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Arch. Min. Sci., Vol. 59 (2014), No 3, p. 761–780

Electronic version (in color) of this paper is available: http://mining.archives.pl

DOI 10.2478/amsc-2014-0053

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REGIONAL DIFFERENCES IN DEMAND FOR COAL AS A BASIS FOR DEVELOPMENT OF A PRODUCT DISTRIBUTION MODEL FOR MINING COMPANIES IN THE INDIVIDUAL CUSTOMERS SEGMENT

REGIONALNE ZRÓŻNICOWANIE POPYTU NA WĘGIEL KAMIENNY JAKO PODSTAWA DO OPRACOWANIA MODELU DYSTRYBUCJI PRODUKTU PRZEDSIĘBIORSTWA GÓRNICZEGO W SEGMENCIE ODBIORCÓW INDYWIDUALNYCH

The article presents a proposal of methodology based on the process of relationship marketing, serving to determine the level of demand for coal in the individual customer segment, as well as fuel distribution model for this customer group in Poland developed on the basis of this methodology. It also includes selected results of tests carried out using the proposed methods. These proposals have been defined on the basis of market capacity indicators, which can be determined for the district level based on data from the Polish Central Statistical Office. The study also included the use of linear programming, based on the cost of coal logistics, data concerning railway, road and storage infrastructure present on the Polish market and taking into account the legal aspects. The presented results may provide a basis for mining companies to develop a system of coal distribution management in the locations with the highest demand values.

Keywords: relationship marketing, coal, individual customers segment, demand, market capacity, distribution model

Artykuł przedstawia opartą na procesie marketingu relacyjnego propozycję metodyki służącej wyznaczaniu poziomu popytu na węgiel kamienny w segmencie odbiorców indywidualnych oraz opartej na niej metodyki modelu dystrybucji tego paliwa do tej grupy jego odbiorców w Polsce. Zawarto w nim również wybrane wyniki badań przeprowadzonych z użyciem proponowanych metod. Powyższe propozycje zostały określone w oparciu o wskaźniki pojemności rynku, których wyznaczanie jest możliwe do powiatowego poziomu szczegółowości na bazie danych pochodzących z Głównego Urzędu Statystycznego. Wykorzystano również programowanie liniowe, opierające się na kosztach logistyki węgla kamiennego, danych dotyczących występującej na polskim rynku infrastruktury kolejowej, drogowej i magazynowej

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oraz uwzględniając aspekty prawne. Prezentowane wyniki mogą stanowić podstawę systemu zarządzania przez firmę górniczą dystrybucją węgla w miejsca lokalizacji najwyższych wartości popytu.

Słowa kluczowe: marketing relacyjny, węgiel kamienny, segment odbiorców indywidualnych, popyt, pojemność rynku, model dystrybucji

1. Introduction

In recent years, the extremely rapid development of technology has significantly increased the competitive struggle for markets, resulting in an increase of production efficiency in virtually every industry worldwide. This led to a reduction of production cost per unit. The above process, in connection with increasing globalization leading to the loosening of restrictions on international trade of goods and development of information society, first resulted in rise and then advancing of the supply over demand.

This situation has forced more and more companies to adopt diverse and extensive actions designed on the one hand to increase the efficiency of resource companies in order to reduce the production cost per unit, and on the other to improve their market position by seeking ways to increase revenues. In most cases, two groups of activities are used in parallel to achieve this purpose: restructuring and relationship marketing (Doyle, 2003).

Restructuring can be defined as a group of internal activities. Within these changes, the most commonly used are technical, financial and organizational restructuring. Its purpose is development of an enterprise with clearly defined organizational structures and responsibilities of individual cells and positions (including costs), establishment of efficient and repeatable business processes, planning and implementation, control and motivation algorithm, construction of effective channels for information as well as internal and external communication. These changes result in an increase in the company's resource management efficiency, thus improving its overall situation.

The second set of measures is guided towards philosophy based on deep penetration of the market and finding an attractive purchasing group for the sale of the company's goods, which is achieved by means of properly constructed set of marketing tools in the context of price, promotion and distribution, with a goal to increase sales revenue. This of course must be done in observance of the above-described principles of effective management of the company's resource planning process. In literature, the philosophy behind such action is referred to as relationship marketing, which is the specific group of activities addressed in this article. Using the philosophy of relationship marketing, based on market research and optimizing the strategy of market activities, this article demonstrates how to measure regional differentiation in demand for coal in the individual customers segment in Poland and proposes an efficient product distribution model, taking into account the reported irregularity of demand. Adaptation of the proposed solutions can bring the mining companies significant benefits associated with the general increase in its market competitiveness, ultimately expressed as an increase sales revenues and better use of their resources.

2. The role of relationship marketing in conducting market activities of a modern enterprise

The concept of relationship marketing was created by Grönroos (1984) and developed into its modern formula by Cheverton (2001). The latter recognized this type of marketing as "profitable

building, maintaining and developing of relationships with customers and other partners in the implementation of the mutual objectives of both parties through the exchange of values and the fulfillment of obligations" (Cheverton, 2001). At the time of development of this concept (70s and 80s of the 20th century), it was a groundbreaking philosophy, because it changed the view and the place of customer interests in relation to the standard concept of transactional marketing, functioning on the basis of: manufacturing a product, finding a customer for it, offering the customer a set of tools designed to convince him to buy the product and reaping profit from the sale. The concept of relationship marketing is based on a different algorithm, that is, on cause and effect relation between two groups of activities: market research and the development and implementation of marketing strategy adequate to their outcome. In the second group of activities, the management of at least four functions should be specified within a process of coordinated marketing, creating a comprehensive and uniform system of marketing management known as the 4P (*Product, Price, Place, Promotion*) (Kotler & Armstrong, 2007). It consists of: product, promotion, price and distribution. The key to planning and directing the product to the customer is distribution, in the 4P methodology referred to as *Place*.

