the future, because the mostly attribute based 2D geographic information system could be integrated in the visually augmented 3D-models providing information ready for queries and qualitative images at the same time (3D-GIS).

3 Specification of the real estate industry as a GIS-user

3.1 Activities in the real estate life cycle

Even with the numerous existing technical solutions and the perspectives of further progress a striking reservation of private users towards GIS is to be noted. While GIS achieved a notable relevance and diffusion in the municipal, sector, e.g. for tourism, urban planning and monitoring, pollution simulation or civil protection,[10] this refers only to a small extent to the economic sector which should have an immediate interest in spatial data: the real estate industry. Despite the new developments on the market of geographic data and the related intents of commercialization by software companies, public data providers and commercial data brokers, the majority of projects started by the GIS industry shows rather vague ideas of a concrete use of the technology in the real estate sector. As the real estate industry does not act as a pioneer on the geographic information market it only makes sense to analyze these concrete uses and to evaluate the importance the technology and the data could develop for the different players in the real estate sector.

The handicap for users, especially in the real estate sector, does not consist of problems of technical capability, data masses or query possibilities in the 2D GIS programs.[11] In fact, it is the acquisition and integration of required geodata linking the spatial and attribute components. Here the so called 'added value paradox' occurs: Generating and actualizing raw data requires high expenditures which itself has a low market value. Only a further GIS-based analysis creates high benefits causing only small additional costs. To get an impression of additional benefits and related potential for adding value to the real estate analysis it is necessary to quantify empirically which data has value relevance for which target group in the real estate industry.

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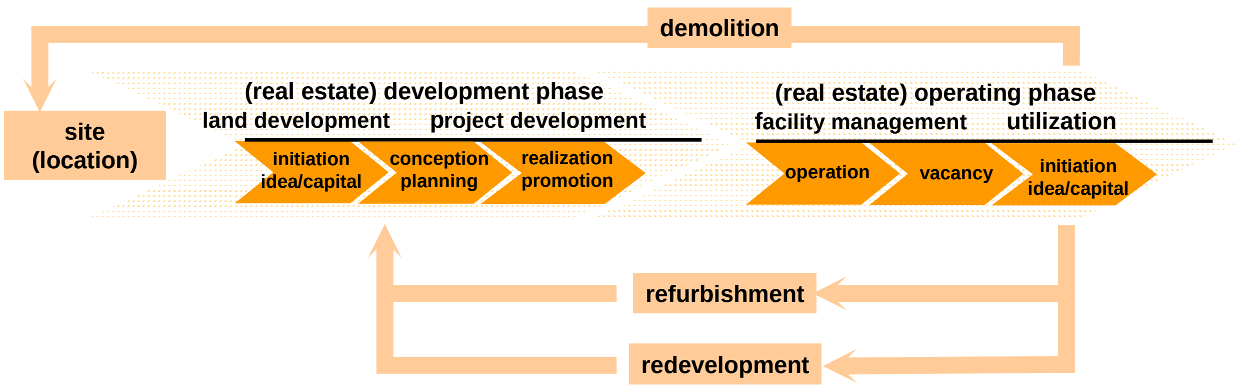
[10] See GUHSE (2005) or KUHLMANN / MARKUS / THEURER (2003) for further details.

[11] For real estate industry the 'normal' GIS-tools like intersecting or buffering objects by different criteria, the construction of driving time buffers or the measuring of distances or areas are very useful and easy to realize in a normal GIS software package.

This purpose requires a dynamic approach to property. In the real estate industry – as in many sectors of economics – the life cycle approach has been established to analyze a product dynamically. Abstractly speaking the cycle refers to one or more periodically repeating events. Speaking of a building a cycle actually does not exist. It is a matter of lifetime with defined beginning and ending. We can call a part of the lifetime a cycle when – e.g. by modernization – a repeating procedure is established.

To expand the life cycle approach the site must be integrated in the analysis. In this case it is justified to speak of a cycle because on one specific part of land different objects are realized, operated and finally torn down. The buildings on the site undergo ideal type life phases which can be visualized in the following form:



Ill. 2: Phases of a real estate life cycle

Even though in the meantime the life cycle model is accepted in Germany,[12] the delimitation and denomination of the phases is not yet consistent. Nevertheless all intents of systematization commonly separate the *phase of real estate development* from the *operating phase*:[13]

- Real estate development is characterized as the linking of project idea, site, capital and tenant to make a profitable and durable investment on microeconomic level and to create a real estate object without ecological or social incompatibilities on macroeconomic level. While the land development aims at creating land ready for construction, the focus is normally on the project development which is the construction of a new (housing, office, retail or industrial) object. In contrast a redevelopment project starts the life cycle once again by refurbishing, modernizing or even changing the purpose of an existing building.

