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ASSESSMENT OF INVESTMENT OPPORTUNITIES FOR DISTRIBUTION CENTER LOCATION IN POLAND

Jacek KARCZ

WSB University in Dąbrowa Górnicza; karczjacek@gmail.com, ORCID: 0000-0003-3050-5790

Purpose: Main reason to write the paper is to show one of possible models in market research for choosing the macro area for location of distribution center. There is lack of such researches in the research studies so it's worth to show different perspectives that are also used in real logistics business.
Design/methodology/approach: The approach to the topic is to present and introduce the theoretical value of the topic with an analysis of the literature to then conduct empirical research. Main methods used for research were Mixed Methods between Observation, Secondary Data Analysis and Experiments. The goals of the article have been achieved through the scientific study conducted.
Findings: The main results developed in the article are concerned with measuring the attractiveness of Poland's regions for investment in creating a goods distribution center for a logistics operator. The analysis model can be used secondarily to analyze other, arbitrarily selected regions.
Research limitations/implications: The research conducted in the course of preparing the publication addresses several key factors, selected by the author. Further research may consider other aspects, factors or may be expanded to include additional factors to deepen the analysis. The research may also be part of the contribution or research part to the creation of a universal model for distribution center location choices.
Practical implications: (if applicable) What outcomes and implications for practice, applications and consequences are identified? How will the research impact upon the business or enterprise? What changes to practice should be made as a result of this research? What is the commercial or economic impact? Not all papers will have practical implications.
Social implications: The research is 100% focused on practical use and application. For logistics operators looking to expand their business, especially in Poland, it provides a starting point for analysis and strategic decision-making within the location of their base of distribution facilities. A limitation is the access to data on demographics and especially considering the level of earnings of operational employees, which is difficult to estimate for a general model due to the lack of specific business assumptions about the scale of operations.
Originality/value: The novelty of the article and the study is the attempt to approach universalization in terms of identifying factors and aspects that are relevant and can be applied to the selection of locations for freely chosen and compared regions, not only the level of provinces as in the case of the study developed in the article.

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Keywords: Assessment of investment in logistics, distribution centers, distribution center location analysis, investments in logistics, location for distribution center.

Category of the paper: market research.

1. Introduction

It is impossible to disagree with the statement that logistic centers and distribution centers are an important elements of the economy of each country. On the one hand, they are quite a key factor for economic development, which has an impact on the systematization of the flow of goods, influencing the increase in the efficiency of logistics channels. On the other hand, logistics centers affect the development of cities and even the region in which they are built and for which they perform various service functions (Kaźmierski, 2012).

The literature on the subject indicates many definitions that describe, characterize what logistic centers or logistics distribution centers are, but does not pay too much attention to the definition of a distribution center. Due to some volume limitations for this material, there is no reason to deal with all terms related to the distribution center, but it would make sense to focus on the most important elements of them.

Regardless of the above, however, it should be clearly indicated that there are several concepts related to distribution that refer to infrastructure facilities and are a kind of buffers for transported goods. These terms are: logistics distribution center, logistics center, warehouse center, warehouse facility, logistics service center and distribution center (Grabiński, 2015). As mentioned earlier, for this material there is no particular justification for detailed attention to each of them, therefore the attention will be focused only on the concept of "distribution center".

2. The place of the distribution centers in logistics processes

Distribution centers are centers of concentration and coordination of logistic services. Their goal is to ensure an integrated, time-saving and cost-effective organization of the physical flow of products, from manufacturers to users. Their basic tasks come down to:

- planning,
- effective implementation of transport between contractors,
- ensuring the proper technique and technology of reloading,
- ensuring proper storage of stored goods, forming load units,
- ensuring communication, as well as an appropriate flow of information,
- offering consulting services within the above-mentioned areas (Czubata, 2001).

On the other hand, according to newer trends, distribution centers are described as an independent economic entity in which products and components are collected and stored, or one or several producers, for further redistribution to: wholesalers, dealership warehouses, importers, partner companies or other subordinate entities (Markusik, 2010).

Anglo-Saxon literature reduces the concept of a distribution center to a facility, often smaller than a company's central warehouse, which is used for the temporary assembly and distribution of goods, hence the term distribution warehouse. It can also be assumed that the distribution center is a spatial object with an organization and infrastructure appropriate for this type of facility, located in such a way as to enable the economic entity to store, handle goods, and to coordinate transport, in order to meet the needs of recipients, in the shortest and lowest time. cost – as far as possible (Grabiński, 2015).

