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[2; 10; 14],
[14]

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Sp A [5].

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MAKING DESITIONS ON THE BASE OF ANALYSIS HIERARHY METHOD

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Summary. Problem statement. The method of analysis of hierarchy process (AHP) provides solution of multi-criteria problems with simple and reasonable, including quantitative and qualitative factors of different dimensions. AHP is used to solve semistructured and unstructured problems. Only now it begins to be applied in Ukraine. The first works [2, 10, 14] were appeared, where the essence of the method is revealed and technology of implementation of it on the computer are shown. [14] An attempt to determine theoretically the eigenvalues to the back of a symmetric matrix, but as a result of wrongly an accepted fact, the sum of the eigenvalues of matrix is equal to its order n , the authors conclude that for perfectly coherent matrix "all of eigenvalues - zeros, except for one, equaled n " In fact, the amount of the eigenvalues numerals of matrix A equals to the sum of the diagonal elements of the matrix, i.e. to its trace $Sp A$ [5]. The shown [10] technology of implementation of method in this work in the Excel indicates that the authors do not own of matrix functions of master of functions. There is no clear method of calculation using the AHP in the literature.

Purpose. To develop a methodology for the application of the AHP to solve unstructured problems and technology of implementation method of Excel. **Conclusion** The proposed method opens the possibility of AHP and quite simply realized in Excel using of the matrix functions of master of functions.

Key words: *analytic hierarchy method, multi-criteria problems, unstructured problems, back symmetric matrix, the eigenvalues, the normalized eigenvector, matrix functions*

() [11-13].

Excel.

[2; 10; 14],

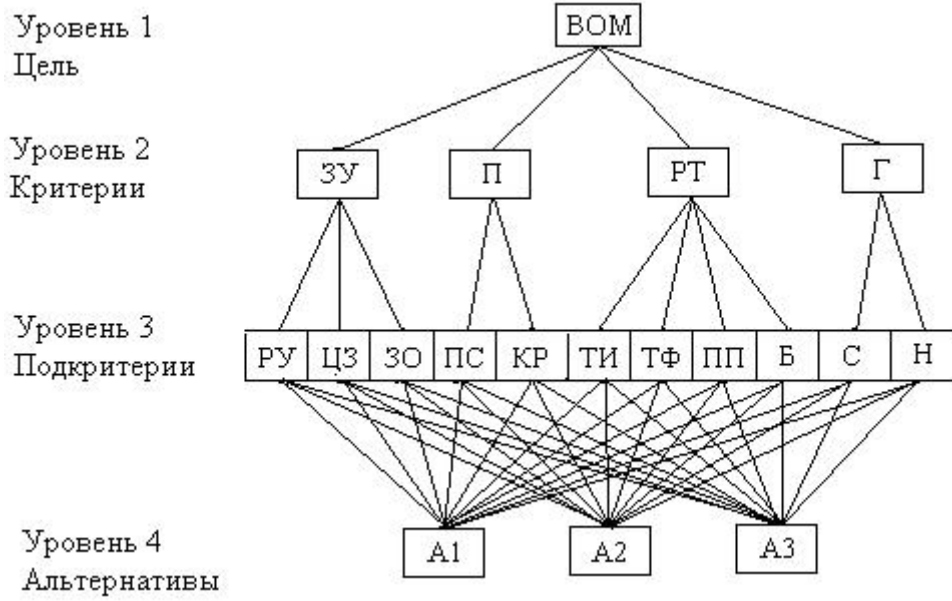
[14]

n ,

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 n ».

A

$Sp A$ [5]. [10]
 Excel



Уровень 1
Цель

Уровень 2
Критерии

Уровень 3
Подкритерии

Уровень 4
Альтернативы

. 1.

1.

2.

3.

4.

[14]

