

# Engineering in Public Administration

**Ass. Professor Tereza Todorova Todorova-Sokolova, PhD**

Faculty of Management, Department of Economics, Industrial Engineering & Management

Technical University

Sofia, Bulgaria

e-mail: [terezat@tu-sofia.bg](mailto:terezat@tu-sofia.bg)

**Abstract — Industrial Engineering is occupied with design and improvement of complex systems consisting of people and other resources. Its methodological tools, principles and techniques are the basis for effective function and management of the industrial enterprises. On the other hand, its implementation in the public administration and practice of non-manufacturing organizations in Bulgaria is very limited. Still, the opportunities that engineering provides about the optimization of processes and systems remain underestimate. Using engineering approach is less known in the public area and that is the reason for missed benefits and missed advantages in management.**

The article discusses the possibilities to assist the management in complex and high-risk management decisions concerning important issues and problems of the public sector through the implementation of well-known in the engineering and widely implemented in the practice of the business organizations method called "Center of gravity".

**Keywords — engineering, Center of Gravity Method, public administration, infrastructure, administrative-territorial and territorial units, decentralized and devolved administration**

I. VERY DIFFICULT AND MANY ALTERNATIVE SOLUTIONS FOR SELECTION OF LOCATION

The most important trends in the economy which modern organizations have to consider [4] are:

- globalization of the markets,
- increasing customer requirements, preferences and desires regarding products (goods and/or services)
- uneven distribution and concentration of financial and material resources
- increasing intensity of competition
- fast appearance and introduction of technological changes in production and in management
- key importance of knowledge and information assurance
- demographic changes creating a discrepancy between vacancies and suitable professionals having the necessary qualifications and experience

- environmental challenges relating to pollution and depletion of resources

- change of the value system expressed in different lifestyles and expectations of the staff, customers and society in general.

These factors make the decision making in management more difficult, multivariable, and requiring an objective assessment of the status and precise analysis of the situation.

## A. Industrial enterprise, positioning of the business

The selection of location of the industrial enterprise and the positioning of the business is one such decision. The selection of the location of an industrial enterprise is based on investigation of variety of options searching for an opportunity to refine the assessment and selection. This selection is affected by increasing number of factors. Until recently, most significant importance was attributed to the production costs, logistics and labor costs. Nowadays the quality of life, the opportunity to hire highly qualified staff, the environmental and other additional factors become more important [3].

The positioning of the organization and its production influences the strategic decisions based on "universal stages" in solving multivariate problems: analysis of the problem, development of alternative solutions, assessment and selection of a decision [3].

Many methods for selection of location of industrial enterprise follow these stages.

One of the most popular methods for assessment of the investigated variants of an industrial enterprise and selection of the final variant the method called "Center of gravity".

## B. Administrative-territorial and territorial units, establishment of administrative and specialized structures of the central institutions

The establishment of administrative-territorial and territorial units in Republic of Bulgaria, as well as the administrative and territorial changes are governed by the "Law of Territorial Administration of the Republic of Bulgaria" (LTARB) [5]. The change of the borders of an area is performed on the base of the borders of the existing municipalities with decree of the President of the Republic of Bulgaria by proposal of the Council of

Ministers. Establishing a new area requires consideration of a number of factors:

- physical and geographical characteristics of the territory;
- existence of a city that is a traditional, cultural and economic center with developed social and technological infrastructure;
- transport network making accessible the surrounding populated places.

The importance of the decisions in the above-mentioned cases require references and compliance with the normative and legal framework in the country and precise selection according influencing factors, required results and expected effects. The planning and development of a territorial structure requires solving of multivariate problems and reliable tools providing opportunities for modeling and optimization.

### C. Infrastructure, location of the infrastructure and positioning of the equipment

Looking at the various definitions of the infrastructure we can conclude that it appears as a general condition for the proper functioning of the industrial process and life activity of the population [1].

Free market economy raises difficult questions related to the establishment and development of economic infrastructure. This establishing is closely linked to the development of production which in turn creates new industries maintaining adjoining sectors and activities, and the growth of labor productivity liberates increasing public resources for services of the population.

Therefore, infrastructure development is a result of development of the productive forces of society, and its content is determined by the internal economic unity and function of the various production sectors. In this process the relationships and dependencies between the main and auxiliary industries became stronger.

A fundamental requirement of the global world is the continuous improvement of quality of goods and services. The implementation of new technologies in the industrial enterprises requires subsequent development of main systems of production infrastructure Fig.1 [1].

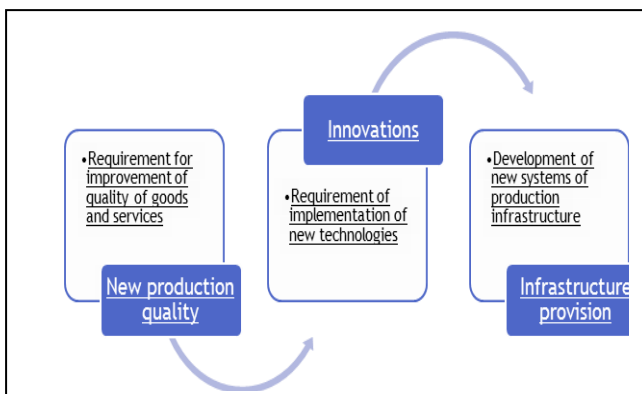


Fig. 1. Development of infrastructure (adapted by [1])

The development of production requires and influences the development of infrastructure which in turn provides the foregoing and helps in searching for additional methods for complex development and increase of the added value of the product.

