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ASSESSMENT OF THE BANK'S ELECTRONIC MONEY USING THE METHOD OF HIERARCHIES ANALYSIS

Abstract. In the article the methodological approach of using the analytic hierarchy method for evaluation of the effectiveness of bank operating with electronic money is proved. The basic stages of the analysis in accordance to this method's algorithm are disclosed. The results of numerical calculation procedure of selection of the most optimal variant for the concrete bank on the basis of priority set of financial indicators are presented. Testing methods are confirmed the possibility of its using under the evaluation of a bank activity with electronic money. In the article the method advantages are also marked out, the usage algorithm on the basis methodical approach of electronic money analysis in banks is represented, each stage of this method within the research area is disclosed, the matrixes of pairwise elements comparing are designed with the requirements of method of hierarchies analysis.

Keywords: electronic money, the method of hierarchies analysis, hierarchy, matrix priority indicator.

Formulas: 0; fig.: 2, tabl.: 19, bibl.: 10.

JEL Classification: G 21, C 50, E 42.

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ОЦІНКА РОБОТИ БАНКУ З ЕЛЕКТРОННИМИ ГРОШИМА З ВИКОРИСТАННЯМ МЕТОДУ АНАЛІЗУ ІЄРАРХІЙ

Анотація. У статті обґрунтовано ефективний методичний підхід щодо використання методу аналізу ієрархій для здійснення оцінки ефективності роботи банку з електронними грошима. Розкрито основні етапи аналізу згідно із алгоритмом даного методу та виділені його переваги. Представлені числові розрахунки процедури вибору найбільш оптимального варіанту для конкретного банку на основі обґрунтованої пріоритетної множини фінансових показників аналізу. Апробація методики підтвердила можливість її застосування при оцінюванні діяльності банку з електронними грошима.

Ключові слова: електронні гроші, метод аналізу ієрархій, ієрархія, матриця, пріоритет, показник.

Формул: 0, рис.: 2, табл.: 19, бібл.: 10.

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ОЦЕНКА РАБОТЫ БАНКА С ЭЛЕКТРОННЫМИ ДЕНЬГАМИ С ИСПОЛЬЗОВАНИЕМ МЕТОДА АНАЛИЗА ИЕРАРХИЙ

Аннотация. В статье обоснован эффективный методический подход по использованию метода анализа иерархий для оценки эффективности работы банка с электронными деньгами. Раскрыты основные этапы анализа в соответствии с алгоритмом данного метода и выделены его преимущества. Представлены числовые расчеты процедуры выбора наиболее оптимального варианта для конкретного банка на основе обоснованного приоритетного множества финансовых показателей анализа. Апробация методики подтвердила возможность ее применения при оценке деятельности банка с электронными деньгами.

Ключевые слова: электронные деньги, метод анализа иерархий, иерархия, матрица, приоритет, показатель.

Формул: 0, рис.: 2, табл.: 19, библи.: 10.

Introduction. The modern conditions of banking activity performing are accompanied with swift development of scientific-technical progress, that favour the appearance, in addition, of innovation products for performing the payments and assets transfer. One of such innovation is the possibility to perform the payments with the help of electronic money. The term «electronic money» is used for different payment tools, which are based on technical solutions [1, p. 5]. Realization of the noted payment tool by bank can substantially increase its popularity among population and competitiveness on financial services market.

But firstly, before start of such business project that requires the large investments to creation and development of infrastructure, popularization of electronic money which issued by current bank among the goods or services sellers and customers, and also to other activities, the bank should thorough plan the future incomes and predict the necessary activity indicators of such business direction. At this, when the operation with the issue and organization of electronic money turnover is started, the banks should have effective tools for analysis of their activity, which in our context in the scientific literature are not enough developed and approved. In this article we will focus on research of indicators of banks operation with electronic money on the basis of econometrics methods, that allows to perform the analysis of banks operation with the noted tool using the scientific grounded approach and to support the management with objective information for adequate decisions making.