$$I_c = \frac{\max - n}{n - 1},$$

$$I_c \leq 0,1,$$

$$B_c = I_c / M(I_y),$$

$$B_c \leq 0,1$$

| | A | B | C | D | E |
|----|------------------------------------------|---------|----------|-----|---|
| 1 | Выбор оптимального места для предприятия | | | | |
| 2 | ВОМ | ЗУ | П | РТ | Г |
| 3 | ЗУ | 1 | 0,5 | 0,7 | 3 |
| 4 | П | 2 | 1 | 1,5 | 6 |
| 5 | РТ | 1,42857 | 0,66667 | 1 | 5 |
| 6 | Г | 0,33333 | 0,16667 | 0,2 | 1 |
| 7 | Собственный вектор W | | | | |
| 8 | алгоритм 1 | | | | |
| 9 | шаг 1 | 5,2 | | | |
| 10 | | 10,5 | | | |
| 11 | | 8,09524 | | | |
| 12 | | 1,7 | | | |
| 13 | шаг 2 | 25,4952 | | | |
| 14 | шаг 3 | 0,20396 | контроль | | |
| 15 | W | 0,41184 | 1 | | |
| 16 | | 0,31752 | | | |
| 17 | | 0,06668 | | | |
| 18 | проверка согласованности | | | | |
| 19 | | 0,83218 | | | |
| 20 | A*W | 1,69612 | | | |
| 21 | | 1,21685 | | | |
| 22 | | 0,26681 | | | |
| 23 | | 4,08013 | | | |
| 24 | лямбда | 4,11837 | | | |
| 25 | | 3,83235 | | | |
| 26 | | 4,0014 | | | |
| 27 | лямбда м | 4,11837 | | | |
| 28 | n | 4 | | | |
| 29 | Ic | 0,03946 | | | |
| 30 | M(Iy) | 0,9 | | | |
| 31 | Bc | 0,04384 | | | |

| | G | H | I | J |
|----|--------------------------|---------|----------|-----|
| 2 | ЗУ | РУ | ЦЗ | ЗО |
| 3 | РУ | 1 | 8 | 4 |
| 4 | ЦЗ | 0,125 | 1 | 0,6 |
| 5 | ЗО | 0,25 | 1,667 | 1 |
| 6 | Собственный вектор W1 | | | |
| 7 | алгоритм 1 | | | |
| 8 | шаг 1 | 13 | | |
| 9 | | 1,725 | | |
| 10 | | 2,91667 | | |
| 11 | шаг 2 | 17,6417 | | |
| 12 | шаг 3 | 0,73689 | контроль | |
| 13 | W1 | 0,09778 | 1 | |
| 14 | | 0,16533 | | |
| 15 | проверка согласованности | | | |
| 16 | | 2,18044 | | |
| 17 | A1*W1 | 0,28909 | | |
| 18 | | 0,51252 | | |
| 19 | | 2,95897 | | |
| 20 | лямбда | 2,95852 | | |
| 21 | | 3,1 | | |
| 22 | лямбда м | 3,1 | | |
| 23 | n | 3 | | |
| 24 | Ic | 0,05 | | |
| 25 | M(Iy) | 0,58 | | |
| 26 | Bc | 0,08621 | | |

.2.

$$AX = \lambda X,$$

AX

X,

A

7.

4, 8-17.

(31,7 %),

6 %.

(. 3)

(. 4)

3, 5, 6,

B,

(. 18).

| | L | M | N | O |
|----|--------------------------|-------|----------|----|
| 33 | РУ | A1 | A2 | A3 |
| 34 | A1 | 1 | 2 | 5 |
| 35 | A2 | 0,5 | 1 | 3 |
| 36 | A3 | 0,2 | 0,333 | 1 |
| 37 | Собственный вес V1 | | | |
| 38 | алгоритм 1 | | | |
| 39 | шаг 1 | 8 | | |
| 40 | | 4,5 | | |
| 41 | | 1,533 | | |
| 42 | шаг 2 | 14,03 | | |
| 43 | шаг 3 | 0,57 | контроль | |
| 44 | V1 | 0,321 | 1 | |
| 45 | | 0,109 | | |
| 46 | проверка согласованности | | | |
| 47 | | 1,758 | | |
| 48 | A1*V1 | 0,933 | | |
| 49 | | 0,33 | | |
| 50 | | 3,083 | | |
| 51 | лямбда | 2,911 | | |
| 52 | | 3,022 | | |
| 53 | лямбда м | 3,083 | | |
| 54 | n | 3 | | |
| 55 | lс | 0,042 | | |
| 56 | M(ly) | 0,58 | | |
| 57 | Вс | 0,072 | | |

. 4.

| | G | H | I |
|----|----|-----|----|
| 28 | П | ПС | КР |
| 29 | ПС | 1 | 5 |
| 30 | КР | 0,2 | 1 |

. 5.

| | L | M | N | O | P |
|---|----|-------|-------|-----|---|
| 2 | РТ | ТИ | ТФ | ПП | Б |
| 3 | ТИ | 1 | 3 | 2 | 9 |
| 4 | ТФ | 0,333 | 1 | 0,9 | 3 |
| 5 | ПП | 0,5 | 1,111 | 1 | 5 |
| 6 | Б | 0,111 | 0,333 | 0,2 | 1 |

. 6.

