WHY DO COMPETING BUSINESSES OPEN UP NEXT TO ONE ANOTHER? NASH EQUILIBRIUM IN OPENING HYPERMARKETS IN BUCHAREST

Cristina STOICESCU[a]*

[a)] *Bucharest University of Economic Studies, Economic Cybernetics and Statistics, Bucharest, Romania*

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Abstract: *Modern Game Theory can be applied in various social and economic situations where the decision made by a single individual is based on the decisions made by others. Companies started to apply these principles in making different management decisions, like opening a new retail center. This paper focuses on the study of the rationale behind the decision of opening a new food retail store very close to the main competitors by applying the Nash Equilibrium in a normal form game with complete information and its extension to the Hotelling model. Early 2017, 36 hypermarkets were operating in Bucharest (Kaufland, Cora, Auchan and Carrefour), all located at a minimum average distance of 2,83 km from one another. Each store serves more than 50.000 people. Most of the stores are placed in the south side of the city. Kaufland is the chain with the highest market share and operating profit in Romania, having the most stores in proximity of other competitors.*

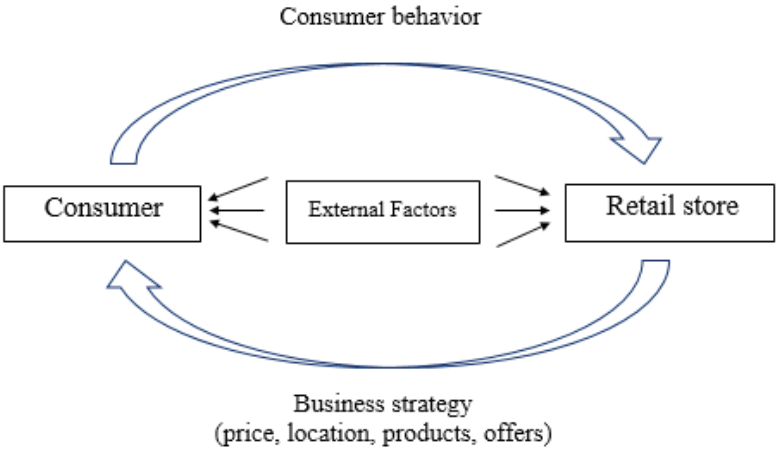
Key words: *consumer behavior; hypermarket; Hotelling model; Nash Equilibrium*
JEL Classification: *C72; D12*

* Corresponding author. *E-mail address:* kris_stoicesku@yahoo.com.

1. Introduction

Over 300 years ago scientists began to study the consumer behavior which has now become an important issue for any company that wants to expand its dimensions, to become more competitive and ultimately, to survive the changes that appear every day in the economic environment. The study of consumer behavior involves the analysis of both components that makes it possible: the buyer (the consumer) and the seller (in this paper the retail store). A continuous feedback loop is created between the two entities that influence the strategies of each other. The consumer changes his behavior according to the business strategy of the retail store (like price policy, location, products, offers), while retail stores adapt their business strategy according to consumer behavior (the customers focus on deals and price, location and layout, or on product quality and variety). Both players are also influenced by external factors such as the political and social context, the technological evolution or the business strategy of other retail stores.

Figure 1. **Feedback loop between consumers and retail stores**



During the last decade, population have registered a strong upward trend, which resulted in overcrowded cities and increasing demands. In order to be able to satisfy the more diverse needs of the consumers, companies began to open more stores, location playing an important role in this decision.

According to AGERPRES, the supermarket is the favorite shopping place for over 83% of Romanians, in 2016 more than 1,400 supermarkets and hypermarkets being open in the country. As a result, the marketplace in Bucharest is overtaken, so choosing the location for opening a new store has become a challenge for every company.

Currently in Romania there are many types of food retail stores like contingency stores (Mega Image Shop&Go, Carrefour Express, Profi City), standard supermarkets (Mega Image, Carrefour Market), discount supermarkets (Lidl, Profi Standard, Penny market), hypermarkets (Kaufland, Auchan, Carrefour, Cora) and Cash&Carry (Metro, Selgros). Each of these types of stores has a certain store area (which may vary from 100 m^2 to 20,000 m^2), a different variety of products and a competitive marketing strategy that influence the type of customers to whom it addresses and so the location of the stores. Contingency stores are mainly built inside the city, on strategic places with high activity and footfall, while hypermarkets are mainly built outside the city, on the main arteries in order to have easy access to the stores.

According to a study made by AMRCR in August-September 2015, for 58% of Romanians the location of the supermarket was a decisive factor in choosing a store (after price and quality of products). In order to study the rationality of the decision to open a new store in a particular location, different models of Game Theory were developed: Reilly's law of retail gravitation, the Huff model, the Hotelling model, Salop's circular city model or the Central place theory of Christaller are some of them.

The goal of this article is to study the location of the hypermarkets in Bucharest by applying two models: Nash Equilibrium and the Hotelling model. At the beginning of the year 2017, there were 4 international companies that opened hypermarkets in Bucharest:

Auchan, Carrefour, Cora and Kaufland. The hypermarkets are using different marketing strategies for choosing the location of their stores.