Although the subject of this material is not logistics centers, but distribution centers, it is worth being aware that the conditions for creating a distribution center can be related to the same factors based on the theory of location that apply to a logistics center, especially in the context of investment and economic aspects.

Thus, the precursor of the location theory was J.H. Thunen, who developed the most economically viable layout of agricultural zones around the city, which was to be an outlet for agricultural products. As part of the developed strategy, he created a graphic model that showed the distribution of various types of agriculture around the market, which was located centrally (Dziekoński, 2014). Thunen, however, used concepts related to agriculture and only Alfred Weber was a pioneer when it comes to the theory of industrial location. According to the definition presented by him: „location factors should be understood as strictly defined benefits occurring when an economic activity is located in a given locality. This advantage is savings on production costs. Achieving it is connected with the fact that the activity is located in a given locality is carried out at a lower cost than if it took place in other places" (Grabiński, 2015).

Interestingly, Weber distinguished only three location factors, namely: transport costs (considering them the most important at the same time), labor costs and agglomeration benefits, which result from the concentration of producers and consumers in a certain area. Weber's theory referred to the turn of the nineteenth and twentieth centuries, with time the evolution of the economy and technology modified, and thus developed the concepts of location factors and their number. Currently, the location factors should be defined as economically specific features that affect the amount of capital expenditure and production costs of localized objects, therefore the costs that change as a result of changing the location. It follows, therefore, that location factors are the most important issue for an enterprise, because it is they who determine the scale of the investment outlays and costs incurred (Budner, 2007).

The group of theories, the purpose of which is to determine the best location, taking into account only such factors as: prices of raw materials, energy, transport costs, labor factor, etc. are called classical theories. They are based on the belief that production costs and profits depend on the geographic location, then the choice of location is associated with the desire to maximize profit (Grabiński, 2015).

Currently, the literature on the subject defines location factors as: "specific features of individual places, having a direct impact on the investment outlays in the plant construction phase and the net profitability of economic activities carried out in these places". When it comes to the real benefits of location, it is mentioned:

- investment outlays related to the purchase of land and utilities,
- investment outlays related to the constructed facility,
- facility operating costs,
- revenues generated by a given unit,
- gains and losses that affect net profitability that arise from running the business.

Due to the fact that the cited definition is definitely universal, it becomes possible to use it and refer to it universally (Grabiński 2015).

Although the location factors are divided into several groups and subgroups (e.g. environmental factors, economic and technical factors, socio-political factors, environmental factors, spatial factors, legal and administrative factors, etc.), economic. These factors result from the socio-economic situation of a given area. They consist of such elements as: inflation, unemployment rate, GDP per capita, but also the size and absorption of the sales market or the size and structure of capital (Grabiński, 2015). As I. Kędra and J. Borowiak argue, the main factors of choosing a location within economic factors remain:

- value of the logistics market,
- attractiveness of the investment project for investors,
- land prices and availability,
- availability of transport and communication infrastructure,
- availability of labor and the level of education of employees,
- purchasing power of the population.

It is worth emphasizing that factors such as environmental damage caused by road transport, unused transport potential of rail transport or road overload, road congestion, etc. are not of particular importance for the investor, as long as there is no state intervention resulting from legal or financial regulations that significantly cost relationships that occur between the various modes of transport (Jędra, Borowiak. 2010).

3. Methods and ways of selecting the location of logistics facilities

All the theories of location that have appeared over the years in the literature on the subject, however, do not serve to describe hypothetical situations, but constitute the basis for the development of mathematical models of the location of objects that can be used by managers when making decisions about the location of new objects or changing the location of these objects. objects that already exist. The basis for the decision is the location of the company's facilities, which optimizes the performance of the value chain (Dziekoński, 2014).