| | A | B | C |
|----|---|-------|---|
| 33 | Г | С | Н |
| 34 | С | 1 | 3 |
| 35 | Н | 0,333 | 1 |

. 7.

| | A | B | C | D |
|----|----|-----|----|------|
| 53 | Ц3 | A1 | A2 | A3 |
| 54 | A1 | 1 | 2 | 0,25 |
| 55 | A2 | 0,5 | 1 | 0,17 |
| 56 | A3 | 4 | 6 | 1 |

. 8.

| | G | H | I | J |
|----|----|-------|----|------|
| 48 | 30 | A1 | A2 | A3 |
| 49 | A1 | 1 | 7 | 2 |
| 50 | A2 | 0,143 | 1 | 0,25 |
| 51 | A3 | 0,5 | 4 | 1 |

. 9.

| | G | H | I | J |
|----|----|----|-----|------|
| 74 | ПС | A1 | A2 | A3 |
| 75 | A1 | 1 | 0,5 | 0,11 |
| 76 | A2 | 2 | 1 | 0,2 |
| 77 | A3 | 9 | 5 | 1 |

. 10.

| | L | M | N | O |
|----|----|-------|-----|------|
| 85 | КР | A1 | A2 | A3 |
| 86 | A1 | 1 | 0,6 | 0,25 |
| 87 | A2 | 1,667 | 1 | 0,33 |
| 88 | A3 | 4 | 3 | 1 |

. 11.

| | L | M | N | O |
|----|----|----|-----|-----|
| 59 | ТИ | A1 | A2 | A3 |
| 60 | A1 | 1 | 0,5 | 0,5 |
| 61 | A2 | 2 | 1 | 1 |
| 62 | A3 | 2 | 1 | 1 |

. 12.

| | R | S | T | U |
|---|----|----------|----|-------|
| 2 | ТФ | A1 | A2 | A3 |
| 3 | A1 | 1 | 8 | 3 |
| 4 | A2 | 0,125 | 1 | 0,333 |
| 5 | A3 | 0,333333 | 3 | 1 |

. 13.

| | R | S | T | U |
|----|----|-------|----|-----|
| 28 | ПП | A1 | A2 | A3 |
| 29 | A1 | 1 | 8 | 5 |
| 30 | A2 | 0,125 | 1 | 0,5 |
| 31 | A3 | 0,2 | 2 | 1 |

. 14.

| | R | S | T | U |
|----|----|-------|-----|----|
| 80 | Б | A1 | A2 | A3 |
| 81 | A1 | 1 | 3 | 5 |
| 82 | A2 | 0,333 | 1 | 2 |
| 83 | A3 | 0,2 | 0,5 | 1 |

. 15.

| | R | S | T | U |
|----|----|----|------|-----|
| 54 | С | A1 | A2 | A3 |
| 55 | A1 | 1 | 0,14 | 0,5 |
| 56 | A2 | 7 | 1 | 5 |
| 57 | A3 | 2 | 0,2 | 1 |

. 16.

| | A | B | C | D |
|----|----|-------|-------|-----|
| 79 | Н | A1 | A2 | A3 |
| 80 | A1 | 1 | 6 | 3 |
| 81 | A2 | 0,167 | 1 | 0,6 |
| 82 | A3 | 0,333 | 1,667 | 1 |

. 17.

| | A | B | C | D | E | F | G | H | I | J | K |
|-----|-----------|-------|-------|-------|-------|-----|-------|-------|-------|-------|-------|
| 111 | матрица В | | | | | | | | | | |
| 112 | 0,57 | 0,204 | 0,592 | 0,081 | 0,144 | 0,2 | 0,674 | 0,744 | 0,641 | 0,092 | 0,677 |
| 113 | 0,321 | 0,105 | 0,082 | 0,162 | 0,233 | 0,4 | 0,082 | 0,086 | 0,238 | 0,729 | 0,12 |
| 114 | 0,109 | 0,691 | 0,326 | 0,757 | 0,623 | 0,4 | 0,244 | 0,17 | 0,121 | 0,179 | 0,203 |

. 18.