As one of the 4P factors, "Place" refers to the distribution and availability. Marketing is an element of effective management of the distribution of the products on the market so that the product is in the right place at the right time, according to the needs of the customers and the appropriate level of costs (Kotler, 2005). Distribution is therefore a set of actions and decisions related to the delivery of manufactured products to end customers. These activities include not only the movement of goods to the places where consumers want to purchase them, but also the provision of goods at the right time, assembling the product range enabling consumers to purchase goods that meet the same need together, and create optimal conditions for the purchase (Kotler, 2004). In the scope of instruments and activities related to distribution, the main element is the distribution channel. Skowronek and Sarjusz-Wolski (2007) understand it as a measure that allows the physical movement of products through the system by which the sale is achieved. It is impossible not to see the strategic importance of distribution channels in this definition. For this reason, an important component of strategic thinking in the organization must be a clearly defined view on delivery channels and expeditionary policy, which should lead to the achievement of the objectives of the organization. For Kotler (2005), the distribution channels include the supply of products to retail outlets and offering these products directly to consumers. They should take into account many factors, such as the location, size and type of retail points of sale, product variety, form of sale and display of goods, forms of service and range of additional services. The main criterion of distribution channels, also important for this study, is the number of entities (cells) that are involved in the process of distribution.

3. The importance of individual customers segment for coal producers and the way it is currently operated by companies in Poland

In the last 20 years, the competitive situation presented above and the way of marketing management with the use of relationship marketing has become relevant to Poland due to its entry into the realities of a free market economy. In many industries the country quickly managed to catch up on decades of development in business and market management style. Unfortunately

however there are still sectors where Poland remains behind in terms of planning and conduct of operations within the system of relationship marketing. One of them is coal mining. While extensive restructuring measures are being applied in this sector since 1992, its market activities are often built in a manner that is incomplete, discontinuous, and often not fully coordinated at the level of ownership (state), and above all without the use of the above described market research model, which allows for better identification of the customer and their needs, and subsequent adaptation of an appropriate action strategy. Multiple voices can still be heard suggesting there is no place for marketing in such a specific sector and that long-term contracts, high barriers to entry as well as high and, according to many, undeniable competitive pricing of this fuel do not require a "marketing service".

Unfortunately, one simply cannot agree with these voices, thus referring to many other experts from closer and more distant past, including Jaśkowski (1998), Jaszczuk and Kania (2008), as well as Bogacz (2009). Coal market is subject to regular rules of the free market, so the product management process should not end on the level of selling it to the next link in the logistics chain. It is especially important because the competitive situation of this product for the Polish manufacturer has undergone a significant, negative change in recent years. Research conducted by Bogacz (2012) shows that the increase in coal production in Eastern Europe and Asia (mainly in Russia) as well as significant improvement of the transport infrastructure in that region and the reloading infrastructure in Poland resulted in a rapid increase in imports of Russian coal. The situation in this area for years 2005-2011 is shown in Figure 1. In order to change this situation, we must begin by analyzing it in terms of both cost for the company as well as revenues, and the possibility of action in the various segments of the coal consumption sector. A collection of these customers is a very large and diverse. This diversity pertains to the different ways of using the product as well as the nature and manner of its purchase by customers.

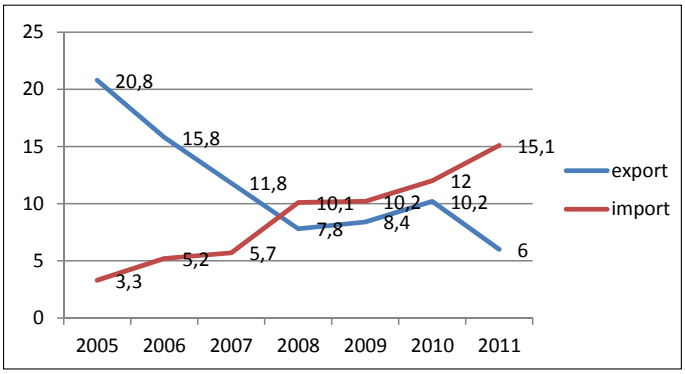

Fig. 1. Import and export of coal to/from Poland (mln Mg)
Source: Bogacz (2012)

One of the target groups for the mining companies comprises the so-called individual customers. This group consists of households, which purchase coal. Overview of the different types of customers of companies from the coal mining industry, taking into account the category of households (hereinafter referred to as individual customers), is illustrated in Figure 2.

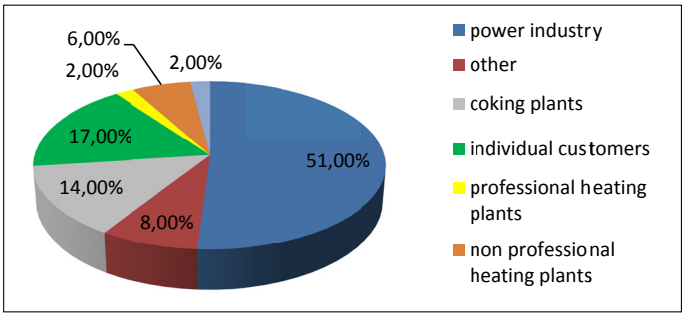

Fig. 2. Quantitative structure of consumers of coal in Poland in 2012 (%)
Source: Developed by authors based on data published by the Ministry of Economy (www.slideplayer.pl/slide/830656) (2014)

As shown in Figure 2, the individual customers market is the second largest sales segment of customers for companies in the coal mining industry in Poland, consuming 17% of their production. It should also be noted that the value share of the individual customers segment of the coal market in Poland is even greater, because the selling prices in this segment are higher than in other segments, resulting in the mining companies' ability to generate the higher profit margins than in other segments of the market. Another reason why this segment should be extremely important for the mining companies is the issue of image. Individual customers are in fact the most opinion-forming customer group for mining companies, influencing their market image through their large number and dispersion.