Cora is the hypermarket with the fewest stores, but better distributed than its main competitor Auchan. Carrefour is the hypermarket with the best distribution of the stores in Bucharest (it is also the only hypermarket with an ultra-central store) and the only brand that also has supermarkets and contingency stores in the city, while Kaufland is the most competitive one, its stores being placed very close to its competitors, having a strong marketing strategy and competitive prices. Kaufland occupies first position among retail food stores in Romania, having the highest market share and operating profit, followed by its main competitor Carrefour.

This paper consists of 5 sections. Section 2 contains a specialty review regarding the main models used to study the location of the stores. Section 3 details two of these models (Nash Equilibrium and Hotelling model) and their relevance for the location of hypermarkets in Bucharest. Section 4 presents a detailed analysis of the location of hypermarkets in Bucharest. Section 5 summarizes the conclusions of the paper.

2. Literature review – Game Theory and location models

Roger Myerson (1991) defined Game Theory as the study of mathematical models of conflict and cooperation between intelligent rational decision-makers.

Game Theory is one of the newest research areas of microeconomics, which started from the mixed strategy equilibria in two person zero-sum game. In 1928 John von Neumann used Brouwer's fixed-point theorem to prove the game. In 1943, John von Neumann together with Oskar Morgenstern, published an extended version of the article from 1928: "The Theory of Games and Economic Behavior" (one of the major works of economic theory). The two authors defined the Game as any interaction between various economic agents, which follows a specific set of rules that establish the possible moves of each participant and the earnings for each combination of moves. All games have three main components (rules which govern

the game, pay-offs such as win, lose or draw and strategies which influence the decision making process) and are developed based on three fundamental principles (players have a rational behavior, everyone knows that the others are rational players and all players know the rules of the game). At the end of a game every player must make a rational decision and choose one of the game's strategy (von Neumann and Morgenstern, 1943).

Game Theory was developed extensively in the 1950s by many researchers, one of the most famous being John Nash, an American mathematician who made fundamental contributions to differential geometry, the study of partial differential equations and game theory.

In 1950, John Nash contributed a remarkable one-page PNAS article (Proceedings of the National Academy of Science of the United States of America) that defined and characterized the notion of equilibrium for *n*- person games. This notion, now called the "Nash Equilibrium," has been widely applied and adapted in economics and other behavioral sciences and it has become the most prominent unifying theory of social science. In "non-cooperative" games proposed by von Neumann and Morgenstern (1943) the payoffs always sum to zero due to the fact that one person's gain is another's loss. Nash proposed a notion of equilibrium that applied to a much wider class of games without restrictions on the payoff structure or number of players.

The theory could be applied to a large variety of phenomena, where the decision of a participant depends on the decision of another. Most of the theories were developed in the field of social sciences and economics, game theory being used to explain different business actions taken by companies, like the choosing the location of a new store. This is one of the main decisions that a company has to make when it starts a new business or expands the current one. The decision is made based on a wide range of factors like population structure, footfall, city infrastructure, costs, real estate, administrative and political factors, proximity of stores with complementary products or services and proximity of competitors.

According to a study made by Akalin, Turhan and Sahin (2013) the store location selection is influenced by 4 main factors: population, retail settlement, costs and competition. They used the AHP (Analytical Hierarchy Process) approach to evaluate the location selection elements for retail stores and their results showed that the population and competition criteria are the most dominant factors. From a more detailed perspective attributes "coherent target market", "competitors' store numbers" and "the amount of money people are willing to spend for buying the retailers' goods" should pay an important role when choosing the location of a new retail store.

When opening a new store a lot of factors must be taken into consideration: demographics (for retailers and for service providers, the type of customers – gender, age, marital status, number of children, religion etc. – and the proximity of the store are critical factors), foot traffic, accessibility and parking, competition, ordinances, utilities and other costs. These factors are taken into consideration when a supermarket opens a new store and the location plays an important role.

Assuming that only the proximity of competitors is taken into consideration, a rational decision will be to choose a location at equal distance from the competitors so that the market is equally distributed. This decision will increase the social satisfaction of consumers and will reduce the competition as the stores don't have to fight for the same market share. So the company can concentrate mainly on the consumer and not on its competitors.

Although, the models and theories developed along with the real locations of stores demonstrate that this social rational principle does not apply. In general, game theory suggests that companies are unlikely to trust each other, even if they conclude and come to an agreement such as raising the price together or splitting the market equally by building retail centers in different parts of a city.

This basic idea of agglomeration was first described in 1929 by an economist named Harold Hotelling in an academic paper entitled "Stability in Competition". The idea was developed extensively in 1933, by a German geographer named Walter Christaller. Christaller's

Central Place Theory posited that the size and location of cities is a function of the type of goods they offer and the relative distance consumers would be willing to travel to consume these goods. This is the main reason why consumers from small towns travel to a larger city to buy higher goods.