- The trigger of redevelopment is often an increasing vacancy in the phase of real estate operation. With a consequent facility management (FM) the problem can

[12] See e.g. the guideline 100 of the German Facility Management Association (GEFMA).

[13] Partially the tearing down and the following brownfield (re-)development is often seen as a separate phase which won't be considered any further in this article. It could also be seen as a part of the land development regardless of the former type of land.

be spotted promptly by the owner of the building. FM analyzes – e.g. corresponding to the standards of the German Facility Management Association (GEFMA) – and optimizes all cost relevant processes around a building. The commercial FM is subsequently an important part of the corporate real estate management (CREM) where the owner optimizes his portfolio considering aspects of risk and yields. If necessary this includes the sale of the building or the plot after tearing down the building. Hereby a new development phase in the life cycle of the site begins.

To evaluate the application potential of GIS in the real estate industry it is necessary to differentiate between those two phases in the life cycle of sites. Both phases have different players and therefore different target groups for GIS applications. Their expectations on technical functions, useful data and required visual quality establish therefore varying added values of geographic information systems.

Since it would exceed the allowed presentation size by far and since the focus of this conference is in using GIS technology for regional and urban modeling, the (real estate) development phase will be in the main focus of the following chapters.

3.2 Geographic data in the real estate development phase

3.2.1 Real estate developments in Germany

Since the middle of the nineties investment and total revenue in the German construction sector are dropping. In 2004 the investment volume only reached the nominal level of 1991, in real numbers it declined by about 6%.

Searching for reasons of this recession the three big investment sectors have to be analyzed separately. For a long time the residential construction created a stable demand for the whole construction sector. This changed in 2001 when the economic situation and the stock market deteriorated rapidly. As a specific private housing subsidy expired at the end of 2005, anticipated effects were created resulting now in a repeated decrease in building permits. The East German commercial construction has been dropping since the middle of the nineties; in the Western part the contraction phase begun in 2001. Since then it enforced dramatically. The letting market for office and industrial parks sticks in a deep crisis. A comparable situation can be stated for the public real estate investment especially in building construction. These dropped since 1991 by nearly 30% nominally (8.5 billion € in 2004). The crucial point was the saving efforts facing the public budget deficit.

In spite or even because of this development the demand of private households and institutional investors remains limited and the related increases in value in all types of

German real estate reaches only small rates.[14] Hence the German real estate market can be characterized as a buyer's market, forcing the real estate sellers to establish a target group oriented *marketing*. Therefore, every real estate developer needs a detailed market *research*, in which the regional demand and supply respectively competition is analyzed, as well as a *distribution policy* to influence potential tenants, investors and opponents. Both action parameters therefore have meaning in the initiation and sales promotion stage of the real estate development phase (cf. illus. 2).

Although a lot of players participate in the real estate development phase (cf. illus. 3), the potential target group for a GIS application is limited: Market research as well as sale promotions can be a 'in-house' service in the development company. Very often the companies of the developers are too small and there isn't enough know-how in business management if real estate developments are done by building companies, architects or civil engineers or municipalities. In this case both market research and sales promotion are awarded by contracts to external real estate brokers or consultants like Jones Lang Lasalle or CB Richard Ellis. Since this market has an oligopolistic structure, the scope of GIS is already limited despite interesting applications (see the following chapters).

	project initiation	project conception	project concretion	project realization
institutional investors	involved	involved	involved	not involved
building companies	involved	not involved	not involved	involved
banks	not involved	not involved	involved	not involved
occupant	involved	involved	involved	not involved
architects / civil engineers	not involved	involved	involved	involved
broker / consultants	involved	involved	involved	involved
municipalities (PPP/PFI)	involved	involved	involved	involved

Ill. 3: Actors and target groups of a GIS application in the real estate development phase

3.2.2 Theoretical fundaments in real estate market analysis – focusing on office market models

During the initiation of real estate development, the location and market analysis is of an outstanding importance for market research. It helps to prevent building companies, investors and city planners from excessive vacancy rates due to new construction, which ignores the requirements of the market.

