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USING HEURISTIC METHODS IN THE PROCESS OF RETAIL SHOPS PLACEMENT IN THE CONTEXT OF MARKETING COMMUNICATION EFFECT MAXIMISATION

Tomáš FAŠIANG – Pavel GEŽÍK

ABSTRACT:
The topic of this empirical study is focused on applying usage of heuristic methods in the process of retail shops placement as a starting point of putting into effect targeted communication of retail shops with a customer in their radius of action. Subsequently, maximisation of communication strategy's effect is based on appropriate communication with the target market within a limited area determined by buying stream, which affects the target customers and influences their shopping decisions and the volume of realised purchases in the given retail shop. The study is based on two mutually interconnected levels of related knowledge. On the first level, it deals with an analysis of relationships between selected macroeconomic indicators in the Slovak Republic and points out their direct influence on development of retail takings as a basic economic premise of retail shop functioning. On the second level the authors focus on the specific application of heuristic methods in the field of optimisation of retail shops placement in the context of maximisation of their radius of action and target group service, in which an ideal precondition for targeted and efficient communication with a customer occurs. The aim of the contribution is to point out, using practical application of heuristic methods ADD and DROP, the optimisation possibilities of retail shops placement with special emphasis on delimitation of direct communication space. The aim of application of the above-mentioned methods is to practically use the outcomes of the realised research and obtained statistical data.

KEY WORDS:
buying stream, consumer, economic development indicators, heuristic methods, marketing communication, retail

1 Introduction

Location of retail shops meets the needs and concentration of customers' demands in order to ensure availability and required capacity according to size, structure and shopping habits of inhabitants in the area of

interest. From this point of view, "buying stream"[1] can be determined as a basis for quantification of possible purchase volume and definition of a space for direct and intensive communication with target customers. The basic premise for identification of a target customer is understanding the whole process of consumers' shopping behaviour; from realising their need to evaluation of the purchase made. Based on procedural description of consumer behaviour of a customer while shopping for goods of daily need, we may identify key elements of the decision-making process related to shopping behaviour, which can be influenced by active influence of the retail shop's communication strategy.[2] Subsequently, the "buying stream" is represented by an active sales radius of a retail shop, in which its performance may be maximised through an appropriate communication strategy. In this regard, there exists a series of spatial interaction models, through which customer tendencies when selecting a retail unit in terms of place of purchase may be measured.

The aim of the study is to point out – via practical application of the heuristic methods ADD and DROP – optimisation possibilities of retail shops placement. The application is focused on non-specialised retail with fast-moving goods. The basis for processing the outcomes is created by the obtained research and statistical data with focus on demographic and economic indicators.

2 Economic Basis of the Retail Shops Placement Process

The basic precondition of the retail shops placement process is the current efficiency of national economy, since it determines economic potential of buying stream, which at the same time points out the scope of application of targeted market communication.[3] If the national economic performance is on a low level, there occurs threat to performance of a retail shop in terms of turnover and achieved sales. In that case it is necessary to consider the significance of location and also influence of rival retail shops. From this point of view, it is important to know the current status of national economy and realise the impacts that may occur under the influence of its cyclical development. The key indicators are gross domestic product (hereinafter only referred to as "GDP"), household consumption and takings achieved for retail performances and goods, except motor vehicles, in accordance with the Statistical Classification of Economic Activities SK NACE Rev. 2 (hereinafter only referred to as "retail takings").

By comparing the mentioned indicators economic influence on the future performance of a retail shop may be identified. The basic macroeconomic variable, through which we can measure the national economic performance, is called GDP indicator. Currently, the GDP volume has reached its maximum, compared to values from the previous years (since formation of the Slovak Republic). In 2016, the GDP value reached the limit of almost 81 billion euros.[4]

The household consumption indicator represents final household consumption expressed by GDP expenditure method. The above-mentioned indicator takes into account expenditure of households intended for purchase of consumer goods and services. Expenditures of all Slovak households for 2016 represent the sum of 44.3 billion euros.[5] It means that each average household in Slovakia spends on average almost 1,789 euros a month (the information is based on census results from 2011).[6]

1 See also: GUPTA, S., RANDHAWA, G.: *Retail Management.* New Delhi : Atlantic Publishers and Distributors, 2008, p. 506.
2 KUSÁ, A., FAŠIANG, T., GREŠKOVÁ, P.: How is the Daily Shopping Behaviour of Consumer Goods Influenced by Gender. In *ICASSR 2015: 3rd International Conference on Applied Social Science Research. Conference Proceedings.* Beijing, China : Atlantis Press, 2016, p. 249.
3 To be compared with: NAGYOVÁ, Ľ., KOŠIČIAROVÁ, I., SEDLIAKOVÁ, M.: Corporate Communication as One of the Basic Attributes of Corporate Identity – Case Study of Chocolate Milka. In *Communication Today,* 2017, Vol. 8, No. 1, p. 86-102.
4 NÁRODNÁ BANKA SLOVENSKA: *Makroekonomická databáza.* [online]. [2017-03-09]. Available at: <http://www.nbs.sk/sk/menova-politika/makroekonomicka-databaza>.
5 NÁRODNÁ BANKA SLOVENSKA: *Makroekonomická databáza.* [online]. [2017-03-09]. Available at: <http://www.nbs.sk/sk/menova-politika/makroekonomicka-databaza>.
6 ŠTATISTICKÝ ÚRAD SR: *Sčítanie obyvateľov, domov a bytov 2011.* [online]. [2017-03-09]. Available at: <http://slovak.statistics.sk/>.