Literature review and the problem statement. Research of banks activity analysis problems is the scientific direction of large amount of modern domestic and foreign scientists, among which Azarenkova G., Gerasymovych A., Adamyk B., Lavrushyn O., Krylova V., Prymostka L., Ryabinina L. and others. But nowadays there is not enough attention in scientific literature to such dedicated direction as the analysis of bank operation with electronic money. At the same time, if take into account the swift development of different technological innovations and the electronic money availability as the mass payment tool, than the need in quality and scientific grounded evaluation of banks activity in this direction, on our opinion, is actual and timely.

The article purpose is to disclose an essence of methodological approach for performing the analysis and evaluation of bank operation with electronic money with the help of the method of hierarchies analysis.

Research results. As to the selected tool, which it is proposed to use for evaluation the bank operation with electronic money, than it is the method of hierarchies analysis (MAH) [2], that allows to effectively determine the most major alternatives, which should be evaluated from the viewpoint of the most influential on the final result.

It is known, that the method of hierarchies analysis was developed by American mathematician Tomas Saati at the end of 70th [2, p. 5] last century. The main its advantages, according to the words Gugarevuch O.K. [3, p.17], firstly, taking into account of "human factor", because, it is needed to examine a concept as display of all totality of the personal humans internals, that influence on her decision, secondly, that at application of method there are not problems at bringing criteria over to identical units, thirdly, the chart of application of method can be used in any sphere of activity.

The method of analysis of hierarchies is currently, according to Pavlov, A. A. [4, p. 48], one of the most used methods for solving multicriterian choice. The purpose of its use is the rationale for the choice of the best of the proposed alternatives that receives the greatest value. It is a stepwise procedure hierarchical image of elements determining the basis of any problem. He is the decomposition of the investigated problem and the separation of the components at all simpler parts [5, p. 26]. This method provides for pairwise comparisons of objects using subjective judgments of experts, numerically evaluated on a certain scale of relative importance [6, p. 67], and the finding by a specific rule of global priorities to achieve the goal, checking judgment on the consistency, decision making studies [7, p. 80]. In turn, the hierarchy is the arrangement of elements of the whole in order from highest to lowest.

Evaluation metrics for the analysis of e-money in the bank using the method of analysis of hierarchies provides for the following stages [8, p. 27]:

1. The synthesis of many judgments. This step of the method is characterized by carrying out the decomposition of the task and its presentation in the form of a definite hierarchy, including the purpose, ways of its achievement and criteria for evaluation of alternatives.

2. Receive priority criteria. It is advisable to set local priorities indicators by creating matrices and implementation of pairwise expert comparisons.

3. Finding alternative solutions. This stage involves the application of the principle of synthesis to determine global priorities hierarchy, and interpretation and analysis of the obtained data.

A great aspect of this method is to determine not only the order of priorities of each individual criterion, but also the value of priority [2].

According to the above method of calculation method of analysis of hierarchies will conduct the assessment of Bank's operations with electronic money.

In [9, p. 288; 10, p. 60] for the basic assessment of the bank's work with electronic money is defined as follows: definition of solvency and liquidity of the bank in the context of his work with electronic money, the study of the structure and dynamics of the amount of electronic money in the composition of bank liabilities, the assessment of the level of business activity of the bank, assessment of the bank's social responsibility.

Based on research described in [9] regarding the tools of economic analysis of electronic money in the banks, consider, and bring the criteria into the model (fig.1).

Typically, in this method, the first level is the ultimate goal, in our case - assessment of bank's operations with electronic money.