In line with the way models are presented in the literature on the subject, they are usually classified into four main categories:

- analytical models that use a significant number of simplifying assumptions. In this type of models, an even demand in the analysed, selected area is assumed, as well as fixed costs of locating objects (regardless of their location) and a constant unit cost of transporting products. It should be noted that the total cost function takes a closed form, which is most often a function related to the number of objects placed. Analytical models provide information on the relationship between the optimal total cost and the number of objects on the one hand and key input parameters on the other. The assumptions that are made in the analytical models limit their value in the practical making of location decisions;
- space continuity models, which assume that the objects to be located may be located anywhere in the analysed space, while the demand is in specific places. In this case, the problem is to determine the location of the facility in such a way as to minimize demand-weighted transport distances;
- network models which assume that in order to determine the location of an object, a network consisting of nodes and connections between them should be built. In this case, the demand is most often generated in the network nodes. At the same time, the network is used to create an algorithm that is dedicated to a specific location problem;
- discrete models that assume that it is possible to define a specific set of places that make up the demand, as well as a set of potential locations. In this case, the problem of object localization is described with the use of linear programming tools.

By the way, it should also be noted that the methods that enable the proper selection of the location of the new facility include, among others: non-hierarchical cluster analysis methods, the Huff model, the radius of the catchment area, network methods or Reilly's trade gravity models (Dziekoński, 2014).

The literature on the subject more and more often points to the fact that when determining a location, quantitative rather than qualitative factors are taken into account. Of course, this has to do with the development of mathematical methods, including optimization, as well as the wider use of IT applications such as DSS or BI (Grabiński 2015).

Undoubtedly, Grabow, Henckel and Hollbach-Grömig presented one of the fullest divisions of location factors, including the division into hard and soft. For this material, the so-called hard factors. They belong to the group of measurable, economic factors defined as objective. They are called objective because they have an indisputable nature, therefore, the use of such input data for statistical analysis or optimization models allows for obtaining an unambiguous result (Grabiński, 2015).

Undoubtedly, the issue of localization in the classical approach, mentioned above, is much more often undertaken due to the essence and possibility of obtaining a mathematical result. At the same time, it is most desirable to use a precise cost analysis related to the planned distribution as well as a financial analysis related to the planned investment. Only a thorough analysis can generate additional savings as well as ensure the efficiency and flexibility of the logistics system. This, in turn, has an impact on the implementation of benefits for customers at the right time, place and in the right quantity and quality, at an acceptable cost (Grabiński, 2015).

Location factors can be divided into three groups: industry location factors, service location factors, and logistics network node location factors. It should be noted that there are several important factors that affect the choice of the best location for the distribution center. The center of gravity method is used for this (Grabiński, 2015). This method (widely described in specialized literature) uses the geographical location of individual sending and receiving points within geographic coordinates as well as the volume of supply and demand at points in the network. In this specific case, optimization consists in selecting a location point for the facility that will guarantee the minimization of the costs of transporting the delivery of raw materials, semi-finished products or goods to the facility, and on the other hand, the export of finished products from the facility. It is true that the choice of location should not be a single-criteria decision, but if the investment conditions in a given geographical area are similar, the choice of location may determine the distance of the created storage location from the sources of supply and to future recipients. Therefore, it can be concluded that the main problem of choosing a location will be to determine such dislocation of the object so that the total transport costs are the lowest, while taking into account the rectangular and Euclidean metrics (Kuczyńska, Ziółkowski, 2012).

The balanced center of gravity method is simple to apply and it really comes down to determining two parameters, assuming that you have the appropriate data concerning the geographical location of suppliers and recipients, the amount of the unit cost of transport as well as the estimated quantities of raw materials and finished products transported (Kuczyńska, Ziółkowski, 2012).

As D. Grewal and V. Thai argue, it has the greatest influence on the decision on the location of the distribution center:

- distance from the audience,
- availability and education of the workforce,
- availability of communal services,
- local taxes, especially on inventories,
- road transport infrastructure,
- opportunities for further expansion,
- customs and tax administration and applicable law in this area,
- standard of living in the region

and

- equipping with appropriate operating devices,
- percentage of lost or damaged parcels,
- convenience and reliability of downloads and deliveries,
- frequency of calls or adequately landings at the port,
- efficient operation of the seaport/airport,
- strategic location,
- competitive fees and taxes,
- speed and adequacy of the response to the needs and requirements of customers.

Of course, you should be aware that the set of criteria presented above is only one of the existing examples in the literature for a comprehensive, holistic approach to the issue of choosing the most convenient location for a distribution center (Grabiński, 2015).

4. Analysis of the selection of the location of the distribution center in Poland

In order to build a holistic view on the topic of siting decisions for distribution centers, you should also look at the practical side. The analysis in this respect also shows that the people responsible for implementing projects related to the location of the distribution center make decisions taking into account a certain pattern of factors. Especially when it is not possible to implement the aforementioned "gravity center" analysis – e.g. due to the lack of unambiguous data on flows – creating a new distribution center for the emerging market.