In the last century location models and theories were extensively studied, developed and applied in cities all over the world. These models are trying to determine the best location of a store before building it and the impact of this decision on the performance after the store is opened.

A study made by Li and Liu (2012) suggested that the selection of stores locations partially explains the difference in performance between Kmart and Wal-Mart stores. In order to prove that, they used a modified Huff model, taking competition and agglomeration into consideration, to estimate the potential sales. Also, according to a study made by Wang, Chen, Xiu and Zhang (2014) speciality stores favor closeness most, department stores and supermarkets prefer betweenness, while consumer product store value straightness most.

Studies show that agglomeration have both positive and negative aspects. Competitive stores open so close one to each other in order to gain more market share. Yet they may also cooperate with each other in relation to marketing and operational matters within the agglomeration in which they are located. According to a study mage by Teller, Alexander and Floh (2016, "The impact of competition and cooperation on the performance of a retail agglomeration and its stores") competition has a negative direct effect on stores' performance (although the overall effect is insignificant), while cooperation affects store performance positively, but only in a indirect manner.

Companies are complex adaptive systems that need to take into consideration the multiple effects of their business decisions. Choosing a location next to a main competitor may be triggered by a competitive reason that can in the end negatively influence the performance, but it can also have positive effects if the management understands the benefits of cooperation.

3. Methodology – Nash Equilibrium and Hotelling model in the analyze of stores locations

In Game Theory, a normal form game is defined through 3 elements:

- the set of players ($player_i \in P$, where P ={1, 2, ..., N});
- the set of strategies (S_i is the set of strategies for player i, and $S = S_1 \times S_2 \times ... \times S_N$ is the set of strategies profile; each player i has a finite number of pure strategies);
- the payoff functions (u_i is the payoff function for player i).

Taking the above elements into consideration, the game can be mathematically defined by the following formula:

$$G = \{P, S_1, S_2, ..., S_N, u_1, u_2, ..., u_N\} = \{P, S, u\} \quad (1)$$

A pure strategy profile is an association of strategies to players, that is an N-tuple, where $s_i^* \in S_i$. s_i is the strategy profile of player i and $s_{-i} = \{s_1, ..., s_{i-1}, s_{i+1}, ..., s_N\}$ is the strategy profile of all players except for player i. When each player $i \in \{1, 2, ..., N\}$ chooses strategy s_i resulting in strategy profile $s = \{s_i, s_{i-i}\}$ then player i obtains payoff $u_i(s)$. The payoff depends on the strategy profile chosen, including the strategy chosen by player i, as well as the strategies chosen by all the other players. The payoff functions $u_i(s)$ are defined as Neumann-Morgenstern utility functions for every strategy profile $s = \{s_1, s_2, ..., s_N\}$. For an economic point of view these payoffs may represent the profit, the income or the cost, while from a political one they may represent the number of votes earned after an election campaign (Roman *et al.*, 2005).

The Nash Equilibrium is a concept of game theory which states that the optimum outcome of a game is the one where no player will desire to deviate from his chosen strategy after considering the opponents strategies. A player can't increase his payoff from changing his strategy, assuming that the other players remain constant in their strategies. A game may have one Nash Equilibrium, multiple Nash Equilibria or none at all. In the normal form game $G = \{P, S, u\}$, a strategy profile $s^* = \{s_1^*, s_2^*, ..., s_N^*\}$ is a Nash Equilibrium if no unilateral deviation in strategy by any single player is profitable for that player:

$$u_i(s_1^*,...,s_{i-1}^*,s_i^*,s_{i-1}^*,...s_N^*) \geq u_i(s_1^*,...,s_{i-1}^*,s_i^*,s_{i-1}^*,...s_N^*),$$
$$\forall s_i \in S_i, \forall i \in \mathbb{N} \quad (2)$$

s_i^* is the solution of the following mathematical problem:

$$\max_{s_i \in S_i} u_i(s_1^*,...,s_{i-1}^*,s_i^*,s_{i-1}^*,...s_N^*) \quad (3)$$

The Nash Equilibrium is considered one of the most important concepts of Game Theory due to its applicability. It is the solution of a game with two or more players that have nothing to gain by changing their strategies (Roman *et al.*, 2005).

The Prisoner's Dilemma is an example of Game Theory where the Nash Equilibrium can be applied. The Prisoner's Dilemma problem can be applied in different economic situations like changing the supplier, entering a new market, establishing the sale strategy of a new product or opening a new store. All these decisions must be taken in a dynamic environment were multiple factors, including the competitors decisions, must be taken into consideration.

The following economic situation often occurs in real life: a company wants to extend its business by opening a new hypermarket. The main elements of the normal form game are:

- the set of players P = {Hypermarket 1, Hypermarket 2};
- the set of strategies S = {S1 – maintain the location from the agreement and equally split the market share; S2 – change the location in order to improve the market share};
- the payoffs, which are represented by the market share (Figure 1).