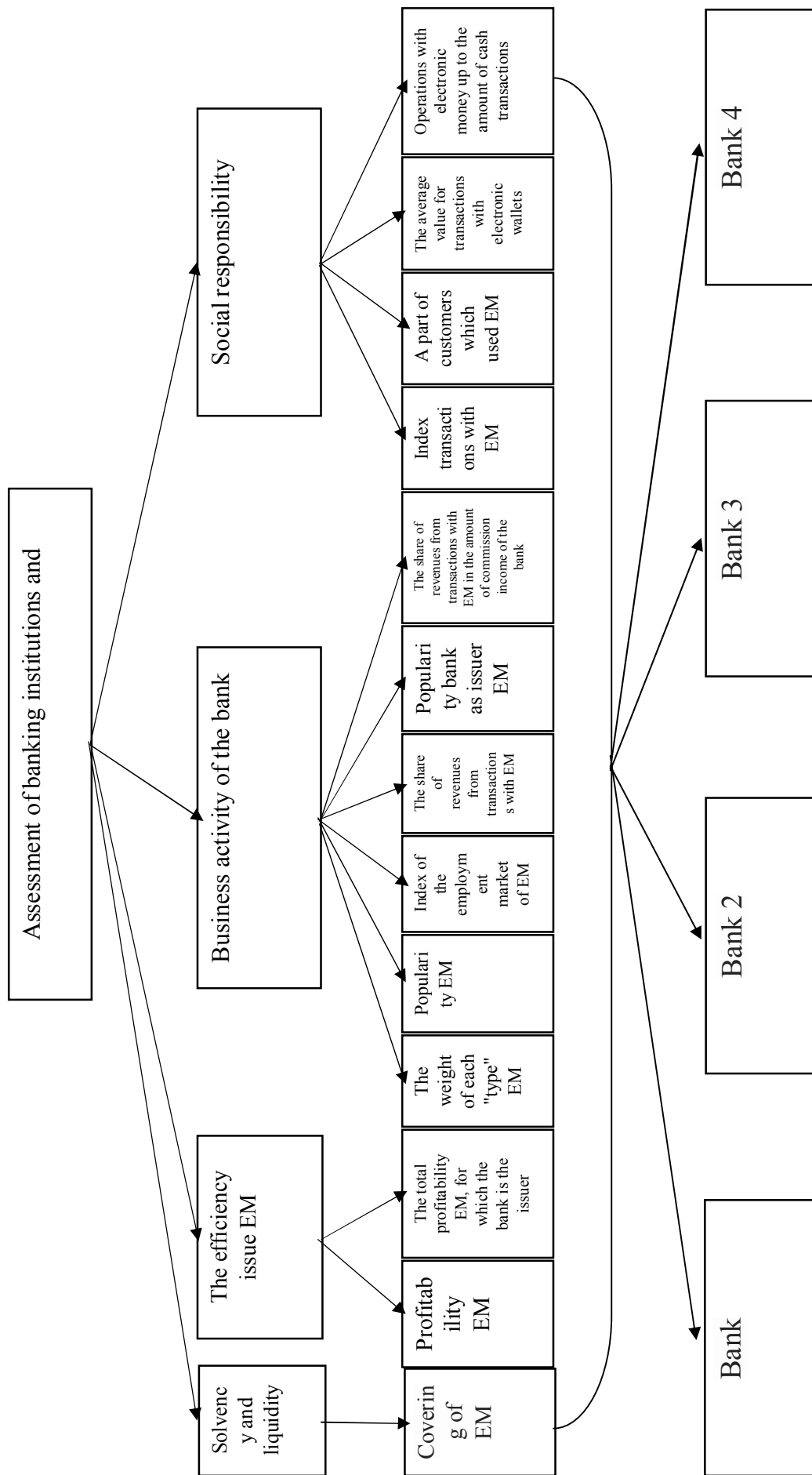


Fig. 1. A hierarchical model for evaluation of banking institutions with electronic money *) built by the authors according to the method of hierarchy analysis method [2], using the model of [9]

As criteria of the second level will be considered the following groups of indicators: the solvency and liquidity (SL), the efficiency of emission of electronic money (EEM), business activity of the bank (BA) and social responsibility (SR) [9, p. 288; 10, p. 60].