Another important indicator arising from the very focus of the study is retail takings. The indicator in question interprets increase or decrease in retail takings and eventually points out increase or decrease in household expenditure.[7] In 2016, retail takings reached 19.3 billion euros. It must be mentioned that their volume still has not reached the highest numbers from 2008.

The following figure displays basic indices of the selected economic indicators. Basic index compares development of GDP values, household consumptions and retail takings in specific years of a given period (year 2008 has been selected as the basic period for the purposes of this study). It follows that GDP, household consumption and also retail takings record year-on-year growth tendency, which has a positive impact on the overall national economic performance.

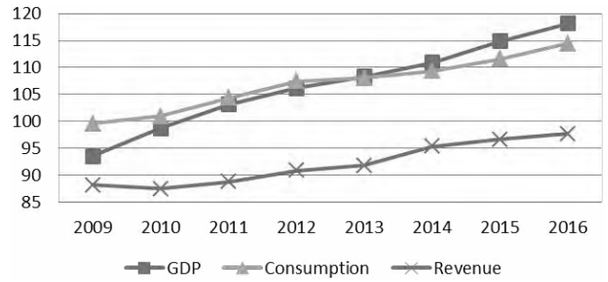

Figure 1: Basic indices of selected economic indicators (2009-2016)
Source: own processing

From the economic viewpoint, we have to point out the interdependence between the indicators of retail takings and household consumption. As long as the economic performance (expressed by the GDP indicator) increases, household consumption increases as well, which eventually means increase in retail takings.

The above-mentioned statement may be verified via regression analysis, which enables estimation of a functional relationship of mutual interdependences between the explained variable (retail takings – dependent variable) and the explanatory variable (household consumption – independent variable). Should the premise of mutual interdependence between the retail takings indicator and the volume of household consumption be confirmed, change in consumption must induce change in takings.

Using the regression model allows us to record mutual bond demonstrated by a linear model. By calculation we gain a point estimate of an equalising straight line with an equation: Revenue = 1161.66 + 0,356602*Consumption. From the value of regression coefficient it may be assumed that if consumption value increases by 1 billion euros, retail takings increase by 356.6 million euros. 95% confidence interval has been used to verify the above-mentioned statement. The following figure interprets position of the regression line.

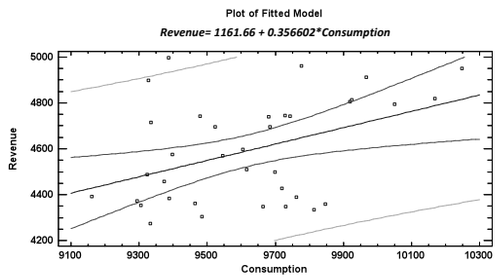

Figure 2: Relationship between retail takings indicator and household consumption in mil. euros
Source: own processing

7 FAŠIANG, T.: Vzťah vybraných ekonomických ukazovateľov k vývoju mediálnych výdavkov v segmente nešpecializovaného maloobchodu. In *Communication Today,* 2012, Vol. 3, No. 1, p. 86.

It follows from the above-mentioned facts that the national economic performance is on the rise, which has a positive influence on market potential of retail shops. For this reason, it is meaningful to consider appropriate placement of retail shops to provide customers with accessibility and service capacity with focus on maximising the takings.

An important precondition for placement of a retail shop is geographical definition of forces attracting the customers within separate areas in which retail shops are situated. The shop's attractiveness has an impact on consumers even locally (within their neighbourhood). In this case it is a force attracting a customer by the retail shop's radius of action, i.e. within its buying stream. For this reason, it is necessary to identify correctly the target market and to know the current state of external market environment with the main focus on the retail shop's buying stream radius of action. The buying stream represents the retail shop's basic market potential which is expressed by the takings volume realised within a certain time horizon – by means of purchases by customers whose number and places of residence fall within the retail shop's area of interest.

The overall market potential is also determined by proximity and character of competition.[8] A retail shop's performance and efficiency of its communication strategy will always be significantly influenced by the number of competitors, their relative size considering the retail's character, mutual similarity of assortment composition as well as by pricing policy resulting from fixed costs within the retail shop's overall cost structure. The most significant intensity of rivalry will appear in the overlapping areas of mutual buying streams' radii of action.

Taking into consideration the stated facts, it is appropriate to approach placement of retail shops in a rational way – by selecting optimisation methods. In the following section of our study we deal with applying two heuristic optimisation methods using an illustrated example.

3 Optimisation of Retail Shops Placement

Optimisation of retail shops placement can be organised according to various characteristics and features. However, the most frequent way is related to suitable placement based on the distance from consumers. Such kind of optimisation is in practice known as location of shops with the aim of minimising the distance.[9]

The given example is a special type of a task to place (allocate) a facility (in English it is called "plant location problem"). Such a task type belongs in a group of so-called distribution tasks. Their solution is usually based on usage of integer or dynamic programming. A number of locating tasks is described also by Pekár et al.,[10] who solve various specifics by using tasks of linear programming and add various limitations to the tasks.

