

# Integration of territorial analysis methods in site selection on the example of Saint Petersburg

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**Abstract.** Capital construction of residential buildings for the purpose of subsequent rent is gaining more and more widespread in the western countries. In Russia, in particular in St. Petersburg, this form of business is just emerging. Due to relevance of this industry, the question of selection the most suitable site for construction arises. The article proposes the solution site-selection case basing on existing methods of territorial analysis, as well as provides examples of application of the obtained databases in the conditions of a narrowly formulated problem. The main tools in the analysis are the calculations of the shares of employment, location quotient and the Hirschman-Herfindahl Index. The mechanisms of solving three types of problems are given, depending on the nature of the input information due to the study of the correspondence between the properties of the object under construction and the urban territories. The theory is formulated on the example of a large city Saint Petersburg and is more suitable for large agglomerations with a population of more than a million people.

## 1. Introduction

Any construction process starts with a site-selection. Rationally chosen area maximizes the profitability and efficiency of the object. It can be analyzed from several points of view, one of which is the economic analysis of regions and areas that can potentially be selected as a site. Each region differs from others in size, location, morphology, diversity of population and donations of factors. Because of these characteristics and some exogenous factors, regions began to specialize in their sectors over time.

Some reference points and investigations are described by of one of the authors, Vladimir Badenko and Nikolay Arefiev [1-3]. Nevertheless, such a modern type of construction as rental houses, is not mentioned in previous works. Malczewski [4,5] experience is also taken into account in this work. Some solution at the intersections of decision-making and selection of sites can be found in his articles. As we focused on the analysis of real estate, we considered previous experience in this field provided by our colleagues [6-8]. Some initial proposals can also be found in our previous paper [9].

Another useful tool that can be applied for decision needs process can be retrieved from different disciplinary fields, fields that already responded with proper methodologies to the need of understanding: “what user want”. Kano model is part of a general strategy for assessing quality in manufacturing environment, starting from the assumption that is possible to provide a precise definition of what the potential customer wants. Application of this model is a current plan for the future research in this field.



Our investigation is focused on calculations describing the economic rationality for the choice of a site for construction. Nevertheless, these methods and all the planned databases can be applied in other cases. In our work, in particular, we are focusing on choosing a site for a particular object - a middle-class rental house. This type of business is becoming increasingly popular in European countries and United States [10,11] and is represented in St. Petersburg and Moscow rarely. The population of large agglomerations, such as St. Petersburg, becomes more comfortable with the accommodation of apartments. Renting real estate in many cases becomes more profitable and, thus, more popular than buying it for citizens. [12] That's why we find our actual methods of dealing with this modern type of real estate. In addition to this, we consider it necessary to evaluate the site without expertise, only on the basis of statistical data (in this investigation all the source data is taken from Rosstat, which is the main statistical database in the country [13]).

Indicators such as employment share [14,15], location quotients [16-19] and Hirschman-Herfindahl index [20,21] are useful tools for analyzing the level of specialization and diversification in the region to understand how this affects the economic indicators and how they behave in relation to the reference area. The purpose of this article is to describe methods that can be integrated into an investigation.

The scale of territorial analysis provides an opportunity to apply such methods to larger cities with a population of more than one million citizens and an area of more than a thousand square kilometers. In urban context we can formulate 3 types of tasks:

- The municipality is an object (which includes the municipality as an access factor and ensures the satisfaction of facilities in accordance with the onset of the municipality property);
- Object + Municipality (which compares the properties of this municipality and the object as an input factor and gives an opinion on their compatibility);
- An object is a municipality (which has an object as an input factor and provides compliance to municipal authorities based on the properties of the object).

## 2. Methods

The main source used in the investigation is Rosstat. It is based on the employment statistics in territories. In the boundaries of Saint Petersburg there are 111 city municipal authorities: 81 municipal districts (some of them have names, some are called by numbers), 9 cities (Zelenogorsk, Kolpino, Krasnoe Selo, Kronstadt, Lomonosov, Pavlovsk, Peterhof, Pushkin, Sestroretsk) and 21 settlements. Russian statistics databases divide employment in following Industries (see Table 1).