((44,9 %) - (57,6 %).
) , . . . - (. 20)
 B1
 A (. 2).
 B1,
 B (. 19).

| | M | N | O | P |
|-----|------------|-------|--------|--------|
| 110 | матрица B1 | | | |
| 111 | ЗУ*W1 | П*W2 | РТ*W3 | Г*W4 |
| 112 | 0,538 | 0,092 | 0,4491 | 0,2384 |
| 113 | 0,26 | 0,174 | 0,2535 | 0,5763 |
| 114 | 0,202 | 0,735 | 0,2973 | 0,1853 |

| | R |
|-----|------------|
| 110 | матрица B2 |
| 111 | B1*W |
| 112 | 0,3060101 |
| 113 | 0,2434578 |
| 114 | 0,4505321 |

. 19. 3.
 « (53,8 %),
 » (73,5 %),
 Excel

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4. / . . . , –
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5. : . . . / . . . ,
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6. / – : , 1979. – 200 . –
 (. . . .) .
7. / . . . ; –
 : , 1987. – 142 .
8. / . . . ,
 – : : , 1996. – 208 .
9. / . . . , –
 : , 1981. – 154 .
10. / . . . , . . . ; . . .
 – : , 2006. – 144 . : . . .
11. / . . . ; ,
 . . . ; – : , 1977. – 303 .
12. / . . . ;
 ; – : , 1991. – 224 .
13. / . . . ; – : –
 , 1993. – 278 .
14. – : , 2003. – 158 .

15. Golden B. L. The analytic hierarchy process: applications and studies / B. Golden, E. Wasil, P. Harker. – New York : Springer-Verlag, 1989. – 265 .

REFERENCE

1. Akoff R. *Iskusstvo resheniya problem* [Skill of problem solving]. Moscow: Mir, 1982, 224 p. (in Russian).
2. Badyul M.G. and Kramarenko V.A. *Zastosuvannia metodu anal zu yerarkh y u proektuvann ta bud vnystv* [Application of analytic hierarchy in the design and construction]. *Stroitel'stvo, materialovedenie, mashinostroenie* [Construction, materials, mechanical engineering]. Dnepropetrovsk, 2013, iss. 70, pp. 27-35. (in Ukrainian).
3. Shakhnova I.F. *Voprosy analiza i protsedury prinyatiya resheniy* [Issues of analysis and decision-making procedures]. Moscow: Mir, 1976, 230 p. (in Russian).
4. Emel'yanov S.V. and Larichev O.I. *Mnogokriterial'nye metody prinyatiya resheniy* [Multi criteria decision making methods]. Moscow: Znanie, 1985, 32 p. (in Russian).
5. Il'in V.P., Karpov V.V. and Maslennikov A.M. *Chislennyye metody resheniya zadach stroitel'noy mekhaniki* [Numerical methods for solving problems of structural mechanics]. Minsk: Vysshaya shkola, 1990, 349 p. (in Russian).
6. Larichev O.I. *Nauka i iskusstvo prinyatiya resheniy* [Skill and science of decision making]. Moscow: Nauka, 1979, 200 p. (in Russian).
7. Larichev O.I. *Ob'ektivnye modeli i sub'ektivnye resheniya* [Objective model and the subjective decisions]. Moscow: Nauka, 1987, 142 p. (in Russian).
8. Larichev O.I. and Moshkovich E.M. *Kachestvennye metody prinyatiya resheniy. Verbal'ny analiz resheniy* [Qualitative methods of decision making. Verbal decisions analysis]. Moscow: Nauka, Fizmatlit, 1996, 208 p. (in Russian).
9. Kini R.L. and Ralfa Kh. *Prinyatie resheniy pri mnogikh kriteriyakh predpochteniya i zamescheniya* [Making decisions with a lot of criteria of preference and substitution]. Moscow: Radio i svyaz', 1981, 154 p. (in Russian).
10. Sier kov A.V. and B lotserk vskiy O.V. *Metod anal zu yerarkh y u pryinyatt r shen* [The hierarchy analysis method in decision making]. Khark v: Burun Kniga, 2006, 144 p. (in Ukrainian).
11. Saati T.L. *Matematicheskie modeli konfliktnykh situatsiy* [Mathematical models of conflict situations]. Moscow: Sovetskoe radio, 1977, 303 p. (in Russian).
12. Saati T. and Kerns K. *Analiticheskoe planirovanie. Organizatsiya sistem* [Analytical planning. Organization of systems]. Moscow: Radio i svyaz', 1991, 224 p. (in Russian).
13. Saati T. *Prinyatie resheniy. Metod analiza ierarkhiy* [Making decisions. Method of hierarchy analysis]. Moscow: Radio i svyaz', 1993, 278 p. (in Russian).
14. Sinyuk V.G. and Shevyrev A.V. *Ispol'zovanie informatsionno-analiticheskikh tekhnologiy pri prinyatii upravlencheskikh resheniy* [Use of information and analytical technologies in management decisions]. Moscow: Ekzamen, 2003, 158 p. (in Russian).
15. Golden B.L., Wasil E. and Harker P. The analytic hierarchy process: applications and studies. New York: Springer-Verlag, 1989, 265 p.

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