Applying the algorithm that maximize the relative gains, if one Hypermarket chooses strategy S1, the other will choose strategy S2 because this strategy improves its market share. As a result, the Nash Equilibrium is the situation were both players choose strategy S2. The result occurs due to aggressive competition, although the outcome is the same as if the players would both have chosen strategy S1. In the situation where the hypermarkets would have both decided to keep the agreement and equally split the market

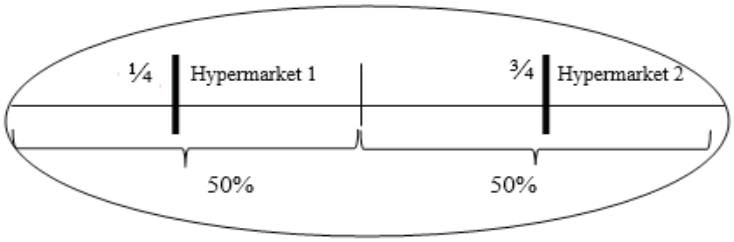
and maximum distance a consumer should take in order to get to a hypermarket would have been minimized. The result is considered in Game Theory as Socially Optimal Solution. The Hotelling model is a visual representation of this game in a linear space, and starts from the Socially Optimal Solution (Figure 2), were both players equally split the market share, but have the possibility to change their location.

Figure 2. **Nash Equilibrium in choosing the location of a new store**

		Hypermarket 2	
		S1	S2
Hypermarket 1	S1	(50, 50)	(50 - 1, 50 + 1)
	S2	(50 + 1, 50 – 1)	(50, 50)

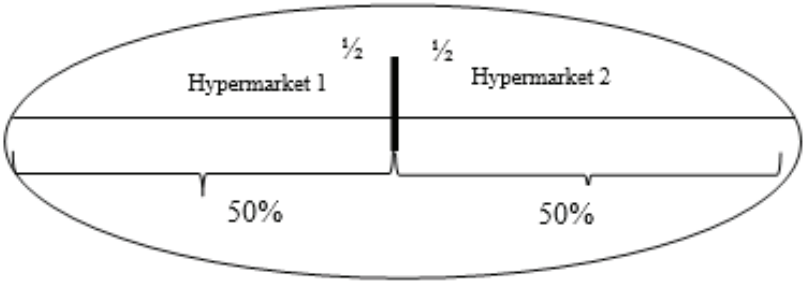
If one of the players choses to betray and move towards the other player, its market share will be increased. Subsequently the two players will change their position by moving closer one to the other in order to improve the market share and to gain more clients. The result would be the Nash Equilibrium, both players meeting midway (see Figure 3).

Figure 3. **Socially optimal solution in Hotelling model**



In reality, it is difficult for a store, particularly for a hypermarket, to change its location, but a new store can be opened closer to the other competitors in order to gain more market share. This situation often occurs in large and crowded cities, like Bucharest.

Figure 4. **Nash Equilibrium in Hotelling model**



4. Data and results – hypermarkets in Bucharest

Due to the political context (communism), the concepts of supermarket, hypermarket and discounter were unknown in Romania until the end of the 20th century, small shops selling few products and wholesale centers still dominating the national trade. Retail stores were first build in Romania 6 years after the 1989 revolution, the market being taken over by international concerts since 2001. In 2017 in Romania there are more than 2000 retail stores (424 supermarkets, 913 discounters, 189 hypermarkets and 51 Cash&Carry), open under the brands Auchan, Kaufland, Carrefour, Cora, Lidl, Mega Image, Metro, Penny Market, Profi and Selgros. Each store has different price strategies and targets specific consumer segments, so the retail market in Romania is an oligopolistic industry.

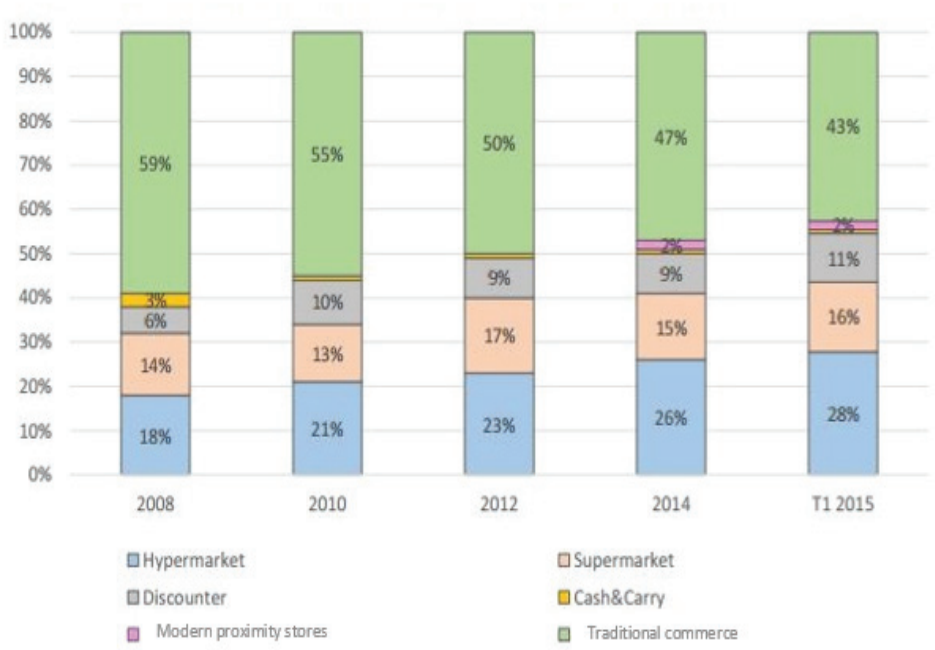
According to a study published online by GfK Romania (2017, "Puterea de cumpărare este în creştere în România"), hypermarkets, supermarkets and discounters started are gaining more market share every year, while Cash&Carry stores have a share less than 1% (the main cause is the activity type of these retail stores, their main clients being other companies and not final consumers). If 10 years ago traditional commerce had a market share of 59%, currently the consumers are more attracted by the buying experience that large retail stores creates (57% of the market share is owned by modern retail). The exponential growth of market share is sustained by the