When planning the future development of the economic infrastructure, particular attention is paid to the information of the state of industrial enterprises and opportunities of infrastructure systems to meet their needs.

- determination of the branch or production link between the objects for complex use of raw material base of the industry, processing of by-products and use of waste products
- determination the optimal distances to raw material companies
- use of nonproductive land, treeless areas and areas occupied by bushes and useless plants
- maximal integration of industrial, processing and service activities and manufacturing infrastructure
- complex use of existing and developing transport installations or installations built for other needs, combining roads, railways, bridges, overpasses, etc.
- provision of additional road connections outside urban areas in industries and businesses based on road transportation
- future expansion of the object
- future development of the transportation network
- protection of the environment
- provision of drinking and industrial water supply
- provision of electricity.

The preparation of investment projects representing a procurement, the assignment follows the regulations of Public Procurement Law according to the requirements and provisions in Section III: "Establishing, announcement and approval of development plans" of Chapter 7 of Law on Territorial Structure.

The positioning of infrastructure objects and the optimizing of the placement of the installations are an important element of infrastructure assurance of the economic system as well as of efficient construction and infrastructure development. Management decisions regarding the selection of location should be based on a careful analysis assured by appropriate methodological tools.

II. OPTIMIZATION OF THE CHOICE OF LOCATION BY USING THE "CENTER OF GRAVITY" METHOD

A. Principle of the method

This method represents a mathematical technique used to find the location of the "center of gravity" where the placement of the industrial enterprise is associated with minimal cost of distribution of products to customers, markets, regional stores or distribution centers. The method takes into consideration the location of the customer enterprises, the markets, the volume of production sent to these markets and the cost of delivery of production. The costs are treated as a linear function of the distance and the volume of transported goods.

Applied to the establishment of administrative and specialized structures of central seats or to the construction of infrastructure objects and installations, the method could take into account the distance of the administrative center/specialized division from various populated places, the infrastructure provision, the size of the population, current and potential users/customers of the object or installation and other considerations and requirements (discussed in the previous section) about determining the location of the center/object.

The aim of the method is to select the best location of the site in – industrial enterprise, central store, service organization, state and/or municipal administration, infrastructure installation – providing certain products (goods and/or services) to existing businesses, consumers, markets, regional stores, distribution centers and users in different geographical points (in different locations) called "centers of distribution".

This method uses an appropriated scaled geographic map to mark the locations of the "centers of distribution". The coordinates of each "distribution center" are specified in a coordinate system as well as the coordinates of "center of gravity" in question where an enterprise or central store is supposed to be established (administrative center or infrastructure object).

B. Application of the method

The method is applied in the following steps:

1) The existing locations are marked on the coordinate system. The center of the coordinate system and used scale are random but the distances are scaled appropriately.

2) The coordinates of the "center of gravity" are determined.

a) If the volume of transported goods\* is the same in each direction, the coordinates of the center of gravity are calculated as mean values using the formulas (1) and (2):

$$C_x = \frac{\sum_{i=1}^I d_{x_i}}{I} \quad (1)$$

$$C_y = \frac{\sum_{i=1}^I d_{y_i}}{I} \quad (2)$$

where  $C_x$  is x coordinate of the center of gravity;  
 $C_y$  – y coordinate of the center of gravity;  
 $d_{x_i}$  – x coordinate of location i;  
 $d_{y_i}$  – y coordinate of location i;  
 $I$  – number of centers of distribution.

\*The "volume of transported goods in directions" could be replaced with other variables – the flow of people in given direction, number of executed orders, number of users, etc.

b) If the volume of transported goods (power / flow rate according the note\*) is different in different directions, the coordinates of the center of gravity are calculated as weighted mean values where weigh coefficients as are volumes of transported goods in every direction using the formulas (3) and (4):

$$C_x = \frac{\sum_{i=1}^I d_{x_i} \cdot W_i}{\sum_i W_i} \quad (3)$$

$$C_y = \frac{\sum_{i=1}^I d_{y_i} \cdot W_i}{\sum_i W_i} \quad (4)$$

where  $W_i$  is the volume of raw materials and other elaborated products (\*number of people, volume of consumption of the product provided by an infrastructure object, etc.) transported to or from location i.

3) Determination of the actual location of the industrial enterprise or central store (object in question being an administrative center or infrastructure object). It should be as close as possible to the localized "center of gravity" and to the nearest populated place (for an administrative center - according to the legislative requirements, for infrastructure project – according to the legal, sanitary, environmental requirements and standards).