[14] Only during the last two years a significant interest of Anglo-Saxon investor groups appeared in Germany. To the reasons of this development see NADLER (2006).

While the markets for office space, industrial buildings and undeveloped land often do not dispose satisfactory geo-referenced information available for market analysis, the retail market is actually the most important field of GIS-elaborated location and market analysis. The elaborated theoretical base, e.g. through gravitation models, logit models or Voronoi diagrams, and the importance of street distances and driving times as input variables which are easy to measure by actual GIS-systems, led to a computer-supported state-of-the-art in retail analysis.[15] Residential markets are well observed regarding their demographic part.[16] The migration (or city-internal movement) research is expandable.

In order to expand the GIS application to other market segments, the focus of the following description of the theoretical base and the subsequent analysis is on *office markets*. Despite the necessary differentiations in submarkets created by quality level of the building, location, building size and economic sectors, the office market is rather homogeneous and can serve as an archetype for real estate markets in general.

The actual German office market studies have mostly an urban planning background and are ordered or carried out by municipal administrations, estimating the space requirements for additional office buildings. These surveys work with stable market equilibriums which mean that in the medium term the suppliers will exactly construct the required space without shortages or vacancies. The planners question is: How much space is required for which user at which location?

In general additional space, requirements are generated for three reasons:

- the number of office employees is increasing,
- the space per employee is increasing,
- obsolete buildings generate a replacement requirement.

The space requirement at time *t+x* is calculated as shown below:

(1) $$SPACE\ REQUIREMENT_{t+x} = OFFICE\ EMPLOYEES_{t+x} * SPACE\ PER\ EMPLOYEE_{t+x} + (б * STOCK_t)$$

With б = demolition rate; t = actual period; t+x = target period

[15] See VON SUNTUM (2000) for details. A problem is the generation of sufficiently detailed database of the users of occupied floor space. Given the rapidly changing retail market this census can give only a punctual overview. Some companies offer special software showing all franchise chains in a GIS (in Germany see e.g. www.geoport.de or Location GIS from Borchert GeoInfo GmbH).

[16] See VOß (1998); PESTEL-INSTITUT (2003); BUNDESAMT FÜR BAUWESEN UND RAUMORDNUNG (2001).

The estimation will be carried out at the whole market level, which in general is a city or a metropolitan area. Subsequently the additional requirement can be distributed by a top-down-approach to different market segments such as building sizes or micro locations. This approach requires an observation of user type specific location choice and a conversion of the employee forecasts into office user types.[17]

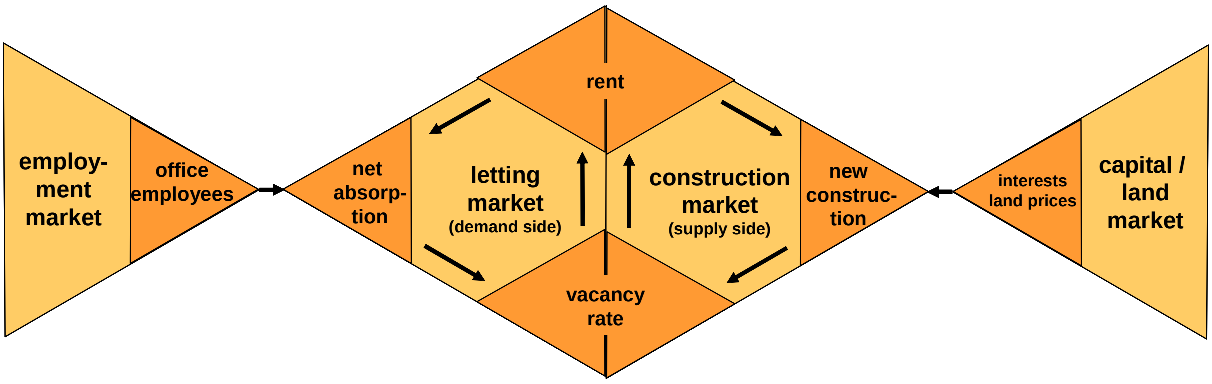
The Anglo-American method is of economic provenience. It models the interdependence of supply (the total stock) and demand (the occupied space). Since an exact balance of the market via prices does not work due to small demand elasticity, and an adaptation of new construction rates takes effect after approximately three years (not considering the fragmented structure of suppliers without information from each other that fosters the genesis of market cycles), it is the vacancy rate which adapts the quickest. Out of the huge quantity of papers[18], a 'standard model' can be extracted:

(2) *VACANCY RATE = f (NET ABSORPTION, NEW CONSTRUCTION, REMOVEMENT RATE)*

(3) *RENT = f (VACANCY RATE)*

(4) *NET ABSORPTION = f (RENT, Δ OFFICE EMPLOYEES)*

These functions are estimated econometrically with time series of a whole market or by analyzing single equations with a cross-sectional model, comparing different metropolitan areas, submarkets or even buildings. From the perspective of a planner or building company, it is reasonable to join the additional office employment and the new construction externally. For the latter parameter, there are intents of internalization considering interest rates and rents (the supply side in ill. 4). From a continental European perspective land use, planning restrictions could be integrated.



Ill. 4: Modeling the office market

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[17] See SENATSVERWALTUNG FÜR STADTENTWICKLUNG BERLIN (2001).

[18] Beside the first office market model from ROSEN (1984), we suggest HYSOM / CRAWFORD (1997) and MCDONALD (2002) for an overview.

The planning based forecast has the advantage of being flexible towards incorporating a variety of future trends (e.g. the demographic development in Germany or the discussion about desk sharing). Even if the restriction of market equilibriums is understandable from a planner's point of view, the total exclusion of vacancy is not adequate, if we consider the future problem of an ageing office stock from the sixties and seventies in the European cities. The input data for this method is difficult to obtain. Consequently, it requires estimates or a calculation with scenarios.

The econometric approach solves this problem by adapting exactly on the kind of data the brokers possess. For example, a ratio of space per employee is not calculated but hidden in the connection between rent and net absorption: A higher rent forces the tenants to search for smaller office space. This intern use however excludes possible future space needs discussed e.g. for improving technical and social services in offices. A long-term use of the econometric model shows cycles, but in general only an employment-induced trend beyond cycles.

In order to benefit from the advantages from both approaches, these advantages could be linked to each other: The econometric approach is enhanced with a long-term space-per-employee-component, and the market-wide space requirement is distributed by the cited top-down-approach to the different submarkets. As a consequence, the required data increases, as we need macro data for the market forecast and micro data for the submarkets. As the data proposed by brokers varies strongly with the company, the alternative is to generate the information completely from micro data.

3.2.3 Application example in real estate marketing: office market forecasts with GIS-stored data

The mentioned theoretical approach could be realized in a GIS based office information system. Such an office market GIS could serve as a better common information source for brokers who put their deals in a 'black box database' and can download aggregate data about rents and vacancies but no information about single deals. As city planners and municipal or regional business agencies could equally profit from this system, a joint database construction could bring benefits for all participants. This office database obviously has such a strong connection to location and geography that a GIS is the proper place to store the data.

Nonetheless the establishment of this extended database will take its time. In the meantime, it is possible to use the GIS for information about the office stock, its occupants and the dynamic monitoring for location choice. The rent and vacancy rates must be drawn from macro data. For all researchers, the worth of GIS application depends on the quality of existing input data.

The stock information is the most difficult database. States of the art are on-site-inspections that are difficult to update and a costly effort especially in big cities. The alternative is the combination of municipal building data and commercial business databases. The building data is generated whenever building permits are defined as an issue. The quality level of this data varies strongly between different cities. Especially mix-use buildings cause many problems and require floor-specific data which exists only in few German cities. As the user type (office, retail, residential) can change in time within the same room without any information of the authorities, the data has to be improved by commercial business databases. This data is necessary as well in order to get information on the economic sectors and the company sizes within the building.

The overlay of the business and building databases can be carried out by GIS, allowing a reasonable submarket division including a map of office characteristics and the calculation of stock for submarkets. Repeating the database overlay at different moments, we generate the moves in location differentiating between business types. The resulting location choice matrix can be used for the top-down-distribution of the additionally required office space to the different office location clusters and thus a simulation of office occupation in the future.

Presently the described method is realized in the city of Stuttgart (600,000 inhabitants, 185,000 buildings, 6,000 buildings with office use). But still there are a lot of further questions which could be answered by a regularly updated office market GIS: which locations and quality levels serve to which extent as substitutes for each other? How does a structural vacancy of overage office buildings influence the market?