The author's aim was to define investment opportunities as part of the construction of a distribution center by an external logistics operator. The main objective of the study was to verify which or which regions of Poland can be considered the most favorable to investments in the construction of the distribution center mentioned. The idea behind the distribution center was to create a multi-user warehouse with an area of 10,000 to 20,000 square meters. The term "multi-user" is understood as an object created, managed and operated by an external logistics operator. As part of the activity in a given facility, logistic operations and distribution may take place for several (up to 10) different customers. There is no significance as to the industries or the specifics of the goods served. The average operating area occupied by each client varies from 1,000 to 4,000 square meters of the distribution center facility. Such a distribution center is often set up by a logistics operator on a speculative basis. The first stage is operational launch, and only then is the search for principals for logistics services. Thus, the choice of location is one of the key elements in the process of creating this type of business.

As part of the research, 16 Polish voivodeships were identified as macroregions, potential places of investment implementation. The research was based on the data available from the Central Statistical Office. Each of the voivodships was analyzed in terms of the following factors:

- Gross Domestic Product.
- Gross value added by type of activity and region.

The next stage of the analysis was to identify the most important industries in terms of the attractiveness of the customer sector for the logistics operator. For this purpose, historical data obtained directly from logistics operators in the most frequently served industries was used. Based on the analysis of the survey responses, the two most frequently emerging industries were identified:

- Manufacturing – section C according to Polish Classification of Activities.
- Wholesale and retail trade – section G according to Polish Classification of Activities.

Then, the gross value added by specific two activities for 2017-2019 for each region was summed up.

The next step was to determine the cumulative annual growth rate for individual regions - voivodships and selected industries. This element of research made it possible to define the first preliminary ranking of voivodships in terms of growth dynamics.

Next, the share of the Gross Domestic Product indicator for 2019 was calculated as the last available for a given voivodeship in the value of this indicator for the entire country.

Table 1.
Voivodship attractiveness index in terms of added value of selected industries and Gross Domestic Product

	2017 [mln PLN]	2018 [mln PLN]	2019 [mln PLN]	CAGR	CAGR - RANK	Weight in 2019 on PL GDP	Weight in 2019 on PL GDP - RANK
Poland [total]	676969	718703	771847	-	-	-	-
Dolnośląskie	59999	62097	66680	5,42%	14	8,64%	4
Kujawsko-pomorskie	34032	36860	38744	6,70%	7	5,02%	8
Lubelskie	23450	24254	26204	5,71%	12	3,39%	10
Lubuskie	16526	17667	18673	6,30%	9	2,42%	13
Łódzkie	42651	45319	49062	7,25%	5	6,36%	6
Małopolskie	51994	55359	58756	6,30%	9	7,61%	5
Mazowieckie	124284	133797	146011	8,39%	1	18,92%	1
Opolskie	15121	16203	17173	6,57%	8	2,22%	15
Podkarpackie	30493	32853	35497	7,89%	2	4,60%	9
Podlaskie	14667	15607	16960	7,53%	3	2,20%	16
Pomorskie	40106	42635	45785	6,85%	6	5,93%	7
Śląskie	88840	94158	98997	5,56%	13	12,83%	2
Świętokrzyskie	16032	17242	18064	6,15%	10	2,34%	14
Warmińsko-mazurskie	17963	18559	19841	5,10%	15	2,57%	12
Wielkopolskie	77744	82013	89534	7,32%	4	11,60%	3
Zachodniopomorskie	23067	24080	25866	5,89%	11	3,35%	11

Source: Own study based on data from the Central Statistical Office.

Based on the analyzed data (Table 1), 6 voivodeships were selected for further analysis, which, taking into account both factors, taking into account the weight of over 50% for the GDP factor, are potentially the best investment option: Mazowieckie, Śląskie, Wielkopolskie, Małopolskie, Dolnośląskie and Łódzkie.

For the selected six voivodships, three main currents of soft factors were identified as the next step of the analysis along with their detailed specification and giving importance to each of the detailed levels (Table 2). All factors were defined on the basis of direct information obtained through interviews with logistics operators. Among them are defined:

- Target market – number of potential customers in industries (less important), type of target market (significant), competition in the form of similar distribution centers (rather important) and the availability of local workforce (very important),
- Details about potential customers – type of customer, type of desired logistics service, customer size, type of means of transport used for supply and target distribution (all as less important),

Infrastructure in the vicinity of the Distribution Center - availability of warehouse space (less important), quality of transport infrastructure in the immediate vicinity (less important), the possibility of developing the current location in the future (most important).