number of stores opened in the last years. According to the Ministry of Finance, the number of retail stores have grown with 15% in 2015 and 20% in 2016 and the forecasts show that this trend will continue in the next years.

Table 1. **History of retail stores in Romania**

Retail store	First time in Romania	Number of stores in 2017	Achievements
Mega Image	1995	4 hypermarkets 222 supermarkets 294 contingency stores Shop&Go	First supermarket in Romania and in 2017 the largest retailer according to number of stores.
Metro	1996	30 hypermarkets	First Cash&Carry and first retailer that creates a B2B online store.
Billa	1999	86 supermarkets (bought by Carrefour)	First large supermarket
Profi	2000	380 supermarkets Profi Standard 95 contingency stores Profi City 63 rural contingency stores Profi Loco	First supermarket that builds a modular store (for rural environment).
Carrefour	2001	32 hypermarkets 116 supermarkets 48 contingency stores	First hypermarket and first retailer that creates a B2C online store.
Selgros	2001	21 hypermarkets	Second Cash&Carry
Penny Market	2001	208 discounter	First discount supermarket
Cora	2003	12 hypermarkets	Introduces the Drive in concept (click&collect)
Kaufland	2005	112 hypermarkets	The largest retailer according to turnover and surface
Auchan	2006	33 hypermarkets	Introduces the “Generalized discount” concept
Lidl	2011	204 discounters	Last international retailer in Romania

Figure 5. **Evolution of market share by type of stores in Romania**



Source: GfK Romania.

According to the balance sheets published yearly by the Ministry of Finance, Kaufland hypermarket has dominated the retail market in the last years, both in terms of turnover and profit. Second in rank is Carrefour, with half the turnover of its main competitor and a profit 5 times lower. The next two positions are being disputed by Metro Cash&Carry (which exceeds from financial point of view its competitor Selgros, but still is heavily affected by the financial crisis) and Auchan, both succeeding to profit. Last in rank from financial point of view is Cora hypermarket, which registered a slight increase in turnover, but higher losses in 2015, the main cause being the closure of one out of 12 stores.

So, the Romanian modern retail market is dominated by hypermarkets.

Bucharest is the capital of Romania, the most populated area and the most important industrial and commercial center of the country. There are 4 international brands of hypermarkets at national and regional level (the data from this article are extracted from the official sites of the hypermarkets which are mentioned below):

- Auchan – 8 stores (http://auchan.ro/magazinul-tau/);
- Carrefour – 12 stores (https://www.carrefour.ro/magazine/bucuresti/);
- Cora – 4 stores (https://www.cora.ro/store-locator);
- Kaufland – 12 stores (https://m.kaufland.ro/Home/01_magazine/index.jsp).

Figure 6. **Hypermarkets distribution in Bucharest sectors**

The 36 hypermarkets are differently spread in the 6 sectors of the city (Figure 6).

Table 2 contains the main information regarding the analysis of hypermarkets on sector level: general characteristics of sectors (aria, population, number of stores, hypermarkets) and agglomeration coefficients. The first agglomeration coefficient was calculated as the ratio between the area of the sector and the number of hypermarkets

in that sector (eg: 67.5 km² / 4 stores = 16.9 km²/store, for sector 1). The second agglomeration coefficient was calculated as a ratio between the population of the sector and the number of stores in that sector (eg: 345,000 residents / 5 stores = 69,000 res/store, for sector 2).

There is no correlation between the aria of a sector and the number of stores build in that sector, but there is a strong positive correlation of 0.75 between the population of a sector and the number of stores which explains the locations of the stores.

On average, a hypermarket in Bucharest has an attraction area of 6.3 km². According to Table 2, that attraction area of the stores in sectors 6, 3 and 4 is lower than the average, while attraction area of the stores in sectors 2, 5 and 1 is higher than the average. The situation is reversed when the number of consumers served by a hypermarket is taken into consideration: stores from sector 2 are the most crowded (aprox. 69,000 consumers come to each store from this sector), while stores from sector 6 are the least crowded (only 36,700 consumers come to these stores, with 47% less from the hypermarkets in sector 2).

