8. Gnann, J. W. Genital Herpes [Text] / J. W. Gnann, R. J. Whitley // New England Journal of Medicine. – 2016. – Vol. 375, Issue 7. – P. 666–674. doi: 10.1056/nejmcp1603178

9. Yarnykh, T. H. Naukove obgruntuvannia vykorystannia efirnoi olii chainoho dereva v hinekolohii ta dermatolohii [Text] / T. H. Yarnykh, Iu. V. Levachkova, O. A. Harkavtseva // Fitoterapiia. Chasopys. – 2011. – Issue 1. – P. 77–79.

10. Isakov, V. A. Immunomodulyatory v terapii i profilaktike gerpesvirusnyh infekcij [Text] / V. A. Isakov, D. V. Isakov // Klinicheskaya medicina. – 2015. – Vol. 93, Issue 4. – P. 16–24.

11. Koch, C. Inhibitory effect of essential oils against herpes simplex virus type 2 [Text] / C. Koch, J. Reichling, J. Schneele, P. Schnitzler // Phytomedicine. – 2008. – Vol. 15, Issue 1-2. – P. 71–78. doi: 10.1016/j.phymed.2007.09.003

12. Letyaeva, O. I. Genital'nyj gerpes: sovremennaya koncepciya terapii [Text] / O. I. Letyaeva, O. R. Ziganshin, Yu. V. Kudrevich, O. A. Gizinger // RMZH. – 2015. – Issue 28. – P. 1701–1704.

13. Levachkova, Yu. V. Spectrophotometric determination of acyclovir in the suppository [Text] / Yu. V. Levachkova, T. G. Yarnykh, A. M. Litvinova, V. M. Chushenko // Der Pharma Chemica. – 2016. – Vol. 8, Issue 2. – P. 356–360.

14. Pat. No. 107464 UA. Farmatsevtychna kompozytsiia u formi supozytoriiv (pesariiv) dlia likuvannia ta profilaktyky henitalnoi formy herpesvirusnoi infektsii [Text] / Levachkova Iu. V., Lytvynova O. M., Chernykh V. V., Zaichenko H. V., Sinitsyna O. S., Chushenko V. M.; zaiavn. i patentovl. NFaU. – No. u 201511570; declareted: 23.11.2015; published: 10.06.2016, Bul. No. 11. – 6 p.

15. Marennikova, S. S. Razrabotka i prakticheskoe ispol'zovanie novyh ehksperimental'nyh modelej raznyh form gerpeticheskoj infekcii [Text] / S. S. Marennikova, G. R. Macevich, E. V. Chekunova // Voprosy virusologii. – 1986. – Issue 1. – P. 59–65.

16. Derzhavna Farmakopeia Ukrainy. Dop. 1 [Text] / Derzhavne p-vo «Naukovo-ekspertnyi farmakopeinyi tsentr». – 1-e vyd. – Kharkiv: RIREH, 2004. – 520 p.

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PREDICTION OF THE COMPETITIVENESS DYNAMICS OF PHARMACY NETWORKS

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У ринковій економіці одним із головних завдань будь-якого підприємства (організації) є перемога в конкурентній боротьбі. Перемога не разова, не випадкова, а як закономірний підсумок ефективного управління цим процесом.

***Метою роботи** є розробка методичних підходів до моделювання динаміки конкурентоспроможності аптечних мереж в умовах мінливої ринкової ситуації.*

***Методи.** В процесі роботи був використаний метод багатовимірного кореспондентського аналізу (correspondence analysis).*

***Результати дослідження.** Для прогнозування динаміки конкурентоспроможності аптечних мереж на початковому етапі було проаналізовано 53 потенційних фактори, що впливають на рівень результуючого показника. З використанням багатовимірного кореспондентського аналізу розроблено математичну модель, що дозволяє прогнозувати динаміку конкурентоспроможності аптечних мереж на основі обчислення «індексу конкурентоспроможності» – числового показника, що приймає позитивні значення в разі підвищення конкурентоспроможності та негативні – при відсутності її позитивної динаміки.*