These approaches are, however, difficult to calculate because of a variety of possibilities; they rank among so-called "NP-hard problems". Heuristics and NP-hard tasks are looked into by Čičková, Brezina and Pekár.[11] By means of heuristics it is possible to reach satisfactory solutions, commonly known as suboptimal solutions, in a relatively short period of time. There are many heuristic methods to locate warehouses, such as the so-called ADD method and DROP method, which may be simply used to locate a facility without and with capacity limits.

3.1 Application of Optimisation: Heuristic Methods

The selected heuristic methods may be shown on the example of the placement of fast-moving-goods retail shops in the city of Trnava. The application is based on the demographic data of Trnava, supplemented by the results of the performed research in the field of identification of the consumer target group and its key attributes. The research focused on recognising preferences of a Slovak consumer. Collecting of data lasted from 24th October 2016 to 9th April 2017 (overall length of the collecting process was 24 weeks). Collecting was performed in the form of an electronic inquiry, using a standardised form of questionnaires.

Taking into consideration the size of the basic research sample of the study (citizens of the Slovak Republic above 14 years of age), it was decided that the selection sample would feature 5,000 respondents. The process of the data collecting was performed by quota selection, in which gender and age of the respondents were taken as the controlled parameters. After evaluation of the level of the collected data (factual and logical check of the filled questionnaires), the research featured 3,353 respondents. This represents 67% return of the planned 5,000 questionnaires. The return may be seen as representative, which is reflected in the thin range of maximum of acceptable amount of errors allowing only 1.7%. The stated data is generated in compliance with the statistical induction, based on the interval of reliability of distribution function of the standardised, common distribution – 0.05 with conservative allowance for share of analysed mark 0.5. In simple words, we may say that replies of one respondent in this research represent standpoints of 1,610 Slovak citizens.

Based on the local plan, the city of Trnava is divided into 6 administrative zones (see the picture below): "Trnava stred" (centre), "Trnava sever" (North), "Trnava východ" (East), "Trnava juh" (South), "Trnava západ" (West) and "Modranka". The example does not contemplate the Modranka zone any further, as it is a rather great and compact municipality which is supposed to have a retail shop of its own.

Figure 3: Administrative zones of the city of Trnava
Source: Administratívne časti Trnavy. [online]. [2017-06-21]. Available at: <http://www.trnava.sk/userfiles/image/ourak_img_Administrativne_casti.png>.

Since the 5 above-mentioned administrative zones of Trnava are of different expanse, and in terms of the city plan they do not refer to particular consistent neighbourhoods, or more precisely, to the city quarters according to their built-up areas, the example required selecting different division of zones, which would depict the status quo more realistically. Another rather essential reason for different division was the question of the length of a journey to a retail shop a common consumer is willing to make. It is necessary to point out that for a consumer distance is one of the most important criteria when opting for a retail shop. As it was proven by research, the average distance of the main shopping trip is somewhere between 1.1 and 5 kilometres. The stated distance determines the power of a retail shop's radius of action. Consumers cover the distance most often by car (46% of the respondents) or by public transport (23% of the respondents). Other respondents use local coaches (19% of the respondents) or they go on foot (12% of the respondents).

The stated administrative zones represent the platform for determining the number of population. Their size determines the number of dwellers, identified and based on the demographic data of the Trnava city (see the diagram below).

8 To be compared with: PAVLŮ, D.: The Beginnings of Market Research and Measurement of Market Advertising Effectiveness. In *Communication Today*, 2016, Vol. 7, No. 1, p. 52-64.
9 To be compared with: BREZINA, I.: *Kvantitatívne metódy v logistike.* Bratislava : Vydavateľstvo EKONÓM, 2003, p. 294.
10 PEKÁR, J. et al.: *Modelovanie rozmiestňovania recyklačných centier.* Bratislava : Vydavateľstvo EKONÓM, 2012, p. 226.
11 To be compared with: ČIČKOVÁ, Z., BREZINA, I., PEKÁR, J.: Routes Design Using Own and Hired Vehicles. Mathematical Methods in Economics. In *MME 2015: 33rd International Conference in Cheb, Czech Republic. Conference Proceedings.* Plzeň : University of West Bohemia, 2015, p. 105-108.

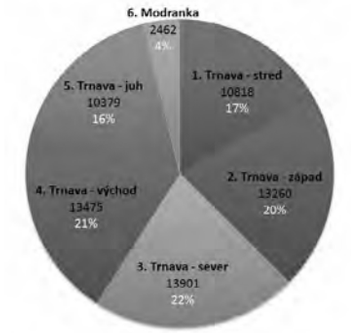

Figure 4: The number of dwellers of administrative zones of the city of Trnava (31st December 2016)

Source: Počet obyvateľov podľa meststkých častí. [online]. [2016-12-31]. Available at: <http://www.trnava.sk/userfiles/image/Demografia_Pocet_obyvatelov_podla_mestskych_casti_31-12-2016.png>.

With regard to the topic concerned, it is vital to determine the right target group of consumers who participate in the fast-moving merchandise shopping. By the same token, considering the large group of retailers, the opting of consumers is subject to many factors and it is already a case of multi-criteria decision. For instance, such approach is described by Kita et al.[12]

It follows that not all dwellers of Trnava belong to the target group. For calculation, it was necessary to adjust the demographic data, taking into consideration the age range of the target group. The research pointed out the fact that the target group consists of dwellers at 31-40 years of age, and at the same time, dwellers at 51-60 years of age. These are the consumers who do the main buying for their households. As far as retail shops are concerned, these consumers represent the source of their major takings. The following figure shows the age range of the Trnava dwellers and it proves that the major part is represented by dwellers at 25-45 years of age, and dwellers at 55-65 years of age, which quantity-wise supports the results of our research.