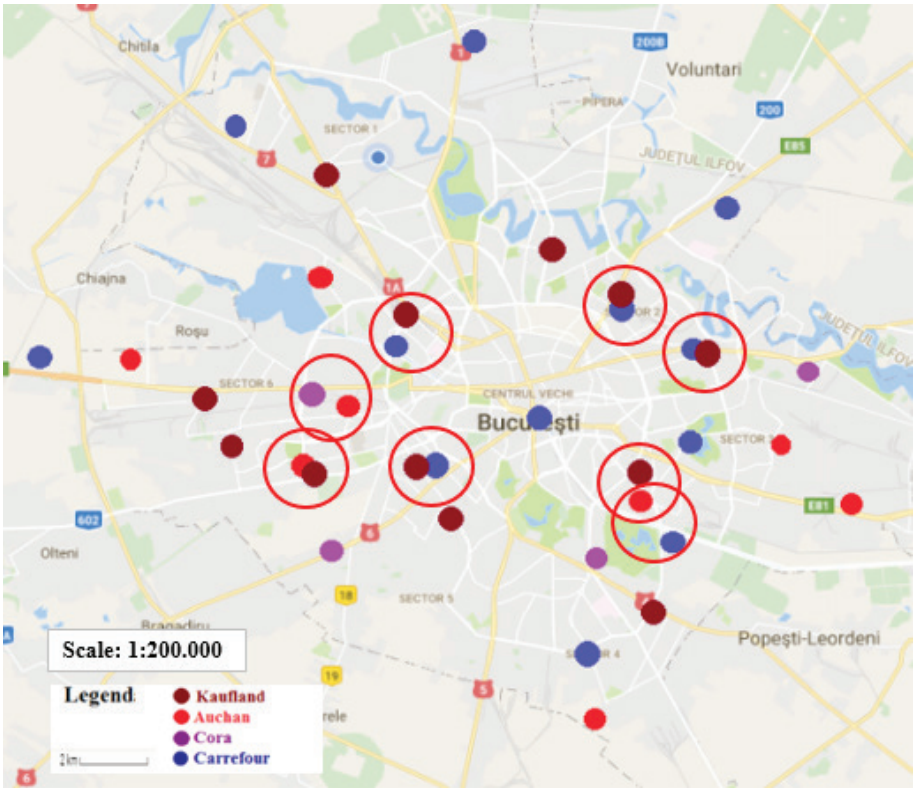
Table 2. **Hypermarkets analyze on sector level**

Sector	Area (km²)	Population (oct. 2011)	No. stores	Agglomeration coefficients		Competitors
Sec 6	38 km²	367,000	10	3.8 km²/store	36,700 res/store	All
Sec 3	32 km²	385,400	7	4.6 km²/store	55,057 res/store	All
Sec 4	34 km²	287,000	6	5.7 km²/store	47,833 res/store	All
Sec 2	32 km²	345,000	5	6.4 km²/store	69,000 res/store	Kaufland, Carrefour
Sec 5	30 km²	217,600	4	7.5 km²/store	54,400 res/store	Kaufland, Carrefour, Cora
Sec 1	68 km²	225,400	4	17 km²/store	56,350 res/store	Kaufland, Carrefour

Most hypermarkets in Bucharest are placed on the main arteries, in strategic places with high traffic and footfall (Figure 7). All hypermarkets

have stores in the south side of the city, while only Kaufland and Carrefour have stores in the north-west side (office buildings density is higher in this area). The only ultra-central hypermarket is Carrefour, the brand with the best coverage (stores are dispersed evenly in the entire city). Cora is the hypermarket with the fewest stores, Auchan is the hypermarket with the lowest coverage, while Kaufland is the hypermarket with the highest number of stores opened very close to the other competitors.

Figure 7. **The representation of hypermarkets on Bucharest map**



Starting from Figure 7, the hypermarkets were mapped in a two-dimensional space, resulting the coordinates from Table 3.

Table 3. **Mapping of the hypermarkets in a two-dimensional space**

Cora		Auchan		Kaufland		Carrefour	
X	Y	X	Y	X	Y	X	Y
				9	10	5	13
				13	12	7	8
		12	10	16	7	10	20
		15	5	17	8	13	17
16	10	16	11	18	10	14	12
20	10	18	10	18	12	14	19
20	17	25	17	19	13	15	3
15	22	19	18	22	18	16	15
		19	23	18	18	17	19
		17	21	14	20	18	13
				12	18	20	19
				11	16	23	17

In order to determine the distance between two stores the Euclidian distance was used. In Cartesian coordinates, if $p = (p_1, p_2, ..., p_n)$ and $q = (q_1, q_2, ..., q_n)$ are two points in Euclidian n-space, then the distance from p to q, or q to p, is given by the following Pythagorean formula:

$$d(p,q) = d(q,p) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + ... + (p_n - q_n)^2} = \\ = \sqrt{\sum_{i=1}^{n} (p_i - q_i)^2} \quad (4)$$