Observations conducted by Bogacz (2011) and subsequently confirmed by Grabowska (2013), showed that all companies operating in the coal mining industry focused primarily on strategic use of indirect distribution channels in the context of distribution of their products to individual customers. Although they allow them the opportunity to buy directly from the mines, but the terms of such purchases (minimum purchases, contracting rules) clearly indicate that *business-to-business* sales are their imperative in this regard. Within the framework of indirect distribution, coal is sold to consumers through a network of authorized dealers. These are external companies affiliated with the manufacturer with certain conditions of cooperation imposed to a lesser (LW Bogdanka S.A., KHW S.A.) or higher (KW S.A., PKW S.A.) degree. However, these companies do implement their own trade policy and marketing, including product and promotion. The second group, much less associated with mining companies, consists of the so-called trading partners (KW S.A.), dealers (PKW S.A.) or coal holding companies (KHW S.A.), who do not receive any indications from the manufacturer on how to conduct product marketing. The choice of how to conduct this type of distribution is dictated by cost considerations. It is simply the cheapest. It is involves minimal financial commitment while providing market access for the product. On the other hand, low maintenance costs do not sufficiently translate into establishing a market image or brand building. This results in the lack of relevant long-term effects. As shown by data published by the *Rzeczpospolita* monthly, "the amount spent by 2 million Poles on coal in the heating season is by about one billion PLN higher than the annual revenue of KHW S.A." (Baca-Pogorzelska, Łakoma, 2012).

The above data clearly indicates a high development potential for the mining companies' margins and profits, as well as market image, in the individual customers segment. Unfortunately,

as shown above, due to the increased coal imports, mainly from Russia, in conjunction with the not fully effective method of distribution adopted by the mining companies, the marketing potential of this segment is not realized. Considering the above facts and the methodology of relationship marketing presented above, in the remaining part of this article, the authors shall attempt to identify and develop an algorithm for actions which would allow to estimate the quantitative and qualitative value of individual customers segment in Poland by region (doing so at the level of estimate of the capacitive differentiation of the market at the district level), and on this basis put forward a proposal of a basic model of changes in the distribution of coal by a mining company in this market sector. Their proposals are supported by the results of analytical work.

4. Methodology for measuring regional differentiation of demand for coal and the basis for its distribution model in the individual customer segment

4.1. Theoretical basis of the method for measuring regional differentiation in demand

The principal and fundamental element of the proposed measurement method is the establishment of fundamentals, definitions and conditions of use. Implementation of the above indications resulted in a proposal of a measurement method based on effective demand, which is the demand for coal in the segment of individual customers segment in real time expressed in a numeric manner. It should be noted that the following methodology can also be used for calculating the potential demand, which, however, shall be presented in other scientific articles. It was also assumed that this method may be used not only for the purpose of preparation of the mining company's strategy, but also its implementation, supervision and, if necessary, implementation of corrective measures – basically, within the scope of operational works. With usefulness and ease of use of the method in mind, the authors opted to use input data with a high level of availability, published on-line, and updated at least once a year. Thus, the calculations were performer based on figures derived from public analysis of the Polish Central Statistical Office (GUS) and collected by mining companies.

The main indicator the authors propose in order to determine the demand in different regions of Poland using the proposed method is market capacity. According to the methodology of relationship marketing, market capacity can be defined as quantitative and valuable. Quantitative capacity is defined as the amount of particular type of products sold in a particular market (to consumers comprising this market) in a given period of time. Valuable capacity refers to the value of these products (Mruk, 2003). Proceeding from the above definitions, quantitative capacity may be determined by way of calculating these ratios as the product of the number of consumers comprising the market in a given time and the amount of products purchased by them in that time period. In order to calculate the valuable capacity, the quantitative capacity value must be multiplied by the selling price of the product on the market at this time.

Applying the above definitions to the situation prevailing in the market of coal mining in Poland, while also taking into account the methodological assumptions presented above, it was concluded that the quantitative and valuable market capacity indicator shall be calculated based

on the input data collected under the Local Data Bank of the Central Statistical Office (hereinafter referred to as LDB CSO).

Before proceeding to description of the various components of market capacity indicators, the authors would like to point out that the terms: "individual customer", "household" and "inhabited dwelling" are used interchangeably in the remaining part of the article. As mentioned earlier, the concept of "individual customer" is a term used by the mining companies to describe household coal buyers. The following proposals followed the logical assumption that households inhabit dwellings, which thus results in full interchangeability of the two categories in relation to the same subject matter. In order to fully confirm this assumption, Pearson's correlation analysis was performed of the number of inhabited dwellings and households in each province of Poland using data collected during Census of 2002 (CSO, 2003), which marked the last time the CSO collected parallel data for households and dwellings. The correlation coefficient obtained on the basis of these calculations reached the level of 0.9997. This result fully confirms the thesis about the interchangeability of the figures collected by LDB CSO for dwellings and for households.

The authors propose two categories of dwellings defined by the Central Statistical Office (CSO, 2014) to be considered as building units of the individual customers market: inhabited dwellings with an individual energy source powered by solid fuel and inhabited dwellings equipped with room furnace powered by solid fuel. As demonstrated by the authors' analyses carried out in the LDB CSO, the sum of these two (fully accessible and updated annually) categories lists all households in Poland using solid fuel for heating their homes. It was observed that the solid fuel used by 98% of these households was coal and the remaining 2% used alternative fuels, which could be used interchangeably with coal to power the furnaces (CSO, 2013). Heating devices used in the above housing categories are mainly central heatingfurnaces, that is, individual furnaces used to heat an entire building using central heating installation. The other category of devices comprises room furnaces located in different rooms of the house to heat each of them separately. It follows that one household may use a single central heating furnace or more in the case of room furnaces, depending on the number of rooms in their homes.