For each group of indicators is necessary to allocate submitter (third level): covering of electronic money (IC_{EM}); profitability of the electronic money (P_{EM}); the total profitability e-money, for which the bank is the issuer (P_{EM}^{int}); the weight of each "type" of electronic money (W_{EM}^n); popularity of e-money (P_{EM}); the index of the employment market of electronic money (IEM_{EM}); the popularity of the bank as an issuer of e-money (PB_{EM}); the share of revenues from transactions with electronic money (SR_{EM}); the share of revenues from transactions with electronic money in the amount of commission income of the bank (SR_{EM}^C); index transactions with electronic money (IT_{EM}); a part of customers which used electronic money (PC_{EM}); the average value of transactions with electronic wallets (AVW_{EM}); operations with electronic money up to the amount of cash transactions (EMC).

The fourth level of the hierarchy is the last hosting alternatives that pass the comparison. In our case will be compared four alternative objects, which will be banks to select the most effective ones.

Next should be calculated local priorities of elements and conducted a pairwise comparison using a scale of expert ratings from 1 to 5 [2, p. 53]. To construct matrices will be from the first level to the last. The first matrix will have a pairwise comparison of the second level, relative to the main goal. On the analogy of building a matrix of the third level.

So, we build a matrix of level 2 and 3, carry out the corresponding calculations for the ratios (tabl. 1) using the expert data.

Table 1

The ratio for the calculation method of analysis of hierarchies [2, p. 49-51,72]

Name	Relations for calculation	Description
The vector of local priorities (u_i)	$u_i = \frac{\bar{u}_i}{\sum_{i=1}^n \bar{u}_i}; i = \overline{1, n};$	Based on the calculation of the vector of local priorities, you can make a conclusion about the dominance of criteria that should be considered when prioritizing goals
The average value vector locale-priorities (\bar{u}_i)	$\bar{u}_i = \sqrt[n]{\prod_{j=1}^n a_{ij}}; i = \overline{1, n};$ де n- the number of criteria; a_{ij} - i-y item j-column matrix;	The average value we calculated for further use in the determination of the vector of local priorities
Maximum the value of pay-but-symmetric matrix (λ_{max})	$\lambda_{max} = \sum_{j=1}^n u_j \left(\sum_{i=1}^n a_{ij} \right);$	Calculating the value back to a symmetric matrix, we can say that the closer λ_{max} to n, the more coordinated it
The consistency index (CI)	$CI = \frac{\lambda_{max} - n}{n - 1};$	Using this index to determine the level of consistency of experts' opinions
Attitude consistency (AC)	$AC = \frac{CI}{RI_n};$	Consistency is considered to be acceptable when $AC \leq 10\%$. Failure to meet these conditions for any matrix should be adjusted pairwise evaluation matrix

The global priorities of the elements (Z_i)	$Z_i = \sum_{j=1}^3 V_{ij} U_j$; где V_{ij} – the local priority of the i -th element 3 levels with respect to the j -th element of the criterion level 2; U_j – local priority – i level 2 item.	Vector global priorities of a particular level of the hierarchy shows the measure of influence of each of the elements of this level to the first level, namely, goal - assessment of Bank's operations with electronic money
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The next step builds the matrix of pairwise comparisons according to certain criteria of the second level 2 level in order to assess the importance of the elements (tabl. 2).

Table 2

The matrix of pairwise comparisons for items level 2 *)

The elements are compared on the 2nd level a hierarchical model	Item numbers				Local priorities u_i	λ_{max}	CI	AC
	SL	EEM	BA	CR				
SL	1	2	3	3	0,43	4,2	0,07	0,07
EEM	1/2	1	4	4	0,35			
BA	1/3	1/4	1	2	0,13			
SR	1/3	1/4	1/2	1	0,09			