Table 2.
Soft factors for the analysis in terms of the attractiveness of selected voivodships

Macroarea	Guideline	Subject	Weight
Market	Target markets	Spare parts	Less important
		Machinery	
		Steel	
		Components	
		Finished products	
		Automotive	
		Electronics	
		Dry food and beverages (DF&B)	
		Fast moving consumer goods (FMCG)	
	Type of final market	E-commerce (E.g., Amazon)	Important
		Wholesale	
		Industry	
	Composition of the business of local market	High vs. low competition	Slightly important
	Ability to access local labor market	Complex vs. easy local labor market situation	Very important
Customer	Type of customer	Presence of producer clients	Less important
		Presence of seller clients	
	Type of activities	Storage only	Less important
		Easy handling	
		Value added services	
	Presence and size of clients	Level of small clients' presence	Less important
		Level of medium clients' presence	
		Level of big clients' presence	
	Type of inbound transports	Intermodal transport	Less important
		FTL road transport	
		Groupage	
		Air & Ocean	
	Type of outbound transports	Intermodal transport	Less important
		FTL road transport	
		Groupage	
		Air & Ocean	
Infrastructure	Warehouse availability	Areas with or without warehouses	Less important
	Transportation infrastructure	Presence of ports, roads' connections	Less important
	Location evaluation	Location evaluation based on clients/industry needs	Extremely important

Source: Own study.

Each factor was rated on a scale from 1 to 5 for each voivodeship. The scale reflects a factor that fully corresponds to the presence in a given voivodship (5) or not at all (0). This part of research was made with assumptions of own research done by author in accordance with interviews done with logistics operators.

Table 3.
Scoring factors for each voivodeship

Subject	Mazowieckie	Śląskie	Wielkopolskie	Dolnośląskie	Malopolskie	Łódzkie
Spare parts	1	4	4	2	2	2
Machinery	1	4	3	4	3	3
Steel	2	5	3	3	4	2
Components	3	4	4	4	3	4
Finished products	5	4	4	4	4	5
Automotive	0	5	4	4	3	2
Electronics	2	2	3	4	1	4
Dry food and beverages (DF&B)	5	3	4	3	4	3
Fast moving consumer goods (FMCG)	5	4	4	4	4	4
E-commerce (E.g., Amazon)	5	5	4	5	4	5
Wholesale	3	5	5	4	3	5
Industry	3	5	3	3	3	4
High vs. low competition	1	0	2	1	4	3
Complex vs. easy local labor market situation	2	2	1	1	4	4
Presence of producer clients	1	5	4	3	3	4
Presence of seller clients	5	5	4	4	4	4
Storage only	4	4	4	4	3	4
Easy handling	4	4	3	4	4	4
Value added services	5	5	4	5	5	4
Level of small clients' presence	4	5	4	4	3	5
Level of medium clients' presence	3	4	4	3	3	4
Level of big clients' presence	1	3	3	4	2	2
Intermodal transport	5	3	5	1	0	3
FTL road transport	5	5	5	5	4	5
Groupage	5	5	5	5	5	5
Air & Ocean	2	1	0	0	2	3
Intermodal transport	5	3	5	1	0	3
FTL road transport	5	5	5	5	4	5
Groupage	5	5	5	5	5	5
Air & Ocean	2	1	0	0	2	3
Areas with or without warehouses	3	3	3	2	0	4
Presence of ports, roads' connections	3	4	3	4	3	5
Location evaluation based on clients/industry needs	4	4	3	5	3	5

Source: Own study.

Next step of research was to assigned each factor in significance according to the assumptions: less significant – 0.5; rather important – 0.75; significant – 1 ; very important - .25; the most important – 1.5 (Table 4). This kind of analysis is based on factors described by logistics operators that author made a personal interview with. It's mix of most important factors scored by interviewed logistics operators.