To calculate the quantitative and valuable market capacity for the individual customers segment, we must also use the information about the average consumption of coal per consumption unit, which in this case is the household (precisely the heating device it uses). This type of data for households using central heating furnaces and room furnaces is published by LDB CSO and updated on an annual basis. Determination of valuable capacity requires the use of data on coal prices for individual customers (households). This type of data is also collected by LDB CSO as the average price in PLN per ton of coal sold by depot companies. Analysis of the availability and comprehensiveness of the data necessary for measurements enabled the authors to develop mathematical formulas used to calculate the quantitative market capacity indicator for the individual customers segment. This indicator should adopt a structure, which combines the capacity resulting from the use of central heating furnaces and room furnaces. This indicator can be expressed by the following formula (1):

$$P_I = N_{pco} \cdot U_{pco} + N_{pi} \cdot U_{pi} \tag{1}$$

where:

P_I — quantitative capacity of a given market in a given year, thousand Mg,
N_{pco} — number of inhabited dwellings with an individual energy source powered by solid fuel present on the market in a given year,

U_{pco} — average coal consumption in a given market in a given year per single inhabited dwelling with an individual energy source powered by solid fuel, thousand Mg/y,
N_{pi} — number of inhabited dwellings equipped with furnaces powered by solid fuel in a given market in a given year,
U_{pi} — average coal consumption in a given market in a given year per single inhabited dwelling equipped with furnace powered by solid fuel, thousand Mg/y.

Given the above, the rate of quantitative market capacity of the individual customers segment will adopt the system described by the following formula (2):

$$P_W = (N_{pco} \cdot U_{pco} + N_{pi} \cdot U_{pi}) \cdot c \tag{2}$$

where:
P_W — quantitative capacity of a given market in a given year, thousand Mg/y,
c — average price of a ton of coal sold by coal depot companies in a given market in a given year, PLN/Mg.

The relationship between the valuable capacity value and the quantitative capacity can be described by the following formula (3):

$$P_W = P_I \cdot c \tag{3}$$

The final stage of methodological assumptions involved verification, allowing to determine the level of detail of regional data, and thus the results, based on which the subsequent assumption of the method, that is the differences in the level of demand in different parts of Poland, may be determined. In the course of analyses conducted by LDB CSO, it was determined that the data needed for the calculation of quantitative and valuable market capacity are collected at the district level. By combining this issue with the mining companies' need for deeper analysis of the geographical market capacity, resulting in turn from the need of the best marketing service, it was concluded that the district level is a sufficient for data collection and market analysis performer by mining companies. Starting with this proposal, it was possible to calculate the market capacity not only at the national level, but also for provinces or districts. This significant opportunity to show data in different geographical sections is reflected in Section 5, which presents some of the results of analysis.

4.2. Theoretical basis of coal distribution

Based on the considerations set out above, which showed varied, significant demand for coal in the individual customer segment, a concept of a system of its distribution was developed. This system is based on individual depots – main and district. Graphical representation of the proposed system (exemplified by two main depots) is illustrated in Figure 3. The general, model approach was based on the following assumptions:

- i – main depot index, $i = 1, \ldots, m$,
  where: m – number of main depots in the distribution system,
- j – district depot index, $j = 1, \ldots, n$,
  where: n – number of district depots in the distribution system.

In order to conduct analytical studies covering the costs associated with the distribution of coal in the individual customers segment, a mathematical model was developed describing the

Loading station of mining company		Main depot		District depot
Coal loading into rail wagons	Railway transport	Unloading coal from wagons and loading on cars	Car transport	Coal unloading

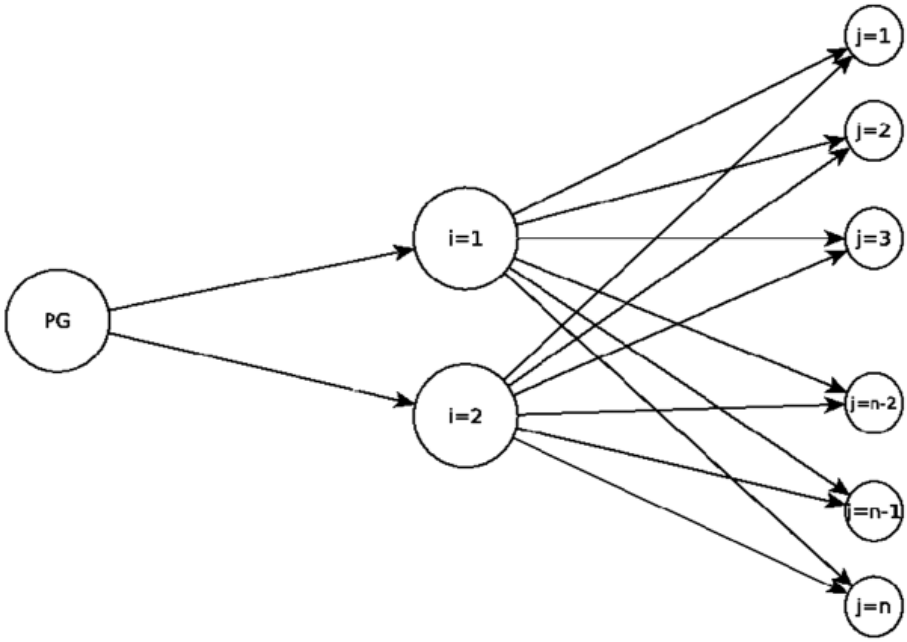

Fig. 3. Diagram of the proposed coal distribution system
Source: Developed by authors

economic aspects of the distribution system operation, taking into account the price of operating the ex-works mining company loading station and the cost of transporting coal to the various district depots.

Within the spatial (territorial) system, we are dealing with certain locations characteristic for the process of coal distribution in the individual customer segment, distributed in different locations, which may include:

- mining company loading station,
- main depots,
- district depots.

Delivery route of coal from the manufacturer to the customer requires it to be moved some distance with the use of appropriate means of transport (Gawlik et al., 2013; Grudzinski, 2012).

In fact, this movement uses two means of transport: rail and road. In this regard, the following fundamental assumptions were made for the purpose of the mathematical model:

- transport of coal between the mining company loading stations and the main depots is conducted by rail,
- transport of coal between the main depots and the district depots is conducted by road,
- coal may be supplied from any main depot to any district depot.