*) Source: constructed by the authors on MAH [2] on the basis of expert judgment

The components of the eigenvectors of the local priorities for our example will have the following values:

$$1) u_1 = \frac{2,06}{4,83} = 0,43; u_2 = \frac{1,68}{4,83} = 0,35; u_3 = \frac{0,63}{4,83} = 0,13; u_4 = \frac{0,45}{4,83} = 0,09;$$

$$2) \bar{u}_1 = \sqrt[4]{1 \cdot 2 \cdot 3 \cdot 3} = 2,06; \quad \bar{u}_2 = \sqrt[4]{0,5 \cdot 1 \cdot 4 \cdot 4} = 1,68; \quad \bar{u}_3 = \sqrt[4]{0,33 \cdot 0,25 \cdot 1 \cdot 2} = 0,63; \\ \bar{u}_4 = \sqrt[4]{0,33 \cdot 0,25 \cdot 0,5 \cdot 1} = 0,45;$$

$$3) \sum_{i=1}^4 2,06 + 1,68 + 0,63 + 0,45 = 4,83;$$

The maximum value is inversely symmetric matrix

$$1) \sum_{i=1}^4 a_{i1} = 1 + 1/2 + 1/3 + 1/3 = 2,17; \sum_{i=1}^4 a_{i2} = 2 + 1 + 1/4 + 1/4 = 3,5; \sum_{i=1}^4 a_{i3} = 3 + 4 + 1 + 1/2 = 8,5;$$

$$\sum_{i=1}^4 3 + 4 + 2 + 1 = 10.$$

$$2) \lambda_{max} = 0,43 \cdot 2,17 + 0,35 \cdot 3,5 + 0,13 \cdot 8,5 + 0,09 \cdot 10 = 4,2;$$

Consistency of evaluation criteria:

$$1) IV = \frac{4,2 - 4}{4 - 1} = 0,07;$$

$$2) BV = \frac{0,07}{0,9} = 0,07.$$

The value of the global priorities:

$$1) Z_1 = 0,54 * 0,33 = 0,18; Z_2 = 0,54 * 0,67 = 0,36.$$

The analysis of the elements of the third level, respectively, of the second level are shown in the following table. 3-5. The element of the second hierarchy level "Solvency and liquidity", the obvious is its significance for criteria of the third level.

Table 3

The matrix of pairwise comparisons for item 3 level « The efficiency of emission of» *)

The elements are compared on the 3rd level hierarchical models	Item numbers		Local priorities u_i	λ_{max}	CI	AC
	P_{EM}	P_{EM}^{int}				
P_{EM}	1	1/2	0,33	3	0	0
P_{EM}^{int}	2	1	0,67			

*) Source: authors constructed by MAH [2] based on expert judgment

Table 4

The matrix of pairwise comparisons for item 3 level «Business activity of the bank» *)

The elements are compared on the 3rd level hierarchical models	Item numbers						Local priorities u_i	λ_{max}	CI	AC
	W_{EM}^n	P_{EM}	IEM_{EM}	PB_{EM}	SR_{EM}	SR_{EM}^C				
W_{EM}^n	1	1/3	1/4	1/5	1/3	1/5	0,04	6,31	0,06	0,05
P_{EM}	3	1	1/2	1/3	2	1/3	0,12			
IEM_{EM}	4	2	1	2	3	2	0,30			
PB_{EM}	5	3	1/2	1	2	1/2	0,19			
SR_{EM}	3	1/2	1/3	1/2	1	1/3	0,09			
SR_{EM}^C	5	3	1/2	2	3	1	0,26			

*) Source: authors constructed by MAH [2] based on expert judgment

Table 5

The matrix of pairwise comparisons for item 3 levels «Social responsibility» *)

The elements are compared on the 3rd level hierarchical models	Item numbers				Local Priorities u_i	λ_{max}	CI	AC
	O_{ET}	ΨK_{ET}	CT^{zpu}	EIT				
$CBem$	1	2	3	4	0,48	4,24	0,08	0,09
Fem	1/2	1	1/2	1/2	0,13			
$PCem$	1/3	2	1	2	0,23			
EEM	1/4	2	1/2	1	0,15			

*) Source: constructed by the authors on MAH[2] on the basis of expert judgment

Table 6

We calculate the global priorities of the elements of level 3 (tabl. 6).