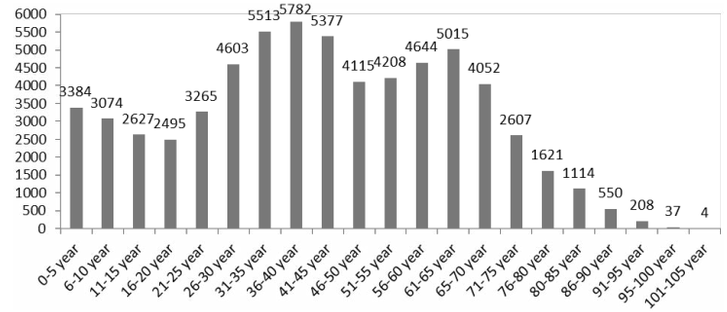

Figure 5: Age range of the Trnava city dwellers (31st December 2016)

Source: Demografia. Veková štruktúra obyvateľov. [online]. [2016-12-31]. Available at: <http://www.trnava.sk/userfiles/image/Demografia_Vekova_struktura_obyvatelov_31-12-2016.png>.

Based on the above-mentioned facts, we created the following local zones. These zones reflect already-existing neighbourhoods (or city quarters), featuring certain urban attributes and, in particular, they reflect the main traffic lines (see the following picture). The picture shows that the zones do not include industrial parts of the Trnava city (especially former TAZ factory and ŽOS factory). At the same time, potential areas for opening a retail shop were created, too. These were created within an intersection of a minimum of three selected zones.

12 To be compared with: KITA, P. et al.: Impact of Consumer Preferences on Food Chain Choice: An Empirical Study of Consumers in Bratislava. In *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 2017, Vol. 65, No. 1, p. 293-298.

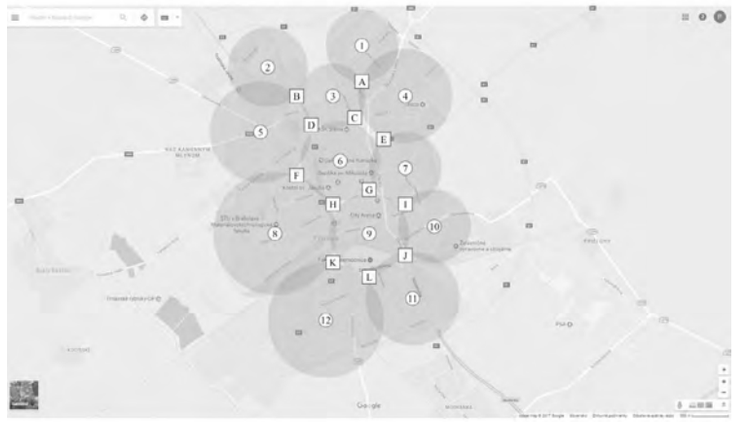

Figure 6: Selection of the Trnava city zones

Source: own processing

The size of selected zones is defined by the radius of a particular circle. This fact is based on the fact that a consumer who lives on the margin of a circle, close to the potential area of opening of a retail shop, is in the so-called zero distance to this area. By contrast, the distance of a consumer who lives on the opposite margin of the circle equals the diameter of the circle. Based on what has been stated, we may presume an average distance of a consumer at different spots within a circle as a radius of a circle r, which describes given part of the circle calculated as $(0 + 2r)/2 = r$. Radii of particular selected parts, as well as estimated number of dwellers, based on the above-mentioned data, are displayed in the following table. It is essential to emphasise that the stated zones represent action radius of a retail shop, demarcated by a semidiameter. Regarding communication strategy, it is inevitable to communicate with a target customer within the radius.

Table 1: Radii and estimated number of dwellers of the selected zones

City zones	1	2	3	4	5	6	7	8	9	10	11	12
Radius (km)	0.50	0.55	0.45	0.65	0.70	0.55	0.50	0.85	0.55	0.50	0.65	0.80
Number of dwell.	623	485	1112	1986	1843	1302	2340	2236	1532	1698	1671	1727

Source: own processing

Optimisation, using the ADD method and the DROP method, lies in minimisation of variable and fixed expenses. Variable expenses are often represented by costs related to a distance, alternatively by financially expressed distance that is often calculated as the distance in kilometres and multiplied by unit cost for 1 km. Since it is not possible to estimate such expenses for this specific example, the example abstracts the expenses from the research objectives and focuses solely on the issue of distance. Hence, we can conclude that the main (and at the same time, the only) criterion is the distance between the target group of consumers living in a selected city zone and a potential area of a retail shop placement.

The example also does not deal with the issue of fixed expenses, which represent quantity point of view and their quantification is a rather attitudinal subject. Here, we focus on attributes that determine very specific characteristics of each retail shop in the context of personal perception of a consumer.[13] Based on the conducted research, the following factors of the target group may be featured among the most significant parameters: price, quality, range of products and locality of a shop (variable expenses). The results reveal the attributes which consumers consider and contemplate when they knowingly opt and decide for a retail shop of their future buying.

13 HES, A., ŠÁLKOVÁ, D.: Aspekty chování spotrebitelů při nákupu potravin. In *Communication Today*, 2010, Vol. 1, No. 1, p. 125-132.