In the process system, delivery of coal from the manufacturer to the customer includes a series of consecutive actions, which may include:

- loading coal onto rail cars in the mining company loading station,
- transport of coal by rail from the mining company loading station to the main depot,
- unloading coal from the rail cars at the main depot,
- loading coal onto road cars at the main depot,
- transport of coal by road from the main depot to the district depot,
- unloading coal from the road car at the district depot.

The above-mentioned processes are related to the corresponding costs. For the purposes of the mathematical model involving the unit cost of loading, transportation and unloading of coal in consideration of its distribution system, the following notations were adopted:

- kzp – unit cost of loading coal at the mining company loading station, PLN/Mg,
- kzo – charge for stopping the train at the mining company loading station calculated per one ton of cargo, PLN/Mg,
- ktk_i – unit cost of rail transport from the mining company loading station to the i-th main depot, PLN/Mg,
- kwo_i – charge for stopping the train at the i-th main depot unloading station calculated per one ton of cargo, PLN/Mg,
- kwg_i – unit cost of unloading coal from a train at the i-th main depot, PLN/Mg,
- kzg_i – unit cost of loading coal onto a road car at the i-th main depot, PLN/Mg,
- kts_{ij} – unit cost of coal transportation by car from the i-th main depot to the j-th district depot, PLN/Mg,
- kwp_j – unit cost of unloading coal at the j-th district depot, PLN/Mg.

The proposed system of coal distribution in the individual customers segment should take into account the maintenance and operating costs of the main and district depots. The proposed mathematical model adopts the following notations:

- kug_i – costs of maintaining and operating the i-th main depot per one ton of coal, PLN/Mg,
- kup_j – costs of maintaining and operating the j-th district depot per one ton of coal, PLN/Mg.

Unit cost of loading coal onto rail cars at the mining company loading station is included in the price of coal, because loading is performed by the manufacturer.

The charge for stopping the train for the disposal of the supplier/recipient is compliant with the PKP CARGO S.A. tariffs. This fee pertains to three records:

- numerical (per car and hour), dependent on the number of rail car axles,
- quantitative (per car and hour),
- tonnage (per each 10 Mg and hour).

The cost of transporting coal by road from the mining company to the *i*-th main depot can be determined using formula (4), which takes into account the component dependent on the distance of transport and component independent of it:

$$ktk_i = Atk_i \cdot Lk_i + Btk_i \tag{4}$$

where:

Atk_i — coefficient of the unit cost dependent on transportation distance between the mining company loading station and the *i*-th main depot PLN/(Mg·km),
Lk_i — distance of rail transport between the mining company loading station and the *i*-th main depot, km,
Btk_i — unit cost of transport independent of the distance between the mining company loading station and the *i*-th main depot, PLN/Mg.

Unit cost of unloading coal from a train at the main depot depends on the type of train cars used for its transportation. In the case of dumpcars, it can be close to zero. Unit cost of loading coal onto a road car at the main depot depends on the type of loading equipment used. The cost of transporting coal by road from the *i*-th main depot to the *j*-th district depot can be determined from the formula (5):

$$kts_{ij} = \alpha_{ij} \cdot Ls_{ij} \cdot Cs_{ij} \tag{5}$$

where:

α_{ij} — dummy variable which takes on the value of:
$\alpha_{ij} = 0$ — in the event of no transport between the *i*-th main depot and the *j*-th district depot,
$\alpha_{ij} = 1$ — in the event of transport between the *i*-th main depot and the *j*-th district depot,
Ls_{ij} — road distance between the *i*-th main depot and the *j*-th district depot,
Cs_{ij} — unit price of conventional road transport of one ton of coal between the *i*-th main depot and the *j*-th district depot, PLN//(Mg·km).

Unit cost of unloading coal at the district depot in the event of using dumpcars can be likened to zero.

The limit of viability of the considered distribution system is determined by the price that covers all costs associated with its operation, i.e. prices of coal ex-works mining company loading station, the cost of loading, transportation and unloading, and the costs of maintaining and operating the main and district depots.

Denoting:

- Czb – price of coal ex-works mining company loading station, PLN/Mg,
- kug_i – *i*-th main depot maintenance and operating cost per one ton of coal, PLN/Mg,
- kup_j – *j*-th district depot maintenance and operating cost per one ton of coal, PLN/Mg.

formula (6) can be used to determine the price limit, Cgr_{ij}, which compensates for the distribution cost of at the *j*-th district depot of coal supplied by the mining company through the *i*-th main depot:

$$Cgr_{ij} = Czb + kzp + kzo + ktk_i + kwo_i + kwg_i + kzg_i + kts_{ij} + kwp_j + kug_i + kup_j \tag{6}$$

Selling price of coal to the final customer at the *j*-th district depot must be higher than the price limit determined by formula (3) in order for distribution of coal through this depot to be economically viable. As illustrated by formula (3), the price is affected by a number of cost

components, which in turn are characteristic of the technical, technological and organizational solutions adopted in the process of coal distribution.

The model can be used to perform the simulation calculations of practical, after collecting appropriate input data characteristic of the projected technical, technological and organizational solutions adopted in the process of coal distribution. Selected examples of applications for this model are presented in subsection 5.2.

5. Selected examples of application of the developed methodology

5.1. Results of measurements of the regional differentiation in demand

Based on the measurement methodology presented in subsection 4.1 and using the data from the year 2012 (at the closing date of this publication the last year with complete data available) published by LDB CSO, the quantitative and valuable capacity, and therefore demand, was measured in the segment of individual customers in Poland, though application of various geographical sections. The limited volume of this article does not allow the authors to show all of the results, so the results of calculations are presented in three geographical sections:

- quantitative and valuable market capacity for Poland as a whole,
- quantitative and valuable market capacity for individual provinces,
- valuable market capacity for eight districts of provinces, covering the western half of Poland, namely the provinces of: Lower Silesia, Lubusz, West Pomeranian, Pomeranian, Kuyavian-Pomeranian, Greater Poland, Łódź and Opole.