Table 4.
Total assessment of each voivodship taking into account the weight of factors

Guideline	Mazowieckie	Śląskie	Wielkopolskie	Dolnośląskie	Małopolskie	Łódzkie
Target markets	12,00	17,50	16,50	16,00	14,00	14,50
Type of final market	11,00	15,00	12,00	12,00	10,00	14,00
Composition of the business of local market	0,75	0,00	1,50	0,75	3,00	2,25
Ability to access local labor market	2,50	2,50	1,25	1,25	5,00	5,00
Type of customer	3,00	5,00	4,00	3,50	3,50	4,00
Type of activities	6,50	6,50	5,50	6,50	6,00	6,00
Presence and size of clients	4,00	6,00	5,50	5,50	4,00	5,50
Type of inbound transports	8,50	7,00	7,50	5,50	5,50	8,00
Type of outbound transports	8,50	7,00	7,50	5,50	5,50	8,00
Warehouse availability	1,50	1,50	1,50	1,00	0,00	2,00
Transportation infrastructure	1,50	2,00	1,50	2,00	1,50	2,50
Location evaluation	6,00	6,00	4,50	7,50	4,50	7,50
Total	**65,75**	**76,00**	**68,75**	**67,00**	**62,50**	**79,25**

Source: Own study.

The final analysis of soft factors for selected regions allowed to determine the ranking of voivodeships (Table 5). Based on that it was able to make a final suggestion about best possible location for distribution center for logistics operator. Analysis is based on attractiveness of voivodeships based on assumptions chosen by author.

Table 5.
Ranking of the attractiveness of voivodeships in terms of the location of the distribution center

Region	Mazowieckie	Śląskie	Wielkopolskie	Dolnośląskie	Małopolskie	Łódzkie
Scores	65,75	76,00	68,75	67,00	62,50	79,25
Ranking	**5**	**2**	**3**	**4**	**6**	**1**

Source: Own study.

5. Summary

Based on the presented research, the following ranking of the attractiveness of provinces in terms of building a distribution center can be presented:

1. Łódzkie.
2. Śląskie.
3. Wielkopolskie.
4. Dolnośląskie.
5. Mazowieckie.
6. Małopolskie.

The assumptions adopted in the analyses assume various approaches to the problem. A look from several independent perspectives, both directly statistical – related to the GDP and CAGR indicators, as well as to soft factors, which are often overlooked in scientific studies due to the inability to define them on the basis of interviews with logistics operators. An important aspect that should be emphasized is the fact that the assessment shown in the research is up-to-date for the time it is carried out and that analysis of this type should be carried out in the current cycle before starting the investment project, because the assessments of factors in the currently rapidly changing business environment tend to expire at short intervals.

There are many methods, models, criteria, factors, and selection conditions. Due to the dynamic development of the economy, they are constantly transformed, changed and modified. It is impossible to present all of them, or at least some of them, in this material. It should be borne in mind that the issues raised belong to the general and most important ones, which should affect the reception of the presented topic. This material should rather be a stimulus for further research and exploitation of the topic and as a source of inspiration or comparisons of conclusions in the context of research on the discussed issue.

References

1. Budner, W. (2007). Czynniki lokalizacji inwestycji a możliwość rozwoju ekonomicznego gmin w Polsce. *Acta Scientiarum Polonorum. Administratio Locorum, Nr 6/3*.
2. Czubata, A. (2001). *Dystrybucja produktów*. Warszawa: PWE.
3. Dziekoński, K., Matusewicz, E. (2014). Koncepcje lokalizacji nowego centrum logistycznego w Polsce. *Logistyka, 3*.
4. Grabiński, S. (2015). *Wyznaczanie lokalizacji centrum dystrybucji. Modelowanie z wykorzystaniem systemów geoinformacji*. Poznań: Uniwersytet Ekonomiczny w Poznaniu.
5. Jędra, I., Borowiak, J. (2010). Uwarunkowania lokalizacji centrów logistycznych w Polsce. *Logistyka, Nr 6*.
6. Kaźmierski, J. (2012). Konsekwencje lokalizowania centrów logistycznych w przestrzeni miejskiej. *Problemy Rozwoju Miast, vol. 9, no. 1*.
7. Kuczyńska, E., Ziółkowski, J. (2012). Wyznaczanie lokalizacji obiektu logistycznego z zastosowaniem metody wyważonego środka ciężkości – studium przypadku. *Biuletyn WAT, Vol. LXI, No. 3*.
8. Markusik, S. (2010). *Infrastruktura logistyczna w transporcie*. Gliwice: Wydawnictwo Politechniki Śląskiej.