***Висновки.** Запропоновано методичні підходи до прогнозування конкурентоспроможності аптечних мереж, що дозволяють приймати управлінські рішення, спрямовані на протистояння негативним зовнішнім впливам і досягнення лідерства у відповідності з поставленими стратегічними цілями організації*

***Ключові слова:** прогнозування, динаміка конкурентоспроможності, аптечні мережі*

1. Introduction

In market economy, one of the main tasks of any enterprise (organization) is to defeat rival competitors. It should not be single or random victory, but it should be natural result of effective management of this process.

2. Formulation of the problem in a general way, the relevance of the theme and its connection with important scientific and practical issues

Pharmacy chain as integrated system characterized by a number of interrelated elements implies competitiveness modeling subsystem oriented to successful functioning in volatile market environment; it is necessary for effective management in constantly changing conditions.

Peculiarities of the studied process can significantly influence on the choice of the method of the pharmacy networks competitiveness dynamics; counted parameters variety, non-linearity of correlation between them, and the probabilistic nature of the studied process are the most significant of them. Simulation models, directed to the studied process reproduction for optimization of the analyzed parameters possible correlation to select the most efficient way to achieve the objectives, in this case the pharmacy networks competitiveness, are the most appropriate to solve the given problems.

3.Analysis of recent studies and publications in which a solution of the problem and which draws on the author

Issues devoted to the enterprise (organization) competitiveness management were disclosed in the studies of M. Porter, B. Waterman, E. Chamberlain, F. Edgeworth, M. Ermikh, Yu. Ivanov, A. Voronkova, A. Tishchenko, and others.

Thus, in particular, theoretical aspects of enterprise potential competitiveness determination are shown in the [1]; enterprise competitiveness in marketing system was studied in [2]; in [3] publication the method for estimation of industrial enterprises competitiveness level is displayed.

The number of articles are also devoted to research of the content and study of methodological and methodical approaches in pharmacy. In [4] the analysis of the indexes influencing on pharmaceutical enterprises competitiveness is shown. The content, as well as methodical aspects of pharmaceutical enterprises competitiveness are presented in [5, 6]. In [7] the relevance of the use of qualitative and quantitative methods for pharmaceutical enterprises competitiveness assessment is substantiated. In [8] scientific approaches to remedies competitiveness are explained.

4. Allocation of unsolved parts of the general problem, which is dedicated to the article

At the same time, the issues of the modelling of dynamics of pharmacy networks competitiveness remain unexplored.

5. Formulation of goals (tasks) of Article

The aim of the present study was development of the methodical approaches for the pharmacy networks competitiveness dynamics modelling under volatile market situation conditions using modern mathematical methods. The advantage the mathematical methods is in reproducing properties, functions and methods of functioning of pharmacy networks, which are characterized by:

– accordance with the modeling objects;

– common modeled object properties required for the research goals;

– the ability to formalize the competitiveness description, as well as the presence of the certain rules for transition from the model information to information about the specific pharmacy chain.

The mentioned goal was to solve the following tasks:

• determination of the main factors influencing on the pharmacy chain competitiveness, study of the multiple connections between them and construction of the contingency table of competitiveness indicators and predictors of the pharmacy networks competitiveness improvement (the Burt matrix);

• construction of the map which shows graphically correlation between the pharmacy networks competitiveness improvement and the variables affecting it;

• model building for competitiveness dynamics predicting on the basis of the multiple correspondence analysis.