Decision to present the demand level Poland as a whole arose from the desire to show the demand for coal in the entire individual customers segment, which, according to the authors, should be considered as fundamental information in terms of strategy (decision-making) for the evaluation of this customer segment and potential effectiveness of its service by the mining company. Focusing on individual provinces intended to show regional differences in demand for coal in different parts of Poland, as well as illustrate quantity-value changes arising from differences in selling prices of this product. Presenting valuable market capacity of districts was primarily indented to demonstrate the possibility of calculating demand levels in such geographical section, which, according to the authors, should be a cause for special interest of mining companies in this type of analysis due to the district-based activities of coal depots (as demonstrated by Bogacz (2009)). Focus on the 171 districts located in the eight provinces covering the western part of Poland stemmed from the proposal of a coal distribution model for this part of Poland set forth in subsection 4.2, with use of already existing rail, road and storage infrastructure, and implemented taking into account the current EU legislation. Due to the direction of the analyses carried out in subsection 4.2, the results of measuring the market capacity at the district level are presented in terms of quality only.

Following the above assumptions, the quantitative and valuable capacity was first calculated for the entire individual customer segment of coal in Poland, using formulas 1 and 2. The results of these calculations are shown in Table 1, both as total values and broken down by central heating and room furnaces.

TABLE 1

Quantitative and valuable market capacity of individual customers segment for coal in Poland in 2012

Quantitative capacity [thousand Mg]			Valuable capacity [thousand PLN]		
C.H. Furnaces	Room Furnaces	**Total**	C.H. Furnaces	Room Furnaces	**Total**
16413.8	2837.5	**19251.3**	13334038.9	2301000.5	**15635039.4**

Source: Developed by authors

The results of the analysis indicate that the total level of effective demand for coal in Poland in 2012 closed at the level of over 19.2 million tons (Table 1). Taking into account the selling price yielded a value of just over 15.6 billion PLN (Table 1). These two figures show in a straightforward and clear manner the attractiveness of the individual customers to the mining companies. On this basis, it was possible to determine whether or not this part of the Polish market is strategically interesting. The results quite significantly differ from the values obtained by other methods in studies conducted by other research teams, who primarily focus on the level of 10.5 million tons, as defined by the Polish Coal Retailers Chamber of Commerce (www.polski-wegiel.pl/rynek-wegla.html, 2014). The differences between the consumption of coal by central heating and room furnaces is also worth noting, because it can clearly be seen that the central heating furnaces are the main "generator" of demand. The level of this advantage can also be expected to further increase in the coming years.

Further studies were performed at the province level. In order to best illustrate them, the results are summarized in the form of maps, which were prepared respectively for the quantitative capacity in Figure 4, and for the valuable capacity in Figure 5. Both types of capacity were based on collective values, that is, taking into account two types of devices used for combustion of solid fuels.

The results shown in Figures 4 and 5 show different levels of demand for coal in different provinces in the group of individual customers in 2012. Greater aggregation of demand can be noted in the central and southern part of the Poland, with particular reference to Silesia and Masovia. Referring to the results of research, one should further note the higher attractiveness of the northern Polish provinces within the qualitative (Fig. 5) in relation to the quantitative system (Fig. 4). This follows directly from higher prices of coal sold by depots in this part of the country, related directly to the higher costs of transport from the region of Upper Silesia. If we take into account the increasing amount of coal imported into Poland, as was indicated in Section 3, mostly imported by sea (which in the opinion of the authors will contribute to lowering the price of coal in the north of the country in the future), due to the relatively small quantitative capacity of the northern provinces (Fig. 4), their potential for loss to imported coal should not decide, at least in the short term, of the loss of competitiveness of Polish coal in the segment of individual consumers as a whole.

The third group of studies, which is also crucial for the analysis in subsection 5.2, is shaping the demand at the district level, formulated for the eight provinces that make up the western part of the Poland. For clarity purposes, these results have been presented in the form of maps, which are provided in Figure 6. The main conclusions drawn from the results of these studies confirm the picture of market differentiation shown earlier in Figures 4 and 5. They point to demand localized to a greater extent in southern and eastern areas of Poland covered by the analysis. The decidedly more important factor, resulting from the analysis of the level of demand in districts, is the fact that larger, and in many cases significantly higher, levels of demand are focused in

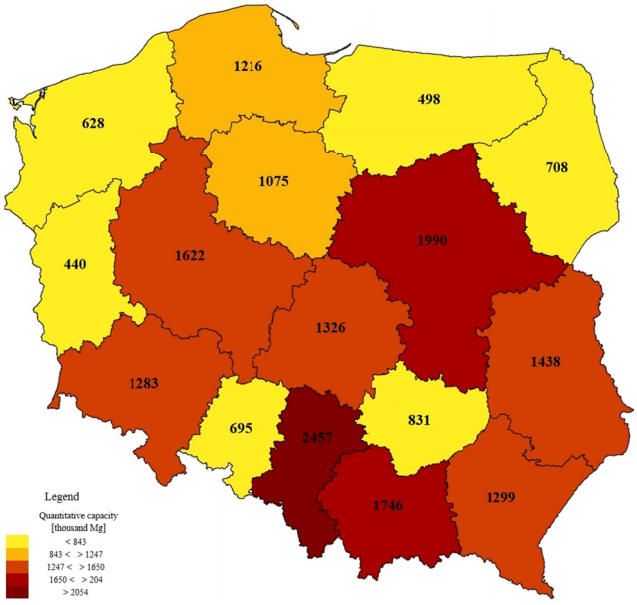

Fig. 4. Quantitative capacity of individual customers segment for coal at the level of provinces in 2012 (thousand Mg)
Source: Developed by authors