**Table 1.** Industry breakdown according to Rosstat

	Industry
A	Agriculture
B	Fisheries, fish farming
C	Mining
D	Manufacturing Processes
E	Energy
F	Construction
G	Wholesale and retail trade
H	Hotels and restaurants
I	Transport and Communications
J	Financial activities
K	Real estate
L	Public administration
M	Education
N	Healthcare
O	Other

In order to understand the level of renting activities we need to analyze all the related industries among the ones mentioned above. More detailed and focused data could have given more exact results and conclusions about municipal employment statistics. Each of the industries can be investigated on particular while we decided to focus on the following ones: K (real estate transactions, leasing and provision of services) and H (hotels and restaurants).

Employment statistics analysis strongly depends on the quality of data available. We find Rosstat data not perfect as not all the numbers are present and actual. Improvement of this database might give a strong push for researches development on this area.

For each of the municipalities and industries the following coefficients are going to be calculated. Appropriate share:

$$Sh_{i,j}^K = \left( \frac{E_{i,j}^K}{E_{i,j}^T} \right) \quad (1)$$

where  $T$  stands for Total sum of the industries,  $E_{i,j}^K$  is employment in industry  $K$ , municipality  $i$ , year  $j$ .

Share identification gives an opportunity to calculate location quotients which represent a measure of relative specialization by comparing the degree of municipality specialization taking Saint Petersburg as reference:

$$LQ_{i,j}^K = \left( \frac{Sh_{i,j}^K}{Sh_{S,j}^K} \right) \quad (2)$$

where  $S$  stands for reference municipality (Saint Petersburg) representing data for the whole employment statistics of the city.

Growth coefficient might be a useful tool for the future shift-share analysis. Growth  $G_i^K$  for each industry and municipality will be calculated as follows:

$$G_i^K = \left( \frac{E_{i,2016}^K}{E_{i,2011}^K} \right) - 1 \quad (3)$$

As for the specialization intensity for different part of the city it will be possible to calculate Hirschmann-Herfindahl Index:

$$HHI_i = \sum_K (Sh_{i,2016}^K)^2 \quad (4)$$

Some techniques are currently used in the manufacturing engineering, a context in which is hard to develop a sharp profile of the potential customer due to different types of perceived quality and an extreme complexity and competition amongst market players. The idea behind the QFD “Quality Function Deployment”, the discipline that include The Kano model as its methodology for customer needs assessment, is to create a model able to develop a pattern of qualities that a product should have in order to fulfil the needs of the market. Another consideration to be made is the “gold plating risk”, providing to the market some attributes that are not perceived or required. Attractive quality attributes and the enhancement of customer satisfaction is the main purpose of the model, providing to Architects and Engineers a decision making tool for better designing solution for fulfilling the idea of the potential customer. The use of manufacturing-driven techniques, mainly coming from consumer goods, can be combined with hard skills typically in the hands of Civil and Construction Engineers in order to create an optimum. The optimum is ideally represented by a hybridization of technique retrieved from different disciplines of the Engineering field, from different sectors (i.e. manufacturing) and mixing project teams.

### 3. Results and Discussion

#### 3.1. Data analysis

All the collected data and all the calculations are going to be formed in a database. For each coefficient mentioned in the previous chapter we will have a table in three dimensions: location (111 municipal authorities and Saint Petersburg in total), time (we collected as much data available as possible for the last six years) and industry (the full list is mentioned in the introduction).

For example concerning decision for the first type of tasks mentioned in the introduction (Municipality – object) we can use shift share analysis. All the industries that are situated above the bisecting line on the planned graphs represent higher employment share than the reference area (Saint Petersburg). For example if some points in shift-share analysis graph concerning healthcare or education may lie above the bisecting line. It will lead to the consequence that this municipality suits more for selection of the sites for types of construction connected with education or healthcare.

Planned analysis provides an ability to make conclusions about municipal authorities that are favorable for such type of construction as rental house. By analyzing location quotient for two investigated industries and determining municipal authorities on their intersection we can postpone which of them suit for selection of the site for rental home type of construction.