As the mapping of the stores was made in a two-dimensional space, any point (store) can be mapped by two coordinates, X and Y, the Euclidean distance can be expressed as follows:

$$d(p,q) = \sqrt{(X_p - X_q)^2 + (Y_p - Y_q)^2} \quad (5)$$

Using formula 5 and the coordinates from Table 3, the distances from every two stores were determined (Annexes 1-6). According to the results the hypermarkets can be split in two clusters: the stores of Cora and Auchan are placed at an average distance of 2.39 km, while

the stores of Kaufland and Carrefour are placed at an average distance of 2.25 km. Kaufland has the most stores placed near to the other competitors (4 stores placed near to Carrefour and 2 stores placed near to Auchan, the distance being less than 1 km between these stores), while Cora has the most stores placed far from the other competitors (the main cause is the limited number of stores). On average, the distance between all the hypermarkets from Bucharest is 2.83 km.

5. Conclusions

In the last century, retailers have constantly adapted their business strategies to the demographic, economic, social and technological changes, choosing the location for a new store in an overpopulated city becoming one of the most difficult decisions to make. Although the rational and optimal solution would be to choose a location equally spaced from the other competitors, in order to divide evenly the market share and to offer the best distribution of products to the consumer, in reality this situation is uncommon. Several models and theories were developed in order to identify why competitors place their stores next to one another, like the Hotelling model, the Slope curvature or the Central place theory, all of them proving that the retailers have a natural tendency to the Nash Equilibrium.

The food retail market in Romania registered a strong upward trend in the last decade. This predicts that in the next years new stores will be opened and the supermarket will remain the perfect shopping place for Romanians. However, by comparing the Romanian market with over saturated markets from countries like USA or China, it can be assumed that the food retail market in Romania will reach in future a saturation level as consumers will turn to contingency stores that offer a narrower range of products, but who place high emphasis on quality and on the individual preferences of their customers.

In 2017, in Bucharest there were more than 2,000 food retail stores, 36 of them being hypermarkets divided in 4 international brands: Auchan, Carrefour, Cora and Kaufland. The average distance between these stores is 2,83 km (although there are 8 places in the city were the distance between the competitors is less than 1 km), each

store having on average an attraction area of 6.3 km^2. The location of the stores sustain the business strategy of the companies.

Carrefour strategy is to gain market share by covering an area as large as possible, placing stores both at the periphery, but also in center of the city. Also, it is the only brand that has all types of stores: hypermarkets, supermarkets, contingency stores and online store. Kaufland has the most aggressive strategy, its stores being placed very near to the other competitors, trying to dominate the markets from strategic areas, like sectors 6 and 2, by opening several stores very close one to the other. Auchan has stores only in the sectors with the larger population, while Cora has the fewest stores, but very well distributed (4 stores in 3 sectors, at a minimum average distance of 2 km from the other competitors).

As market share is difficult and expensive to gain in an agglomerate city, hypermarkets are trying to attract more clients by building new stores in strategic places and by having competitive prices and appealing offers in the already existing ones.

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Annexes

Annex 1. **Distances between Auchan and Cora (km)**

Cora \ Auchan	A1	A2	A3	A4	A5	A6	A7	A8	MIN
C1	4.00	5.10	1.00	2.00	11.40	8.54	13.34	11.05	1.00
C2	8.00	7.07	4.12	2.00	8.60	8.06	13.04	11.40	2.00
C3	10.63	13.00	7.21	7.28	5.00	1.41	6.08	5.00	1.41
C4	12.37	17.00	11.05	12.37	11.18	5.66	4.12	2.24	2.24
MIN	4.00	5.10	1.00	2.00	5.00	1.41	4.12	2.24	2.39

Average minimum distance

Annex 2. **Distances between Kaufland and Carrefour (km)**

Carrefour \ Kaufland	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	MIN
C1	5.66	6.32	7.62	8.25	10.82	13.04	13.42	13.60	13.15	13.60	14.04	17.46	5.66
C2	2.83	8.94	10.30	7.21	13.89	9.06	10.00	11.18	11.70	14.87	13.00	18.03	2.83
C3	10.05	4.12	3.61	8.54	4.00	14.32	13.89	12.81	11.31	8.25	11.40	12.17	3.61
C4	8.06	2.24	1.00	5.00	3.16	10.44	9.85	8.60	7.07	5.10	7.21	9.06	1.00
C5	5.39	5.00	5.39	1.00	8.00	5.39	5.00	4.47	4.00	7.21	5.10	10.00	1.00
C6	10.30	4.24	2.83	7.07	1.00	12.17	11.40	9.85	8.06	4.12	7.81	8.06	1.00
C7	9.22	13.60	14.32	9.22	17.03	4.12	5.39	7.62	9.49	15.30	10.77	16.55	4.12
C8	8.60	5.10	4.47	4.24	5.39	8.00	7.07	5.39	3.61	3.61	3.61	6.71	3.61
C9	12.04	6.71	5.39	8.06	3.16	12.04	11.00	9.06	7.07	1.41	6.32	5.10	1.41
C10	9.49	7.62	7.21	5.10	8.06	6.32	5.10	3.00	1.00	5.00	1.00	6.40	1.00
C11	14.21	9.49	8.25	9.90	6.08	12.65	11.40	9.22	7.28	2.24	6.08	2.24	2.24
C12	15.65	12.04	11.00	11.18	9.49	12.21	10.82	8.60	7.07	5.10	5.66	1.41	1.41
MIN	2.83	2.24	1.00	1.00	1.00	4.12	5.00	3.00	1.00	1.41	1.00	1.41	**2.25**