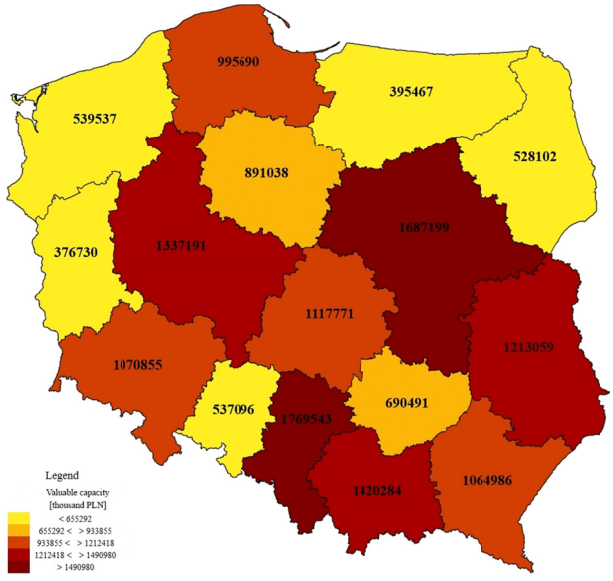

Fig. 5. Valuable capacity of individual customers segment for coal at the level of provinces in 2012 (thousand PLN)
Source: Developed by authors

districts surrounding large cities. You can see it very well, i.e. in the district of Łódź, Poznań, Toruń, Konin and Opole. This situation is mainly due to the large accumulation of single-family homes in the outer parts of the urban areas, due to the migration of people from cities to towns located in their immediate vicinity and a large number of single-family homes in these places. This situation, in the opinion of the authors, will continue to persist.

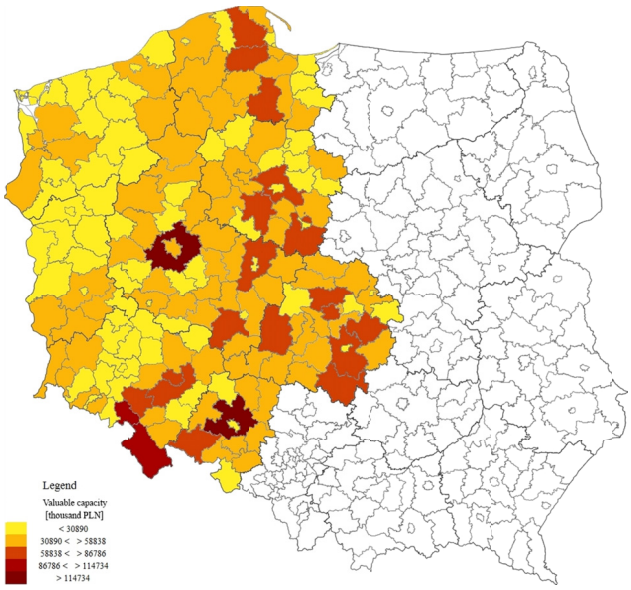

Fig. 6. Valuable capacity of the individual customers segment for coal on the district level in eight selected provinces of Poland (thousand PLN)
Source: Developed by authors

The decidedly more important issue is the fact of possessing such knowledge in numerical system, which is fully reflected by the presented methodology, as well as its use for the best organization of the distribution strategy of products and their promotion by the mining companies or their trading partners in these regions.

5.2. Selected results of calculations using the developed distribution model

In order to illustrate the results of calculations performed using the developed model of coal distribution in the individual customers sector, pilot calculations were performed using a particular set of input data.

The analyzed distribution system of coal in the individual customers sector includes:

- a mining company loading station, designated as PG (Fig. 7),
- two main depots located in the central and western parts of the country, designated as A and B (Fig. 7),

- 171 district depots located in the points corresponding to the locations of district capitals of the following provinces: Lower Silesia, Lubusz, West Pomeranian, Pomeranian, Kuyavian-Pomeranian, Greater Poland, Łódź and Opole.

It was assumed that rail transport from the mining company loading station to the main depots shall be carried out by train, consisting of 40 2-axle cars with a capacity of 25 Mg. The total mass of coal in a single transport is 1000 Mg. It was assumed that the efficiency of the loading/unloading is 90 Mg/h, and the time of loading/unloading is 12 h.

It was assumed that the transport of coal from the main depots to the district depots shall be carried out by road, using dump trucks with a capacity of 14 Mg.

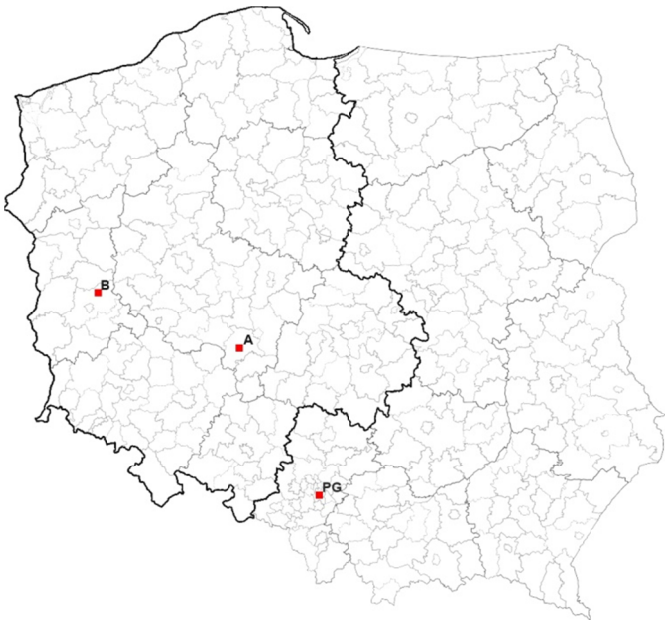

Fig 7. Location of the mining company and the main depots
Source: Developed by authors

The following input data was used in pilot calculations:

- Czb = 330 PLN/Mg,
- kzp = 0 (it was assumed that the cost of loading is included in the price),
- kzo = 7.58 PLN/Mg (in order to calculate this cost component, the authors assumed the fees compliant with the current tariff of PKP CARGO S.A. (Tariff 2013): according to numerical record 2.60 PLN per car and hour; according to quantitative record 6.20 PLN per car and hour; according to tonnage 2.80 PLN per 10 ton unit and hour),
- Atk_i = 0.3268 PLN/(Mg·km), value determined on the basis of PKP CARGO S.A. tariff,
- Btk_i = 29.32 PLN/Mg, value determined on the basis of PKP CARGO S.A. tariff,
- Lk_1 = 356 km,
- Lk_2 = 204 km,

- kwo_i = 7.58 PLN/Mg, by analogy with the *kzo* cost,
- kwg_i = 1.00 PLN/Mg,
- kzg_i = 1.30 PLN/Mg,
- Cs_{ij} = 0.70 PLN/Mg,
- kwp_j = 0 (dumptrucks),
- kug_i = 40 PLN/Mg,
- kup_j = 10 PLN/Mg.

Selected results of calculations made using the adopted input data are summarized in Table 2. This table also includes the values of road distance between the *i*-th main depots and the *j*-th district depots as well as the cost of road transport on these routes. Quoted values of the price limits are equal to the cost of coal distribution. Green color indicates a lower value of the price limit for each district depot, obtained by comparing the cost of distribution, taking into account the possibility of transport via two main depots – A or B. For example, in case of the district depot with the index *j* = 1, the cost of coal distribution via main depot A is 633.14 PLN/ Mg, and via main depot B – 812,34 PLN/Mg.

TABLE 2

Selected results of the pilot calculation

District	**Road distance km**		**Road transportation cost PLN/Mg**		**Price limit PLN/Mg**	
j	*i* = 1	*i* = 2	*i* = 1	*i* = 2	*i* = 1	*i* = 2
1	386	130	270.2	91	812.34	633.14
2	369	126	258.3	88.2	800.44	630.34
3	310	130	217	91	759.14	633.14
4	338	165	236.6	115.5	778.74	657.64
5	357	131	249.9	91.7	792.04	633.84
6	422	198	295.4	138.6	837.54	680.74
7	380	155	266	108.5	808.14	650.64
8	370	162	259	113.4	801.14	655.54
9	409	183	286.3	128.1	828.44	670.24
10	380	155	266	108.5	808.14	650.64
11	351	108	245.7	75.6	787.84	617.74
12	334	125	233.8	87.5	775.94	629.64
13	276	96	193.2	67.2	735.34	609.34
14	322	71	225.4	49.7	767.54	591.84
15	297	89	207.9	62.3	750.04	604.44
16	267	58	186.9	40.6	729.04	582.74
17	337	86	235.9	60.2	778.04	602.34
18	304	144	212.8	100.8	754.94	642.94
19	291	119	203.7	83.3	745.84	625.44
20	347	172	242.9	120.4	785.04	662.54
21	439	213	307.3	149.1	849.44	691.24
22	419	195	293.3	136.5	835.44	678.64

Source: Developed by authors

The above studies constitute a very important, almost fundamental level of information that should be used as a starting point for the mining companies in determining a strategy for their product in the individual customers segment, especially in scope of its distribution. They allow to conduct marketing activities in places with localized demand, thus increasing economic efficiency.

6. Conclusions

The proposals and results presented in this article have a number of interesting and important applications for mining companies in terms of the marketing situation in the segment of individual customers in Poland and the way of managing this part of the market. By proposing a useful and practical methodology for the study of differentiation of demand in the individual customers segment, and subsequent application of this methodology as the basis for development of a distribution system, taking the best possible advantage of infrastructure already in place and taking into account present and future EU legislation, the mining companies are able to determine the directions and types of effective market activities in this segment of the market. The most important conclusions of this publication may be summarized as follows:

- activities of mining companies in the field of marketing based on the relationship marketing principle should be based on a system of market research (analysis of quantitative and valuable capacity and its regional differentiation) and a strategy of differential market impact, with particular emphasis on the distribution system. It is also a key element in terms of the increasing competitiveness of foreign coal imported into Poland;
- individual customers segment should be considered as strategic and developing customer group for the mining companies. This is due to the fact that it consumes 17% of coal sold in Poland, making it the second, after the power industry, largest market segment in Poland. It is also the most opinion-forming segment when it comes to the for the mining company image and brand-building activities;
- calculation of the level of demand in the individual customer sector should be performed based on the quantitative capacity indicators, as well as valuable market capacity, determination of which is possible based on the proposed formulas filled with data collected for households on an annual basis by the Polish Central Statistical Office. Their highest attainable level of detail has been defined by the authors as a the district level,
- calculation of the capacity of individual customers segment in Poland for 2012 based on the proposed methodology yielded a level of over 19.2 million tons, which translates into more than 15.6 billion PLN. These values are the result of coal combustion in central heating furnaces, which use about 85% of the fuel sold to individual customers;
- studies of differentiation in the quantitative and valuable capacity of the individual customers segment showed the highest levels of demand in the regions of central and southern Poland, with particular emphasis on the Silesian and Masovian provinces. Referring to the results of research, the higher level of attractiveness of the northern provinces of Poland in terms of quality to quantity ratio should further be noted. This follows directly from higher prices of coal sold by depots in this part of the country;
- studies of demand levels in terms of districts indicate that the occurrence of higher, in many cases by far, values in provinces surrounding large cities. This is evident for example. In the district of Łódź, Poznań, Toruń, Konin, and Opole. This situation is largely due to

the large accumulation of single-family homes in the outer parts of the urban areas, due to the migration of people from cities to towns located in their immediate vicinity. These results should be used by mining companies or their trading partners to best to organize the distribution strategy of their products and their promotion in these regions;

- the developed model of distribution system of coal in the individual customers segment can be used to perform calculations and multivariate analysis aiming to optimize the distribution system in spatial, technical, technological and economic dimensions.

Works carried out within the framework of statutory research – contracts: 11.11.100.481; 11.11.100.693

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Received: 07 May 2014