Some of the municipal authorities have not provided information about 2016 year or 2017. Lack of data in the Rosstat system is one of the major problems we are going to face during analysis.

For all the determined municipal authorities and the industries we are interested it will be possible to solve the second type of the tasks mentioned in the introduction. By considering them both as an input factor and using Shift-Share Analysis Chart as an instrument we can analyze the growth rate for the last 5 years comparing to the whole territory of Saint Petersburg which was chosen as a reference area.

The created databases also provide possibility to analyze intensity of municipal authorities specialization by the Hirschmann-Herfindahl Index. The closer it is to 1, the higher specialization of the regions in particular industries.

3.2. Kano model application

At the base of a correct analysis of the potential of an area it is useful to introduce the idea of supply and demand, we can think on supply of spaces (locations) and demand of products (housing) introducing the idea of the market and the potential customer, both representing the supply and the demand.

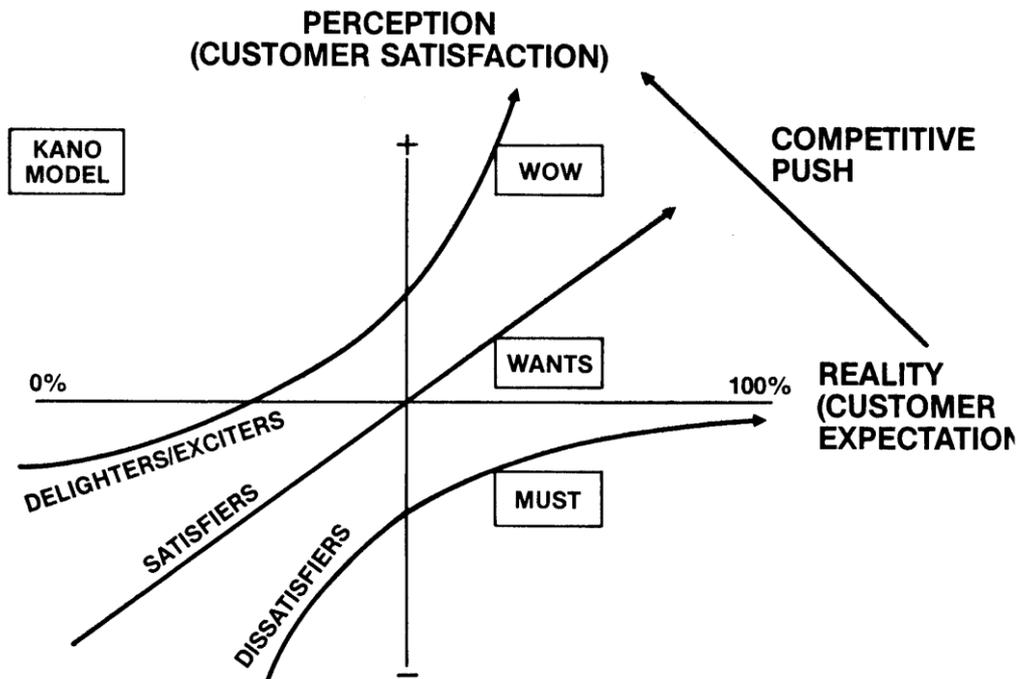


Figure 1. Kano model (from ISIXSIGMA)

It is demonstrable that in particular products such as the one analyzed in this work it is important to understand the market potential of the product to be developed in the selected area. As for studying particular products and for their placement in the market, in the manufacturing world (in which the set of products and its customizations is wider) it has been developed a number of models for merging the production needs with the needs of the market. It can be also considered that traditionally market and production meet their strategies on the base of “push and pull strategies”: in the push strategy is the Company to decide what product the customer can buy and in pull strategy is the market to demand the product, for characteristics and quantities. In this research we decide to study the potential of the “Kano Model” (Figure 1 and Table 2) for the specific study case presented.