As it follows from the figure below, the crucial factors in the process of deciding for a retail shop consist mainly of price (38.6%), quality of goods (25%), range of products (18.2%) and locality of a shop (13.6%).

The stated percentage figures take into consideration the most significant attributes of the share structure within the group of the first or the second factor of selection. It means that the total of the shares is not 100%. When studying the following graph, we can observe the distance and bevelling on the way to the corresponding attributes. The bigger the size and bevelling, the bigger the significance of an attribute of a factor in a customer's process of deciding and selecting a retail shop. Within the initial decision making of a consumer (factor 1), the focus is on price of goods and locality of a shop. It is only in the following stage of the process (factor 2) when quality of goods and range of products or previous experience with a shop, come to play a part.

Figure 7: Attributes of selecting a retail shop

Source: own processing

Hence, for further calculations, we only needed data concerning the distances from the selected zones of the city of Trnava to the potential areas of opening a new retail shop. Distances were measured by the 'beeline' from the centre of a circle (based on the parameter of an average distance) to the corresponding potential area. These distances are stated in the following Table 2.

Table 2: Distances in the selected territories to potential areas in km

		Territory											
		1	2	3	4	5	6	7	8	9	10	11	12
Potential areas	A	0.5	1.32	0.44	0.63	1.58	1.14	1.33	2.4	2.1	2.22	3.07	3.32
	B	1.14	0.57	0.5	1.5	0.72	1.08	1.8	1.92	2.15	2.62	3.22	3.13
	C	1	1.39	0.44	0.76	1.32	0.63	0.99	1.94	1.61	1.86	2.63	2.83
	D	1.3	1	0.5	1.37	0.71	0.65	1.44	1.59	1.7	2.2	2.77	2.71
	E	1.32	1.89	0.92	0.68	1.71	0.67	0.5	1.98	1.32	1.39	2.23	2.62
	F	2.01	1.55	1.2	1.85	0.78	0.63	1.49	0.85	1.28	2.01	2.32	2.04
	G	2	2.2	1.38	1.39	1.7	0.57	0.58	1.43	0.6	1.03	1.61	1.89
	H	2.24	2.1	1.49	1.8	1.42	0.61	1.12	0.88	0.63	1.43	1.7	1.6
	I	2.28	2.68	1.79	1.49	2.24	1.08	0.5	1.84	0.63	0.5	1.3	1.94
	J	2.96	3.22	2.4	2.19	2.63	1.58	1.2	1.81	0.58	0.55	0.6	1.42
	K	3.04	2.84	2.29	2.5	2.06	1.4	1.64	0.89	0.64	1.49	1.2	0.8
	L	3.2	3.2	2.54	2.54	2.5	1.65	1.58	1.43	0.6	1.14	0.67	0.86

Source: own processing

The above-mentioned optimisation was conducted in two manners. Firstly, the method only dealt with specific distances between the areas and parts. Secondly, it also included the numbers of potential consumers in a target group. For the second calculation, input values represented particular distances multiplied by a number of potential consumers within a target group belonging to a specific district. Consequently, values of kilometres reflected the importance of the number of consumers. These values are stated below (Table 3).

Table 3: Distance of all the consumers from the selected regions into potential area in km

		Territory											
		1	2	3	4	5	6	7	8	9	10	11	12
Potential areas	A	311.50	640.20	489.28	1251.18	2911.94	1484.28	3112.20	5366.40	3217.20	3769.56	5129.97	5733.64
	B	710.22	276.45	556.00	2979.00	1326.96	1406.16	4212.00	4293.12	3293.80	4448.76	5380.62	5405.51
	C	623.00	674.15	489.28	1509.36	2432.76	820.26	2316.60	4337.84	2466.52	3158.28	4394.73	4887.41
	D	809.90	485.00	556.00	2720.82	1308.53	846.30	3369.60	3555.24	2604.40	3735.60	4628.67	4680.17
	E	822.36	916.65	1023.04	1350.48	3151.53	872.34	1170.00	4427.28	2022.24	2360.22	3726.33	4524.74
	F	1252.23	751.75	1334.40	3674.10	1437.54	820.26	3486.60	1900.60	1960.96	3412.98	3876.72	3523.08
	G	1246.00	1067.00	1534.56	2760.54	3133.10	742.14	1357.20	3197.48	919.20	1748.94	2690.31	3264.03
	H	1395.52	1018.50	1656.88	3574.80	2617.06	794.22	2620.80	1967.68	965.16	2428.14	2840.70	2763.20
	I	1420.44	1299.80	1990.48	2959.14	4128.32	1406.16	1170.00	4114.24	965.16	849.00	2172.30	3350.38
	J	1844.08	1561.70	2668.80	4349.34	4847.09	2057.16	2808.00	4047.16	888.56	933.90	1002.60	2452.34
	K	1893.92	1377.40	2546.48	4965.00	3796.58	1822.80	3837.60	1990.04	980.48	2530.02	2005.20	1381.60
	L	1993.60	1552.00	2824.48	5044.44	4607.50	2148.30	3697.20	3197.48	919.20	1935.72	1119.57	1485.22

Source: own processing

3.2 Outcomes of Application of the Heuristic Method ADD

The basic principle of the ADD method lies in gradual addition of potential areas with the purpose of minimising the total of distances from all the regions into potential areas. The detailed algorithm is described in the literature below.[14]

Algorithm – ADD method:

1. $IO = \emptyset$, $IO^{pre} = I$ and calculation $c_i = \sum_{j=1}^{n} c_{ij}$.
   Finding such a potential area k, which is valid to $c_k + f_k = \min (c_i + f_i, i = 1, 2, ..., m)$.
   $I = \{k\}$, $IO^{pre} = I - \{k\}$ and calculation of the value of function $z = c_k + f_k$.