6. Statement of the basic material of the study (methods and objects) with the justification of the results

For prediction of the pharmacy networks competitiveness dynamic 53 indexes were analyzed initially to characterize:

– chain pharmacy location features;
– its daily turnover and number of employees;
– pharmacy chain type (national/regional);
– format;
– additional services and discount cards availability;
– organization structure type;
– efficiency of the marketing complex;
– quality system implementation;
– work schedule;
– competent management;
– financial position of the pharmacy;
– effective system for the employees motivation etc.;
– the ones influencing on the given resulting feature, and estimation of their influence was determined [9, 10].

The following methods were used for research: pairwise intergroup comparisons method using Mann–Whitney test; contingency tables analysis using maximum likelihood criterion χ^2; Gamma correlation coefficient; Chaddock scale; χ^2-test, used by Feature Selection and Variable Screening tool of the Stat Soft Statistica Data Mining software module. Later, to create the model for predicting the binary target variable «pharmacy chain competitiveness improvement» values, four indicators that have the most statistically significant relationship with competitiveness were identified (Table 1).

To analyze the correlation between the pharmacy chain competitiveness dynamics and the influencing factors, the multiple correspondence analysis method was used. Representation of the outcome and predictor varia-

bles as a single space of reduced dimension projection was obtained using this method, which made it possible to investigate multidimensional correlations between the indexes. On the obtained projection, each of the categories of considered variables values is given as a separate point with its coordinates. On the basis of closeness or remoteness of points, it became possible to analyze the strength of the studied indexes mutual influence (the closer the points to each other, the stronger relationship between those indexes values that they represent).

Table 1

Predictors, influencing the most significantly on the pharmacy networks competitiveness improvement

Predictors	Features
Level of the marketing complex efficiency estimation	ordinal index, considered on three levels: *low, medium* or *high*
Pharmacy location features	nominal dichotomous index taking the value of 1 if the pharmacy is located in a residential area, and 0 – otherwise
Strong financial position	nominal dichotomous indexes taking the value of 1 if the pharmacy chain is characterized by the given advantage, and 0 – otherwise
Competent management	

At the model constructing, both the points corresponding to the target variable values (i. e. competitiveness improvement presence/absence), and the points corresponding to the explanatory variables values were separately positioned. The points' coordinates were used to calculate the distances between them. The distances from the points corresponding to the predictor variables values to the points corresponding to the outcome (target) index values were calculated. The Euclidean metric was used for the distances calculation. On the basis of the calculated distances, the weighting coefficients of competitiveness improvement predictors were determined by the following principle – the closer the point-predictor is to the point-value of the target variable, the more weight it has. The weighting coefficients of this index in the pharmacy chain competitiveness prediction model also decreases proportionally to the increasing of the distance between the predictor point and the point-value of the target variable.

The initial information showing the relationship between the predictor indexes and the target variable is represented by their common contingency table (Figure 1), called the Burt matrix. Elements on the main diagonal of this matrix correspond the number of observations for each of the categories of values of the analyzed variables; off-diagonal blocks are two-input contingency tables for each pair of the indexes.

Fig. 1. Correspondence analysis results: graphical scheme of the two-dimensional projection of the relationship between the pharmacy networks competitiveness dynamics and the factors that determine it

Since both rows and columns of the Burt matrix are determined by the same categories of the indices under consideration, it is obviously symmetric. For the studied variables, the Burt's matrix dimension is 11×11, that is all the existing correlations are described by only 66 numerical values observed in the frequency contingency table.

By using the multiple correspondence analysis, the Burt matrix dimension can be reduced with the maximum possible retention of the given multidimensional

relationships. The analysis showed that in order to represent the studied 11×11- contingency table that keeps at least 90 % of the information in it, it is sufficient to use a 5 dimension-space (Fig. 2 and Fig. 3). In this case, the projection quality is 94.01%, which is a rather good indicator.