Global priority	Values
Z1	0,43
Z2	0,12
Z3	0,23
Z4	0,01
Z5	0,02
Z6	0,04
Z7	0,02
Z8	0,01
Z9	0,03
Z10	0,04
Z11	0,01
Z12	0,02
Z13	0,01

*) Source: constructed by the authors on MAI [2] based on the results, shown in table. 3-5

Best global priority will correspond to the highest value ($Z2 = 0,43$) and vice versa, the worst will correspond to the smallest value ($Z3 = 0,01$).

Determined by local priorities for level 4 relative to each criterion level 3 (tabl. 7-19).

Table 7

The local priorities of elements 4 relative to the element - criteria level 3 «Covering of electronic money»*)

IC_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	2	3	2	0,42	4,35	0,17	0,13
Bank 2	1/2	1	4	2	0,32			
Bank 3	1/3	1/4	1	3	0,14			
Bank 4	1/2	1/2	1/3	1	0,12			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 8

The local priorities of elements 4 relative to the element - criteria level 3 " «Profitability of the electronic money» *)

P_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	3	1/2	4	0,34	4,68	0,22	0,25
Bank 2	1/3	1	2	3	0,26			
Bank 3	2	1/2	1	5	0,32			
Bank 4	4	1/3	1/5	1	0,08			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 9

The local priorities elements 4 relative to the element--criteria level 3 «The total profitability e-money, for which the bank is the issuer» *)

P_{EM}^{int}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	2	1/3	3	0,26	5,12	0,37	0,41
Bank 2	1/2	1	4	4	0,37			
Bank 3	3	1/4	1	3	0,27			
Bank 4	1/3	1/4	1/3	1	0,09			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 10

The local priorities of elements 4 relative to the element-criteria level 3 «The weight of each "type" of electronic money» *)

W_{EM}^n	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	2	3	1/2	0,32	4,96	0,32	0,36
Bank 2	1/2	1	3	2	0,32			
Bank 3	1/3	1/3	1	3	0,18			
Bank 4	2	1/2	1/3	1	0,18			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 11

The local priorities of elements 4 relative to the element-criteria level 3 «Popularity of e-money» *)

P_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	3	2	1/3	0,29	5,28	0,43	0,47
Bank 2	1/3	1	2	3	0,29			
Bank 3	1/2	1/2	1	2	0,21			
Bank 4	3	1/3	1/2	1	0,21			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 12

The local priorities of elements 4 relative to the element-criteria level 3 «The index of the employment market of electronic money»*)

IEM_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	4	3	1/2	0,37	5,60	0,53	0,59
Bank 2	1/4	1	3	4	0,31			
Bank 3	1/3	1/3	1	3	0,18			
Bank 4	2	1/4	1/3	1	0,15			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 13

The local priorities of elements 4 relative to the element-criteria level «The popularity of the bank as an issuer of e-money» *)

PB_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	2	2	3	0,41	4,35	0,12	0,13
Bank 2	1/2	1	4	2	0,31			
Bank 3	1/2	1/4	1	3	0,17			
Bank 4	1/3	1/2	1/3	1	0,11			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 14

The local priorities of elements 4 relative to the element-criteria level 3 «The share of revenues from transactions with electronic money»*)

SR_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	5	4	3	0,53	4,74	0,25	0,27
Bank 2	1/5	1	4	5	0,27			
Bank 3	1/4	1/4	1	3	0,13			
Bank 4	1/3	1/5	1/3	1	0,07			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 15

The local priorities of elements 4 relative to the element-criteria level 3 «The share of revenues from transactions with electronic money in the amount of commission income of the bank»*)

SR_{EM}^C	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	4	3	4	0,51	4,53	0,18	0,20
Bank 2	1/4	1	5	4	0,29			
Bank 3	1/3	1/5	1	2	0,12			
Bank 4	1/4	1/4	1/2	1	0,08			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 16

The local priorities of elements 4 relative to the element-criteria level 3 «Index transactions with electronic money» *)

IT_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local Priorities W_i	λ_{max}	CI	AC
Bank 1	1	5	3	4	0,54	4,51	0,17	0,20
Bank 2	1/5	1	4	3	0,24			
Bank 3	1/3	1/4	1	2	0,12			
Bank 4	1/4	1/3	1/2	1	0,09			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 17