C. Illustration of the application of the method

Because of the increasing number of residents of the town X it is necessary to be modernized and replaced the existing central post office. Since all parcels (sent and received) to/from the seven existing regional offices in the city pass through the central office, the new location of the central office is important. Use the data in Table 1. to determine the new location of the central office by using the method "center of gravity".

Answer:

TABLE I. DATA FOR REGIONAL POST OFFICES

Regional post offices	Coordinates		Number of transportation courses/day
	x	y	
Area A	10	5	3
Area B	3	8	3
Area C	4	7	2
Area D	15	10	6
Area E	13	3	5
Area F	1	12	3
Area G	5	5	10

1) Existing locations are situated in the coordinate system Fig.2.

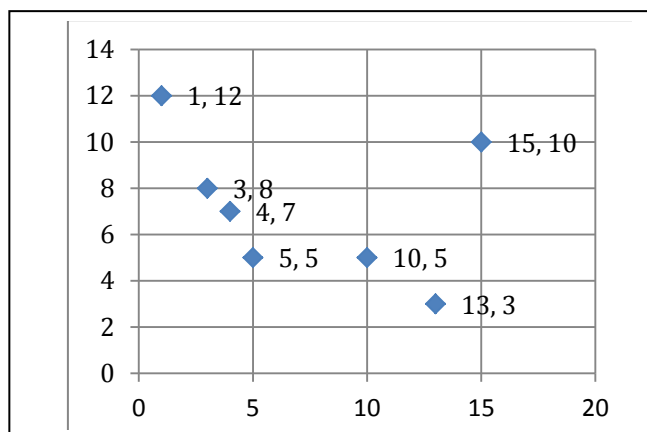


Fig. 2. Existing locations

2) The coordinates of the "center of gravity" are calculated according to (3) and (4):

$$C_x = \frac{10 \cdot 3 + 3 \cdot 3 + 4 \cdot 2 + 15 \cdot 6 + 13 \cdot 5 + 1 \cdot 3 + 5 \cdot 10}{3 + 3 + 2 + 6 + 5 + 3 + 10} = \frac{255}{32} \approx 8$$

$$C_y = \frac{5 \cdot 3 + 8 \cdot 3 + 7 \cdot 2 + 10 \cdot 6 + 3 \cdot 5 + 12 \cdot 3 + 5 \cdot 10}{3 + 3 + 2 + 6 + 5 + 3 + 10} = \frac{214}{32} \approx 7$$

The resulting location has the following coordinates:  
 $x = 8$  and  $y = 7$

3) The most appropriate location of the central post office is found by superimposing a geographic map on the graphic Fig.3.

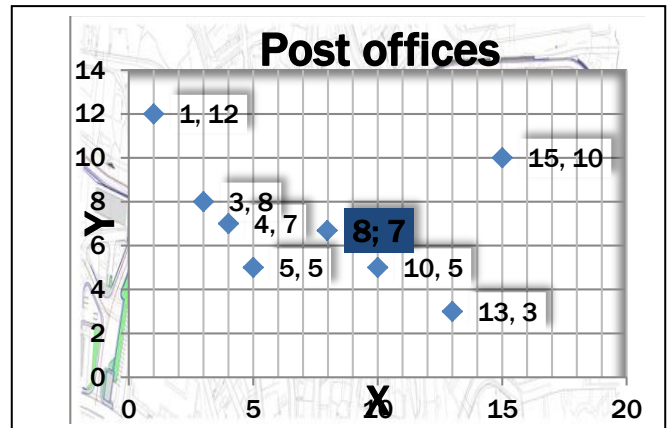


Fig. 3. Location of the post offices

#### CONCLUSION

Using an engineering approach in the administrative and business management practice for resolving business, administrative and infrastructural problems regarding industrial process, establishing favorable living conditions and administrative and infrastructural provision of the population is associated with a number of advantages and benefits.

#### REFERENCES

- [1] Ениманев, К. (2014). *Инфраструктурна осигуреност на устойчивото развитие* (Doctoral dissertation, Варненски свободен университет „ЧЕРНОРИЗЕЦ ХРАБЪР“, Варна, България). Retrieved from [http://www.vfu.bg/doktoranti/doktor\\_na.../krasimir\\_enimanev/avtoreferat.pdf](http://www.vfu.bg/doktoranti/doktor_na.../krasimir_enimanev/avtoreferat.pdf)
- [2]. Ениманев, К. (2007). *Териториално устройство и инфраструктура*. С: "ПЕТЕКСТОН".
- [3] Лефтерова, Т. (2009). *"Ръководство за упражнения по Инженеринг II (Индустиален инженеринг"*. София: "СОФТТРЕЙД". ISBN 978-954-334-085-9
- [4] Тодорова-Соколова, Т. (2014). *Управление на проекти и процеси*. София: "СОФТЕРИД"; ISBN 978-954-334-165-8
- [5] *Закон за административно - териториалното устройство на Република България*. (2015, July). Retrieved from [http://www.mrrb.government.bg/...](http://www.mrrb.government.bg/)