Observed Table (Frequencies) (!!___Spreadsheet560(3_clusters))
Input Table (Rows x Columns): 11 x 11 (Burt Table)
Include condition: v84=2

	Competitiveness improvement ABSENT	Competitiveness improvement PRESENT	The level of marketing complex efficiency LOW	The level of marketing complex efficiency MEDIUM	The level of marketing complex efficiency HIGH	Pharmacy location features IN RESEDENTIAL AREA	Pharmacy location features OTHER	Strong financial position NO	Strong financial position YES	Competent management NO	Competent management YES	**Total**
Competitiveness improvement : ABSENT	22	0	6	14	2	8	14	17	5	17	5	**110**
Competitiveness improvement : PRESENT	0	45	0	17	28	2	43	19	26	17	28	**225**
The level of marketing complex efficiency : LOW	6	0	6	0	0	2	4	4	2	4	2	**30**
The level of marketing complex efficiency : MEDIUM	14	17	0	31	0	6	25	20	11	20	11	**155**
The level of marketing complex efficiency : HIGH	2	28	0	0	30	2	28	12	18	10	20	**150**
Pharmacy location features : IN RESEDENTIAL AREA	8	2	2	6	2	10	0	8	2	8	2	50
Pharmacy location features : OTHER	14	43	4	25	28	0	57	28	29	26	31	**285**
Strong financial position : NO	17	19	4	20	12	8	28	36	0	27	9	**180**
Strong financial position : YES	5	26	2	11	18	2	29	0	31	7	24	**155**
Competent management : NO	17	17	4	20	10	8	26	27	7	34	0	**170**
Competent management : YES	5	28	2	11	20	2	31	9	24	0	33	**165**
Total	**110**	**225**	**30**	**155**	**150**	**50**	**285**	**180**	**155**	**170**	**165**	**1675**

Fig. 2. The Burt matrix of the target variable and predictors of the pharmacy networks competitiveness improvement

The obtained coordinates of the Burt matrix rows and columns in a general 5-dimensional space were used for correlation graphical representation (map) creation, which makes it possible to visually estimate the every predictor's influence degree on the pharmacy chain competitiveness improvement or deterioration. In Fig. 1, the two-dimensional projection of this map into the space determined by the first two dimensions (eigenvalues) is shown.

Eigenvalues and Inertia for all Dimensions (!!___Spreadsheet560(3_clusters))
Input Table (Rows x Columns): 11 x 11 (Burt Table)
Total Inertia=1,2000
Include condition: v84=2

Number of Dims.	**Singular Values**	Eigen-Values	Perc. of Inertia	Cumulatv Percent	Chi Squares
1	0,693332	0,480710	40,05914	40,0591	234,8448
2	0,477200	0,227720	18,97669	59,0358	111,2499
3	0,411131	0,169029	14,08576	73,1216	82,5771
4	0,395231	0,156208	13,01732	86,1389	76,3134
5	0,307296	0,094431	7,86922	94,0081	46,1330
6	0,268146	0,071902	5,99187	100,0000	35,1270

Fig. 3. Correspondence analysis results: eigenvalues of the Burt matrix singular decomposition and the explained by them inertia

The obtained map allows visualizing the correlation between the pharmacy networks competitiveness improvement and the variables affecting it. Thus, on the right side of the map, the pharmacy networks characterized by improvement of competitiveness are depicted (*the big red "YES" point*). Associated with the increased competitiveness factors (marketing complex efficiency high level, location out of the residential area, the availability of the competent management and strong financial position) are sufficiently closely grouped near the "YES" point (responsible for the competitive pharmacy networks group). The mutual arrangement of points allows us to conclude that the most significant factor for competitiveness improvement is high level of marketing complex efficiency (this point is closest to the "YES" point), the pharmacy favorable location and the availability of competent management, as well as a strong financial position, make slightly smaller and approximately equal contribution.

In the left part of the projection, a group of non-competitive pharmacy networks is located (*the big red "NO" point*). As the graphic shows, the location of the pharmacy in the residential area is the most significant factor determining the lack of competitiveness improvement. The low level of marketing complex efficiency has the least impact on the pharmacy chain to be considered as non-competitive. The lack of competent management and a strong financial position are also associated with non-competitive pharmacies (*these points are closer to the point "NO" than to the point "YES"*).