Given the intern use by developers, investors or their brokers and consultants respectively, who form the target group for a GIS (see ill. 4), the GIS system itself and the traditional maps are the desired outputs of GIS application. The crucial point for analysts is the exactness and actuality of attribute data and the detailed level of vector objects. The linkage of vector building geometries and their attribute characteristics (floor numbers, vintage, occupant type, floor space) over a broader urban area would allow a quick and detailed analysis of a whole market segment. The connections with raster photographs (facades in 3D city models, advanced visualizations techniques) are a useful option, but are far too expensive if designated only for the target group in the research departments of real estate agents and consultancies. For this user group, the LOD 2 city models put the wrong emphasis on visual attractiveness. A vector-based modeling of separate floors or apartments would be a significant improvement for the real estate analysis. However this level of detail is not provided in the actual German city models.

3.2.4 Real estate sale promotions as an additional range of application

During the phase of active *sales promotions* the situation is quite different (see also ill. 2). On the one hand the relevant information has to be generated and provided for the customer (tenants and/or investors). On the other hand the presentation form of data is an important additional task: An improvement in visualization techniques is of special interest if a combined analysis and visualization tool serves as an instrument of communication and distribution policy and provides the potential investor, tenant or their consultants with the decision supporting data in an appealing way.

Basically the added value in active sales promotion can be created both by an improvement of geometric or attribute data. Ideally their quality is combined to an object search that the customer can autonomously address to via internet. Minimum standard for this kind of real estate broker/agent portal is a database which allows queries by location, type of land or building and price level. This would also be possible without graphical data objects. But today's advanced portals allow not only a visualization of the query results on a map, but also their linking with photographs, oblique aerial views or even 3D-city models.[19] An overall availability of appealing visualizations including the relevant attribute data would enable the digital synopsis for real estate agents.

Numerous business regions dispose of a *location information system* which allows the search for industrial estate and trade areas: The user can either type in certain criteria like the desired plot size, the distance to the nearest freeway exit or to the airport etc. and results are shown on a map. Or he opens the map directly and finds the relevant attribute information by clicking on the mapped objects. The displayed map background can be chosen interactively from extern sources (e.g. the topographical map as raster data). Depending on the available zoom level an integration of advanced map sources (like oblique aerial views, 3D-city models) seems to be manageable.

Instead of building own portals the communal or regional business development agencies could provide the relevant data (for free) to commercial portals. Given the importance of spatial information for the location choice of companies a joint public-private portal (a '*public-private-partnership (PPP)*') can be an alternative or additional tool to foster the settlement of new firms or the marketing of the publicly owned land. In all of the discussed public and private cases the users request geometric data which allow generating maps and pictures of good quality and attributing data. This data can be incorporated easily in interactive database queries.

On a detailed level of only several blocks or buildings it seems reasonable to create a multifunctional use of expensive visualizations. Especially the joint use for planning (civic participation, plans of new projects viewable via internet) and marketing purposes creates synergies without big time lags between the different applications. With this tool the developer or investor can inform about the characteristics of certain plots (size, price and infrastructure) fading in the additional information about planning laws or detailed regulations of local plans. Completed deals can be marked in the plan. In addition a lot of advanced visualization projects like virtual walks through CAD mod-

[19] See e.g. the solutions on www.immoscout24.de on city level, on www.vdm.de with detailed map (if permitted by the broker). American portals offer additional service. www.realtor.com generates socio-economic profiles of the neighbourhood and informs about schools and shops.

els or racing games exist, especially for large urban development projects offered by public agencies or commercial brokers e.g. on real estate fairs.[20] But they are mostly focused on design and impressing pictures. The deficit exists in the interactive link between picture (geometry) and information (attribute).

Generally spoken all kinds of location information systems dispose of numerous links and even more potential linking possibilities to spatial data and subsequent visualizations. A multifunctional use of data minimizes the necessary effort, especially by connecting attributes from market and location analysis, urban planning and marketing only to one geometric database. The visual improvement of the information by animations or 3D-models doesn't make sense on a regional level. In the marketing of large real estate developments a demand seems to exist if the volume of the project justifies the effort. Synergies between public planning and private marketing could enhance the cost-value-ratio. But one has to wait and see whether the private sector is really willing to pay for a large share of the costs for visualizations.