   Calculation of a complementary matrix $\Omega = \{\omega_{ij}\}$ for all $i \in IO^{pre}$ and all $j = 1, 2, ..., n$
   based on the relation $\omega_{ij} = (c_{kj} - c_{ij}, 0)$.

2. For all $i \in IO^{pre}$ calculation $\omega_i = \sum_{j=1}^{n} \omega_{ij}$ and the rejection of i-area, which is valid to
   $\omega_i \leq f_i$. Creation of a set $IO = IO \cup \{i\}$ and $IO^{pre} = IO^{pre} - \{i\}$.

   Finding such a potential area $k \in IO^{pre}$, which is valid to
   $\omega_k - f_k = \max_i (\omega_i - f_i, i \in IO^{pre})$.

Then $II = II \cup \{k\}$, $IO^{pre} = IO^{pre} - \{i\}$ and $z = z - (\omega_k - f_k)$.

Calculation of a new matrix $\mathbf{\Omega} = \{\omega_{ij}\}$ for all $i \in IO^{pre}$ and for all $j = 1, 2, ..., n$ based on a relation $\omega_{ij} = \max_j (\omega_{ij} - \omega_{kj}, 0)$ and repetition of the step 2.

3. The calculation is finished if $IO^{pre} = \emptyset$. For assigning clients' warehouses k to the areas at minimum costs it is valid that:

$$x_{ij} = \begin{cases} 1 & prec_{ij} = \min(c_{hj} / h \in I1), \text{if there is no } c_{qj}, \text{to be valid to } c_{qj} = c_{ij} \text{ a } q < i, \\ 0 & otherwise. \end{cases}$$

The area $i \in II$ *is* deemed effective for building a warehouse.

Symbols:

m – number of potential areas;
I – the set of all potential areas, i = 1, 2, ..., m;
n – number of customer parts;
J – the set of all of customer parts, j = 1, 2, ..., n;
IO – the set of rejected areas ($y_i = 0$), non-effective areas;
II – the set of selected areas ($y_i = 1$), effective areas;
IO^{pre} – a set of pre-disapproved (ineffective) areas;
II^{pre} – a set of pre-selected (effective) areas.

In the first example solving only the distances, the first to be selected is the possibility G. Should the premises be built only in the area G, the total from all the territories would be 16.38 km with the corresponding distances from the area G into the specific territories as follows: part 1 (2 km); part 2 (2.2 km); part 3 (1.38 km); part 4 (1.39 km); part 5 (1.7 km); part 6 (0.57 km); part 7 (0.58 km); part 8 (1.3 km); part 9 (0.6 km); part 10 (1.03 km); part 11 (1.61 km); part 12 (1.89 km). When adding radii of separate parts to the given values, the highest value is the number 2.75 km for the part 2. It is the longest distance a potential consumer should take on the way for purchase. All the other values are stated below.[14]

By the algorithm, the highest savings possible are in the area B when the total of the distances drops by 4.35 km to 12.03 km. In this case, the selected areas would operate in the following territories by km – the area B: part 1 (1.14 km); part 2 (0.57 km); part 3 (0.5 km); part 5 (0.72 km) and the area G: part 4 (1.39 km); part 6 (0.57 km); part 7 (0.58 km); part 8 (1.43 km); part 9 (0.6 km); part 10 (1.03 km); part 11 (1.61 km); part 12 (1.89 km).

Another possible saving is 2.04 km when the total of the distances drops by 9.99 km when using the potential area K. The corresponding territories would be as follows – the area B: part 1 (1.14 km); part 2 (0.57 km); part 3 (0.5 km); part 5 (0.72 km); the area G: part 4 (1.39 km); part 6 (0.57 km); part 7 (0.58 km); part 9 (0.6 km); part 10 (1.03 km) and the area K: part 8 (0.89 km); part 11 (1.2 km); part 12 (0.8 km).

When using the area A, the total of the distances can decrease by 1.46 km to 8.53 km. The corresponding territories would be as follows: the area A: part 1 (0.5 km); part 3 (0.44 km); part 4 (0.63 km); the area B: part 2 (0.57 km); part 5 (0.72 km); the area G: part 6 (0.57 km); part 7 (0.58 km); part 9 (0.6 km); part 10 (1.03 km) and the area K: part 8 (0.89 km); part 11 (1.2 km); part 12 (0.8 km). By repetition of the algorithm, it is possible to obtain a lower total number of all the distances. However, as the case study does not consider fix costs, it is not clear to what extent building new premises can be profitable, which depends only on the decision of the management of a particular retail operation. Consequently, the total number of the distances would drop to 7.43 km in the areas A, B, G, J and K up to the value 7.25 km, which is minimum for the areas A, B, D, F, G, I, J and K. The given results emphasise implementation of a communication strategy focusing on a target customer. The outcomes are also fundamental for maximising communication outcomes in order to maintain or increase the volume of earnings of a retail operation.

When calculating the number of consumers in the second example, the results differ slightly. The steps of the algorithm and its values are defined in Table 4 below.