The point corresponding to the average level of the marketing complex efficiency is equidistant from the

"NO" and "YES" points on the map, which shows that this index is not the main for competitiveness improvement. That is, with an medium level of the marketing complex efficiency, the competitiveness improvement is possible due to the other factors involvement.

Nevertheless, it should be mentioned, that the given map is one of the two-dimensional projections of the five-dimensional space of interrelations between competitiveness improvement and indicators explaining it. The analysis of the two-dimensional map is useful for understanding (*reflecting*) of the general tendencies and regularities for competitiveness management, but to clarify the features of the influence of explanatory variables on the target index, all five dimensions should be taken into account.

The points' coordinates in all five dimensions of the presentation space were used to quantify the influence degree of each of the explanatory variables on the pharmacy chain competitiveness improvement, which is shown as the following formula coefficients for the so-called competitiveness index (*I*):

$$I = \begin{pmatrix} -4.21 \\ -4.97 \\ 8.11 \end{pmatrix} \cdot \text{marketing complex level} + \begin{pmatrix} -4.99 \\ 11.51 \end{pmatrix} \cdot \text{pharmacy location} +$$

$$+ \begin{pmatrix} 2.75 \\ -5.58 \end{pmatrix} \cdot \text{strong financial position} + \begin{pmatrix} 3.55 \\ -6.17 \end{pmatrix} \cdot \text{competent management}$$

Predictor variables in this model should be considered as vectors:

$$\text{marketing complex level} = \begin{bmatrix} \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, & \text{at low estimation level} \\ \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, & \text{at medium estimation level} \\ \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}, & \text{at high estimation level} \end{bmatrix}$$

$$\text{the pharmacy location} = \begin{bmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix}, & \text{if the pharmacy is located in resedential area} \\ \begin{pmatrix} 0 \\ 1 \end{pmatrix}, & \text{otherwise} \end{bmatrix}$$

$$\text{strong financial position} = \begin{bmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix}, & \text{if the pharmacy chain has this advantage} \\ \begin{pmatrix} 0 \\ 1 \end{pmatrix}, & \text{otherwise} \end{bmatrix}$$

$$\text{competent management} = \begin{bmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix}, & \text{if the pharmacy chain has this advantage} \\ \begin{pmatrix} 0 \\ 1 \end{pmatrix}, & \text{otherwise} \end{bmatrix}$$

The "·" (*dot*) sign means scalar product of vectors.

The obtained value of *I* index as a result of calculations is interpreted as follows: if $I > 0$ it is necessary to predict the competitiveness improvement of the pharmacy chain, in case of $I < 0$ – the absence of it.

Using the developed model, the pharmacy chain competitiveness can be correctly predicted with an accuracy of 76.12%. At the same time, the accuracy of coverage of the pharmacy networks class, in which competitiveness improvement was observed is 80 %, and predictive accuracy for this class is 83.72 %.

The accuracy of coverage for pharmacy networks without competitiveness improvement was 68.18 %, predictive accuracy for this class was 62.50 %.

7. Conclusion

Rivalry is a dynamic, developing and continuously changing process. To increase the validity of management decisions aimed at the pharmacy networks competitiveness improvement under a changing market condition, the use of the modeling methods based on the modern mathematical apparatus is expedient.

Using a multiple correspondence analysis, a mathematical model was developed; the model allows predicting the pharmacy networks competitiveness dynamics on the basis of the "*competitiveness index*" calculation – a numeric index taking positive values in case of increasing competitiveness and negative ones - in case of the absence of its positive dynamics. The use of the coefficient-vectors in the formula for the competitiveness index for explaining variables allows differentiating the importance of each of the possible categories of predictor values when different ways of the competitiveness dynamics are determined.