Annex 3. **Distances between Kaufland and Auchan (km)**

Auchan \ Kaufland	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	MIN
A1	3.00	2.24	5.00	5.39	6.00	6.32	7.62	12.81	10.00	10.20	7.00	6.08	2.24
A2	7.81	7.28	2.24	3.61	5.83	7.62	8.94	14.76	13.34	15.03	12.37	11.70	2.24
A3	7.07	3.16	4.00	3.16	2.24	2.24	3.61	9.22	7.28	9.22	7.21	7.07	2.24
A4	9.00	5.39	3.61	2.24	0.00	2.00	3.16	8.94	8.00	10.77	9.22	9.22	0.00
A5	17.46	13.00	13.45	12.04	9.90	8.60	7.21	3.16	7.07	11.40	13.00	14.04	3.16
A6	12.81	8.49	11.40	10.20	8.06	6.08	5.00	3.00	1.00	5.39	7.07	8.25	1.00
A7	16.40	12.53	16.28	15.13	13.04	11.05	10.00	5.83	5.10	5.83	9.22	10.63	5.10
A8	13.60	9.85	14.04	13.00	11.05	9.06	8.25	5.83	3.16	3.16	6.40	7.81	3.16
MIN	3.00	2.24	2.24	2.24	0.00	2.00	3.16	3.00	1.00	3.16	6.40	6.08	**2.63**

Annex 4. **Distances between Kaufland and Cora (km)**

Cora \ Kaufland	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	MIN
C1	7.00	3.61	3.00	2.24	2.00	2.83	4.24	10.00	8.25	10.20	8.06	7.81	2.00
C2	11.00	7.28	5.00	3.61	2.00	2.83	3.16	8.25	8.25	11.66	10.63	10.82	2.00
C3	13.04	8.60	10.77	9.49	7.28	5.39	4.12	2.24	2.24	6.71	8.00	9.06	2.24
C4	13.42	10.20	15.03	14.14	12.37	10.44	9.85	8.06	5.00	2.24	5.83	7.21	2.24
MIN	7.00	3.61	3.00	2.24	2.00	2.83	3.16	2.24	2.24	2.24	5.83	7.21	**2.87**

Annex 5. **Distances between Carrefour and Auchan (km)**

Auchan \ Carrefour	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	MIN
A1	8.06	5.39	10.20	7.07	2.83	9.22	7.62	6.40	10.30	6.71	12.04	13.04	2.83
A2	13.45	8.54	15.81	12.17	7.07	14.04	2.00	10.05	14.14	8.54	14.87	14.42	2.00
A3	11.40	9.49	10.82	6.71	2.24	8.25	8.06	4.00	8.06	2.83	8.94	9.22	2.24
A4	13.60	11.18	12.81	8.60	4.47	9.85	7.62	5.39	9.06	3.00	9.22	8.60	3.00
A5	20.22	20.12	15.30	12.00	12.08	11.18	17.20	9.22	8.25	8.06	5.39	2.00	2.00
A6	14.56	15.62	9.22	6.08	7.81	5.10	15.52	4.24	2.24	5.10	1.41	4.12	1.41
A7	16.64	19.21	9.49	8.49	12.08	6.40	20.40	8.54	4.47	10.05	4.12	7.21	4.12
A8	13.89	16.40	7.07	5.66	9.49	3.61	18.11	6.08	2.00	8.06	3.61	7.21	2.00
MIN	8.06	5.39	7.07	5.66	2.24	3.61	2.00	4.00	2.00	2.83	1.41	2.00	**3.15**

Annex 6. **Distances between Carrefour and Cora (km)**

Cora \ Carrefour	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	MIN
C1	11.70	9.22	11.66	7.62	2.83	9.22	7.07	5.00	9.06	3.61	9.85	9.90	2.83
C2	9.85	6.32	10.44	7.28	2.83	9.06	7.00	5.10	9.22	5.00	11.40	17.46	2.83
C3	15.30	15.81	10.44	7.00	7.81	6.32	14.87	4.47	3.61	4.47	2.00	3.00	2.00
C4	12.81	16.12	5.39	5.39	10.05	3.16	19.00	7.07	3.61	9.49	5.83	9.43	3.16
MIN	9.85	6.32	5.39	5.39	2.83	3.16	7.00	4.47	3.61	3.61	2.00	3.00	**3.71**