4 Outlook

In the past chapters we pointed out that new developments on the geodata market are of basic interest for the real estate industry. But frequent gaps in the existence of relevant attribute data can not be compensated by technically feasible innovations creating visualizations or steps into the world of 3D. Considering the added value for users in the real estate sector the main challenges are not visualizations but the cheap and easy access to geometric base data and the survey and availability of *additional attribute data*.

In addition internet-based added-value geodata could generate an economic advantage for cities and regions: First a resource-saving land-use management could be oriented towards the relevant spatial value parameters optimizing the possible benefit. This information could be provided to private and commercial investors influencing their investment and location decision with convincing reasons. Second the establishment of such a unique GIS could give the local administration itself valuable information in which policy sectors (like transport, ecology or social conditions) an improvement produces sustainable private real estate investments on the available building land. The resulting tax income of these investments can be used to finance measures in urban regeneration or conversion.

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[20] A good example for visualized local planning and connected marketing aspects with interactive usability is offered by the Freising County in Bavaria: http://fs.mapsailor.de/fs-start.htm. The city of Arnsberg – winner of the internet price of the 'information circle in spatial planning' (Informationskreis für Raumplanung – IfR) in 2004 – publishes such a plan via internet. But here the 'normal' plan is connected only once to the download of a table of all attribute information. For a walk through Colognes new fair district see BECKER / JHA (2003).

3D-city models and advanced visualization technologies can generate an added value in spite of their costs in time, money and effort. But this utility is mainly limited to the development phase of real estate. Normally these visualizations will not be feasible for one player in one project. In Germany the public sector has realized this and is now planning *multifunctional visualization projects* avoiding the start with different projects lacking of interoperability. This decision is basically wise, but brings with it temporal delays because of the augmented coordination between different actors in the development phase of a city.

The real estate sector is often cited as a possible user of this information infrastructure. Nevertheless, an insight reflection of the requirements of the sector towards the usability of multifunctional systems is still missing in Germany. The real estate sector itself should formulate these requirements otherwise it runs the risk of not being supported by adequate public data infrastructure. This incorporates the need for test projects with the spatial base data. A further commitment of the existing GIS providers is to be expected. Additionally an amplified academic research could help to integrate added-value attribute data into (3D-) city models, making them as 'intelligent' as regular GIS. In this (near) future large data sets and impressive visualizations are not separated anymore.

5 References

BECKER / JHA (2003): Für Planung und Marketing: Erstellung eines 3-D-Stadtmodells unter Nutzung vorhandener Daten, in: GeoBIT 2003, No. 11.

BUNDESAMT FÜR BAUWESEN UND RAUMORDNUNG (2001) (ED.): Wohnungsprognose 2015. Berichte Band 10. Bonn 2001.

GUHSE (2005): Kommunales Flächenmonitoring und Flächenmanagement, Heidelberg 2005.

HYSOM / CRAWFORD (1997): The evolution of office building research, in: Journal of Real Estate Literature 1997, pp. 145-157.

KUHLMANN / MARKUS / THEURER (2003): CAD und GIS in der Stadtplanung, Karlsruhe 2003.

MCDONALD (2002): A survey of econometric models of office markets, in: Journal of Real Estate Literature 2002, pp. 223 – 242.

NADLER (2006): Die Vorteilhaftigkeit von Portfolioakquisitionen am deutschen Wohnimmobilienmarkt – eine Frage der Finanzierung?! In: F. Then Bergh (Hrsg.): Private Banking, Wiesbaden 2006.

PESTEL-INSTITUT (2003): Der Wohnungsmarkt in NRW bis 2015. Münster 2003.

ROSEN (1984): Toward a model of the office building sector, in: AREUEA Journal 1984, No. 3.

SENATSVERWALTUNG FÜR STADTENTWICKLUNG BERLIN (2001): Bürostandort Berlin - Strukturen und Perspektiven bis 2010. Berlin 2001.

STÄDTETAG NORDRHEIN-WESTFALEN (2004): 3D-Stadtmodelle: Eine Orientierungshilfe für Städte in Nordrhein-Westfalen. Wuppertal 2004

V. SUNTUM (2000): Kaufkraftströme im Einzelhandel. Ein gravitationstheoretisches Prognosemodell. in: RuR 2000, No. 6.

VOß (2001): Ein empirisches Simulationsmodell für die westdeutschen Wohnungsmärkte. Münster 2001.

WYATT / RALPHS (2003): GIS in Land and Property Management, London 2003.