Table 2. The Kano model attributes (elaboration by the authors)

Needs	Characteristics
Mono-dimensional(satisfiers)	Standard characteristics that increase satisfaction by their degree. These needs are “spoken” (I e III portion satisfiers, II e IV portion dissatisfiers o reverse)
Indifferent	Client is indifferent to whether the feature is present or not
Must-be	Requirements that can dissatisfy (expected, but cannot increase satisfaction)
Reverse	Feature actually causes dissatisfaction
Attractive (delighters)	Unexpected features or characteristics that impress customers and earn the company “extra credit”. These needs are “unspoken”

The use of techniques adapted from Quality Management in manufacturing [22,23] brings a new pattern of possibilities in understanding the built product as a product that brings a pattern of services as is responding to the needs of the identified potential user. The idea of profiling customers in manufacturing environment and understanding marketing strategies for understanding “what the user want” is likely to be seen as the effort of the production industry of creating products that can meet the desire of the market, avoiding to put in the market product that can result as obsolete or priced in a wrong way.

The adaptation of Kano model is open to the hybridation with market analysis techniques considering the flexibility of the quali-quantitative model exposed and based on the qualities of the product. The Kano model is based on the assumptions that attributes of the product can be divided in five classes as in Table 2 and they can be categorized on the basis of the effect on customer's satisfaction of their presence. Connecting the physical characteristics of the area with the attributes of the object is possible to achieve better market results and lower the market risk. It has been performed in similar situations a research [23] by (Lab. Gesti.Tec ABC Dept Politecnico di Milano 2016), using the stock of brownfield areas in Italy as potential market for Real Estate development for Industrial Buildings and studying the feasibility of further developments of the areas on the basis of the needs of the potential customers. It is possible to foresee a further development of the research in a possible extension of the study case worldwide, basing on the assumption that Real Estate assets on the market are like goods that still didn't match with customer expectations and they represent the existing stock available. The stock is also evaluable within the category of market failures (considering the difference between the natural takeover of the zone and the real days of the property on the market) and the differential potential on the market for new developments is represented by the quality of the new projects according to the market perception of the potential customer. New products on the market have to gain market shares over the existing stock, by-passing the market failures that are affecting the existing stock, to make this evolution is needed a strong analysis of the demand and supply.

#### **4. Conclusions**

The created databases of shares, location quotients and employment provide an ability to use them in different cases and for different tasks mentioned in the introduction. In our particular research we are going to determine some areas of the city which may be selected as the site for such type of modern construction as rental houses.

First of all we will have an ability to choose the most suiting areas among 111 municipal authorities as we are given two industries as an input factor by analyzing increase of location quotient for the last 5 years. Then we are going to analyze selected areas more precisely in the context of particular industries with the help of shift-share analysis. All the calculated coefficients may be used as indicators in the general task of site-selection which describe economical rationality of decision-making.

One of the weaknesses that we faced during planning of our investigation was imperfection of databases. Some information was unavailable or not updated. The results of researches also strongly depend on the reliability of data used. The lack of content in Rosstat databases only proves the actuality of regional analysis of economical activities in Saint Petersburg. Scientific society doesn't even have an access to initial statistics about employment, labor and some other statistical data which can be used for site-selection investigations.

Kano model as one of the useful tools in understanding market needs is also going to be applied as it is described in this article. We find it useful to think on supply of spaces (locations) and demand of products (housing) introducing the idea of the market and the potential customer, both representing the supply and the demand.