The local priorities of elements 4 relative to the element-criteria level 3 «A part of customers which used electronic money»*)

PC_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	3	2	3	0,45	4,07	0,02	0,03
Bank 2	1/3	1	1/2	2	0,16			
Bank 3	1/2	2	1	3	0,29			
Bank 4	1/3	1/2	1/3	1	0,10			

*) Source: constructed by the authors on MAI [2] based on realistic data reporting banks

Table 18

The local priorities of elements 4 relative to the element-criteria level 3 «The average value of transactions with electronic wallets»*)

AVW_{EM}	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	4	2	3	0,47	4,41	0,14	0,15
Bank 2	1/4	1	2	4	0,25			
Bank 3	1/2	1/2	1	3	0,20			
Bank 4	1/3	1/4	1/3	1	0,09			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Table 19

The local priorities of elements 4 relative to the element-criteria level 3 «Operations with electronic money up to the amount of cash transactions»*)

EMC	Bank 1	Bank 2	Bank 3	Bank 4	Local priorities, W_i	λ_{max}	CI	AC
Bank 1	1	5	3	3	0,53	4,53	0,18	0,20
Bank 2	1/5	1	2	4	0,23			
Bank 3	1/3	1/2	1	1/2	0,11			
Bank 4	1/3	1/4	2	1	0,13			

*) Source: constructed by the authors on MAH [2] based on realistic data reporting banks

Calculate the global priorities of the 4-th level, respectively for banks 1,2,3,4 and make decisions on the basis of calculations: $W_1=0,38$; $W_2=0,31$; $W_3=0,20$; $W_4=0,11$. For a more visual representation of the obtained values, we build a graph (Fig. 2).

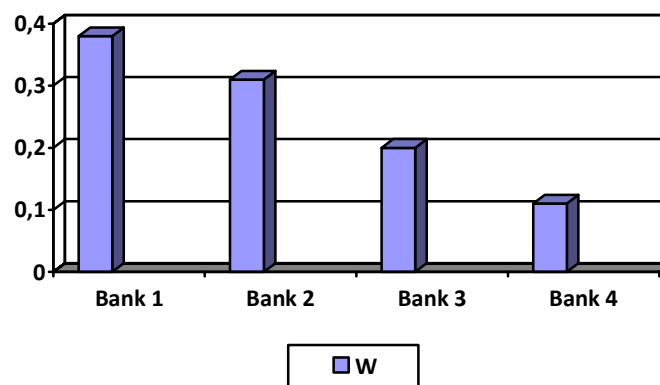


Fig. 2. Priority assessment criteria

*) own calculations

The indication of the priority evaluation criteria indicates the level of the Bank's work with electronic money. The highest value of the criterion (W), according to our calculations (fig. 2), is Bank 1 (0,37), this means that he spends effective management in this area of their business - issue and circulation of electronic money.

The conclusions. We have investigated a method of analysis of hierarchies and demonstrated its capacity during the analysis of the Bank's activities in the context of his work with electronic money. On the basis of indicators with which to assess the work of the Bank with the specified payment means, performed a conditional analysis of banks, which have demonstrated the effectiveness and versatility of the method, its openness and the importance of selecting alternatives or identify the most effective Bank calculations. The paper describes the algorithm and its use without application-specific data banks in order to provide suggestions regarding the effectiveness of the Toolkit, but not a true analysis of specific banks.

Further research in this direction is reasonable, we believe, to carry out the extension of the indicators by which to assess the work of the Bank with his participation in the organization of electronic money circulation, and use of a broader range of economic-mathematical methods in the process of implementing economic analysis in banks

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- Стаття надійшла до редакції 01.12. 2014 © Самородов Б. В., Мельниченко О. В., Коцєєва Н. С.

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Received 01.12.2014 © Samorodov B. V., Melnychenko O. V., Koshcheeva N. S.