The offered mathematical approaches to the pharmacy networks competitiveness prediction allow making substantiated management decisions aimed at confronting all kinds of external influences and achieving the leadership of the pharmacy chain in accordance with the strategic goals.

References

1. Vavulina, Yu. V. Teoretychni aspekty vyznachennya konkurentospromozhnosti potencialu pidpryyemstva [Text]: mat. IV mizhnar. nauk.-pr. konf. / Yu. V. Vavulina, V. G. Kotlyarova // Aktualni problemy rozvytku galuzevoyi ekonomiky ta logistyky. – Kharkiv: NFaU, 2015. – P. 289–291.

2. Goncharov, A. B. Konkurentospromozhnist pidpryyemstva v systemi marketyngu [Text]: mat. II mizhnar. nauk.-pr. int.-konf. / A. B. Goncharov, Ya. O. Antonova // Formuvannya strategiyi naukovo-tekhnichnogo, ekologichnogo i socialno-ekonomichnogo rozvytku suspilstva. – Ternopil: Krok, 2013. – P. 111–113.

3. Konkurentospromozhnist pidpryyemstva: ocinka rivnya ta napryamy pidvyshhennya [Text]: monografiya / O. G. Yankovogo (Ed.). – Odessa: Atlant, 2013. – 470 p.

4. Kotviczka, A. A. Analiz faktoriv, shho vplyvayut na konkurentospromozhnist vitchyznyanykh farmacevtychnykh pidpryyemstv [Text]: mat. IV nauk.-pr. konf. / A. A. Kotviczka, I. O. Surikova // Suchasni dosyagnennya farmacevtychnoyi tekhnologiyi. – Kharkiv: NFaU, 2014. – P. 166–167.

5. Posylkina, O. V. Metodologichni i metodychni aspekty ocinky konkurentospromozhnosti farmacevtychnykh pidpryyemstv [Text] / O. V. Posylkina, N. V. Demchenko // Upravlinnya, ekonomika ta zabezpechennya yakosti v farmaciyi. – 2014. – Vol. 2. – P. 28–35.

6. Posylkina, O. V. Konkurentospromozhnist pidpryyemstva [Text]: metod. rekom. / O. V. Posylkina, O. V. Kozyryeva, K. S. Svitlychna, A. G. Khromykh. – Kharkiv: Vyd-vo NFaU, 2015. – 94 p.

7. Rogulya, O. Yu. Zastosuvannya yakisnykh ta kilkisnykh metodiv ocinky konkurentospromozhnosti farmacevtychnogo pidpryyemstva [Text]: mat. II nauk.-pr. konf. / O. Yu. Rogulya, V. O. Lozenko // Aktualni problemy rozvytku galuzevoyi ekonomiky ta logistyky. – Kharkiv, 2013. – P. 97–99.

8. Mnushko, Z. M. Vyznachennya konkurentospromozhnosti likars'kykh preparativ antyhel'mintnoyi diyi, prysutnikh na farmatsevtychnomu rynku Ukrayiny [Text] / Z. M. Mnushko, Yu. V. Popova // Visnyk farmatsiyi. – 2006. – Vol. 3. – P. 35–40.

9. Mala, Zh. V. Analiz faktoriv vplyvu na dynamiku konkurentospromozhnosti aptechnykh merezh v zalezhnosti vid yikh typu [Text] / Zh. V. Mala, O. V. Posylkina, M. M. Nessonova // Upravlinnya, ekonomika ta zabezpechennya yakosti v farmatsiyi. – 2017. – Vol. 1 (43). – P. 44–47.

10. Mala, Zh. V. Methodological approaches to the analysis and assesment of marketing competitive advantages of pharmacy networks [Text] / Zh. V. Mala, O. V. Posylkina, M. M. Nessonova // Social Pharmacy in Health Care. – 2017. – Vol. 3, Issue 1. – P. 41–51.

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