Table 4: Outcomes of the ADD method per number of consumers

Distances in total for all the consumers	Corresponding potential areas
23660.5	G
19523.4	A, G
15748.42	A, G, K
13799.69	A, B, G, K
11951.41	A, B, G, J, K
11679.31	A, B, G, I, J, K
11589.87	A, B, F, G, I, J, K
11571.44	A, B, D, F, G, I, J, K

Source: own processing

3.3 Outcomes of Application of the Heuristic Method DROP

The DROP method uses a 'different' principle than the ADD method. Instead of gradual addition as stated above, in the DROP method potential areas are gradually deducted. The beginning of the algorithm lies in finding a possible minimum addition of a distance regardless of the number of potential areas and this number is further optimised. The detailed algorithm in described in the literature below.[15]

Algorithm – DROP method:

1. $II^{pre} = I$, $II = IO = \emptyset$, all $\delta_i = 0$ ($i = 1, 2, ..., m$). Determining $c_{h2,j}$, $c_{h1,j}$ for $j = 1, 2, ..., n$ and the writing $h1$ into corresponding lines of an augmented matrix C. Calculation of the value of function $z = \sum_{i=1}^{n} f_i$.

2. Calculation $\delta_{h1} = \delta_{h1} + (c_{h2,j} - c_{h1,j})$ and $z = z + c_{h1,j}$.

3. If $\delta_i \geq f_i$, the i-area is deemed effective, i.e. $i \in II^{pre}$, it is valid that $II = II \cup \{i\}$ and $II^{pre} = II^{pre} - \{i\}$.

   At the same time finding the area $k \in II^{pre}$, where it is valid that $f_k - \delta_k = \max (f_i - \delta_i, i \in I1^{pre})$.
   $IO = IO \cup \{k\}$, $II^{pre} = II^{pre} - \{k\}$ and $z = z - (f_k - \delta_k)$

4. Determining $c_{h2,j}$, $c_{h1,j}$, $h1$ and calculation δ_{h1} for $j = 1, 2, ..., n$.

If for all the $j = 1, 2, ..., n$ is $h1 \in II$, the calculation process is finished, if not, transition to the third step. There are same symbols in both methods.

14 BREZINA, I., ČIČKOVÁ, Z., REIFF, M.: *Kvantitatívne metódy na podporu logistických procesov.* Bratislava : Vydavateľstvo EKONÓM, 2009, p. 180.

15 BREZINA, I., ČIČKOVÁ, Z., REIFF, M.: *Kvantitatívne metódy na podporu logistických procesov.* Bratislava : Vydavateľstvo EKONÓM, 2009, p. 18.

At the beginning of the algorithm it is necessary to determine the shorter and the second longer distances for every corresponding territory to the nearest potential ares (see Table 5 below).

Table 5: Initial level (the DROP method)

		Territory											
		1	2	3	4	5	6	7	8	9	10	11	12
Potential areas	A	0.50	1.32	0.44	0.63	1.58	1.14	1.33	2.40	2.10	2.22	3.07	3.32
	B	1.14	0.57	0.50	1.50	0.72	1.08	1.80	1.92	2.15	2.62	3.22	3.13
	C	1.00	1.39	0.44	0.76	1.32	0.63	0.99	1.94	1.61	1.86	2.63	2.83
	D	1.30	1.00	0.50	1.37	0.71	0.65	1.44	1.59	1.70	2.20	2.77	2.71
	E	1.32	1.89	0.92	0.68	1.71	0.67	0.50	1.98	1.32	1.39	2.23	2.62
	F	2.01	1.55	1.20	1.85	0.78	0.63	1.49	0.85	1.28	2.01	2.32	2.04
	G	2.00	2.20	1.38	1.39	1.70	0.57	0.58	1.43	0.60	1.03	1.61	1.89
	H	2.24	2.10	1.49	1.80	1.42	0.61	1.12	0.88	0.63	1.43	1.70	1.60
	I	2.28	2.68	1.79	1.49	2.24	1.08	0.50	1.84	0.63	0.50	1.30	1.94
	J	2.96	3.22	2.40	2.19	2.63	1.58	1.20	1.81	0.58	0.55	0.60	1.42
	K	3.04	2.84	2.29	2.50	2.06	1.40	1.64	0.89	0.64	1.49	1.20	0.80
	L	3.20	3.20	2.54	2.54	2.50	1.65	1.58	1.43	0.60	1.14	0.67	0.86
1. min		0.50	0.57	0.44	0.63	0.71	0.57	0.50	0.85	0.58	0.50	0.60	0.80
2. min		1.00	1.00	0.44	0.68	0.72	0.61	0.50	0.88	0.60	0.55	0.67	0.86
area		A	B	A/C	A	D	G	E/I	F	J	I	J	K

Source: own processing

Due to rounding, some of the distances we measured were similar to one another and therefore there are alternative potential areas for two territories. It relates to the parts 3 and 7 when the part 3 corresponds to the area A in a different calculation because of its minimum distance to another part as well. For the same reason, the part 7 corresponds to the area I even though it is rather contradictory from a lexicographic point of view.

Within the solution, the area A corresponds with the parts 1, 3 and 4, the area B with the part 2, the area D with the part 5, the area F with the part 8, the area G with the part 6, the area I with the parts 7 and 10, the area J with the parts 9 and 11 and the area K with the part 12.