## References

- [1] Arefiev N, Terleev V, Badenko V GIS-based fuzzy method for urban planning. *Procedia Engineering*. 2015. Vol. 117. Pp 39-44.
- [2] Arefiev N, Garmanov V, Bogdanov V, Ryabov Y, Terleev V, Badenko V A market approach to the evaluation of the ecological-economic damage to the urban lands. *Procedia Engineering*. 2015. Vol. 117. Pp 26-31.
- [3] Fedorov M, Badenko V, Maslikov V, Chusov A Site selection for flood detention basis with minimum environmental impact. *Procedia Engineering*. 2016. Vol. 165. Pp 1629-1636.
- [4] Malczewski J GIS-based multicriteria decision analysis: a survey of the literature. *International Journal of Geographical Information Science*. 2006. Vol. 20. Pp. 703-726.
- [5] Malczewski J Liu X. Local ordered weighted averaging in GIS-based multicriteria analysis. *Annals of GIS*. 2014. Vol. 20. Pp. 117-129.
- [6] Vatin N I, Gamayunova O S, Nemova D V Analysis of the real estate market of St. Petersburg. *Applied Mechanics and Materials*. 2014. Vol. 638–640. Pp. 2460-2464.
- [7] Brzezicka J, Wisniewski R Translocality on the real estate market. *Land use policy*. 2016. Vol. 55. Pp. 166-181.
- [8] Vatin N I, Gamayunova O S Real estate abroad: how to make the right choice. *Applied Mechanics and Materials*. 2014. Vol. 670–671. Pp. 1612-1615.
- [9] Bolshakov N S, Badenko V L Site selection problem solution using multicriteria analysis and GIS. *Topical areas of fundamental and applied research XI : Proceedings of the Conference. North Charleston, 27-28.02.2017—North Charleston, SC, USA:CreateSpace*. 2017. Pp. 14-21.
- [10] Gilbert A Rental housing: The international experience. *Habitat International*. 2016. Vol. 54. Pp 173-181.
- [11] Femi A B, Khan T H, Ahmad A, Udin A impact of tertiary institutions on house rental value in developing city. *Procedia - Social and Behavioral Sciences*. 2015. Vol. 172. Pp 323-330.
- [12] The New York Times. sharing an apartment with strangers. [Electronic resource]. URL: <https://www.nytimes.com/2017/05/05/realestate/rent-long-island-city-room-share.html> (Date of the application: 05.05.2017)
- [13] Federalnaya sluzhba gossudarstvennoy statistiki [Electronic resource]. System requirements: Microsoft Excel. URL: <http://www.gks.ru/> (Date of the application: 20.08.2017)
- [14] Khusaini Moh A Shift-share analysis on regional competitiveness - A case of Banyuwangi District, East Java, Indonesia. *Procedia - Social and Behavioral Sciences*. 2015. Vol. 211. Pp 738-744.
- [15] Goschin Z Regional growth in Romania after its accession to EU: A shift-share analysis approach. *Procedia Economics and Finance*. 2014. Vol. 15. Pp 169-175.
- [16] Billings S B, Johnson E B The location quotient as an estimator of industrial concentration. *Regional Science and Urban Economics*. 2012. Vol. 42. Pp 642-647.
- [17] Morrissey K Producing regional production multipliers for Irish marine sector policy: A location quotient approach. *Ocean & Coastal Management*. 2014. Vol. 91. Pp 58-64.
- [18] Berawi M A, Zagloel T Y, Miraj P, Mulyanto H Producing alternative concept for the trans-sumatera toll road project development using location quotient method. *Procedia Engineering*. 2017. Vol. 171. Pp 265-273.
- [19] Trappey A, Trappey C V, Liu P, Hsiao C-T, Ou J, Chen K Location quotient EIO-LCA method for carbon emission analysis. *Concurrent Engineering Approaches for Sustainable Product Development in a Multi-Disciplinary Environment*. Springer London. 2013. 367-377.
- [20] Sun H, Shao R Herfindahl index applied to Fourier analysis. *Digital Signal Processing*. 2009. Vol. 19. Pp 726-730.
- [21] Yiğit I, Tür S Relationship between diversification strategy applications and organizational performance according to Herfindahl Index Criteria. *Procedia - Social and Behavioral Sciences*. 2012. Vol. 58. Pp 118-127.

- [22] Mikulić J (2007). The Kano Model – A Review of its Application in Marketing Research from 1984 to 2006. Proceedings of the 1st International Conference of Marketing Theory Challenges in Transitional Countries. Maribor: The Institute of Marketing at the Faculty of Economics and Business University of Maribor
- [23] Lab Gesti Tec ABC Dept Politecnico di Milano. Analisi e strumenti per un territorio attrattivo. Ricerca n°05/2016, Milano : Assolombarda Confindustria Milano, Lodi, Monza e Brianza, 2016.