The total distance is 7.25 km. In the first step of the algorithm, the area D was removed as there was a minimum difference between the two shortest distances (only 0.01 km). The total distance increased to 7.26 km and the part 5 was added to the area B. Another step was to remove the area F resulting in the increase in the total distance to 7.30 km and the part 8 being added to the area K.

Consequently, the area G, which had been abstracted, caused an increase in the total distance to 7.81 km and the part 6 was added to the area I. After eliminating the area with one corresponding part, the total distance is 7.81 km and the parts are combined with the areas as follows: the area A: part 1 (0.50 km); part 3 (0.44 km); part 4 (0.63 km); the area B: part 2 (0.57 km); part 5 (0.2 km); the area I: part 6 (1.08 km); part 7 (0.50 km); part 10 (0.5 km); the area J: part 9 (0.58 km); part 11 (0.60 km) and the area K: part 8 (0.89 km); part 12 (0.80 km).

After excluding the area I the total distance would be 8.56 km and the parts are combined with the areas as follows – the area A: part 1 (0.50 km); part 3 (0.44 km); part 4 (0.63 km); the area B: part 2 (0.57 km); part 5 (0.72 km); part 6 (1.08 km); the area J: part 7 (1.20 km); part 9 (0,58 km); part 10 (0.55 km); part 11 (0.60 km) and the area K: part 8 (0.89 km); part 12 (0.80 km). After excluding the area K, the total distance would be 10.10 km and there are three potential areas left – A, B and J. Without J, the total distance is 17.71 km and at the end of the algorithm only the area A is left with the total distance of 20.05 km. The results also emphasise importance of implementation of the communication strategy focused on a target customer.

The outcomes for particular steps of the algorithm per number of consumers are stated in Table 6 below.

Table 6: Outcomes of the DROP method per number of consumers

Distances in total for all the consumers	Corresponding potential areas
11571.44	A, B, D, F, G, I, J, K
11589.87	A, B, F, G, I, J, K
11667.99	A, B, F, I, J, K
12343.33	A, B, I, J, K
14066.23	A, B, J, K
17194.09	A, B, J
29989.09	A, B
33417.35	A

Source: own processing

3.4 Outcomes of Application of the Heuristic Method DROP

From the above-mentioned application of the two methods it is obvious that heuristic methods are rather specific and their usability necessarily depends on the form and specificities of a particular task. The more extended the task, the more difficult the solution. These two methods differ in their basic principle and therefore we may assume that it is the project owner's preferences and expectations what matter. For instance, if the project's owner intends to open fewer operations, it is much simpler to implement the ADD method. On the other hand, if the project' owner would like to eliminate certain less effective operations, the DROP method seems to be more convenient. As stated by Brezina, Čičková and Reiff: *"As no method is proved to have a considerably better solution (it depends on the task formulation as in case of the methods admitting a basic solution when resolving simple transport tasks), we may assume that both methods are equally suitable for solving the given type of the tasks."*[16]

Comparison of the outcomes as well as application of the method with better results for the second calculation and for the two methods are stated in Table 7 below.

Table 7: Comparison of the outcomes of optimising heuristic methods

Number of areas	Distances in total for all the consumers		Corresponding potential areas		Method
	ADD	DROP	ADD	DROP	
1	23660.50	33417.35	G	A	ADD
2	19523.40	29989.09	A, G	A, B	ADD
3	15748.42	17194.09	A, G, K	A, B, J	ADD
4	13799.69	14066.23	A, B, G, K	A, B, J, K	ADD
5	11951.41	12343.33	A, B, G, J, K	A, B, I, J, K	ADD

16 BREZINA, I., ČIČKOVÁ, Z., REIFF, M.: *Kvantitatívne metódy na podporu logistických procesov.* Bratislava : Vydavateľstvo EKONÓM, 2009, p. 185.

6	11679.31	11667.99	A, B, G, I, J, K	A, B, F, I, J, K	DROP
7	11589.87	11589.87	A, B, F, G, I, J, K	A, B, F, G, I, J, K	-
8	11571.44	11571.44	A, B, D, F, G, I, J, K	A, B, D, F, G, I, J, K	-

Source: own processing

As mentioned above, these are heuristic methods, i.e. they do not need to have an optimal solution. For instance, when selecting two areas, these are D and J with the total distance of 11.45 km or the total distance of 18,367.19 km for all the consumers.

Conclusion

Based upon the above-mentioned facts, we may draw a conclusion that macroeconomic development has a considerable impact on the performance and very existence of retail operations. The more positive economic development, the higher households' consumption. This phenomenon is also directly linked to a growth in retail sales paving the way for creation and location of new retail operations.

We have drawn attention to two heuristic optimising methods to determine suitable location of a retail operation. The outcomes point to the field of implementation of a communication strategy focused on a target customer with the aim of maximising communication results and finally increasing retail sales.

Their basis is providing services to a target group of customers in the radius of action of a retail operation with regard to its geographical location and market potential. Applying the ADD and DROP methods on a specific case study has been a suitable approach as the methods are not difficult to implement and each of them provides different results to compare and contrast.

By comparing the methods, we may define possible preferences and at the same time see which of them is more effective in relation to its calculation. The methods draw from a contrasting principle and therefore it is possible to select the one calculation process which may be appropriately applied to a specific case study. For instance, if it is necessary to select one or two retail operations, the algorithm for the ADD method could be finished in the first or the second step.

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