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CyRADARS

Reduction of the Number of Expert Pair-wise Comparisons During Decision Support Using AHP

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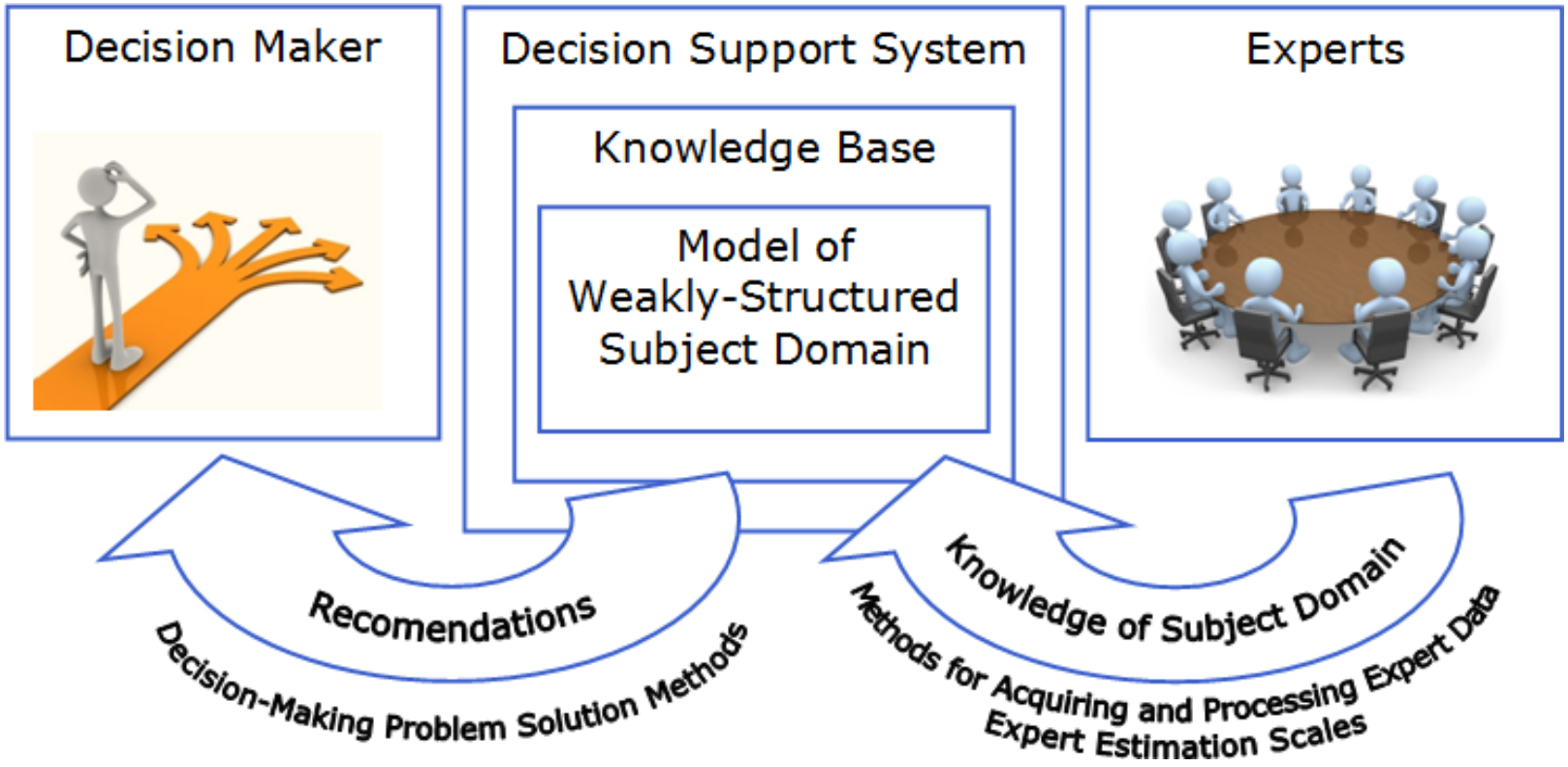
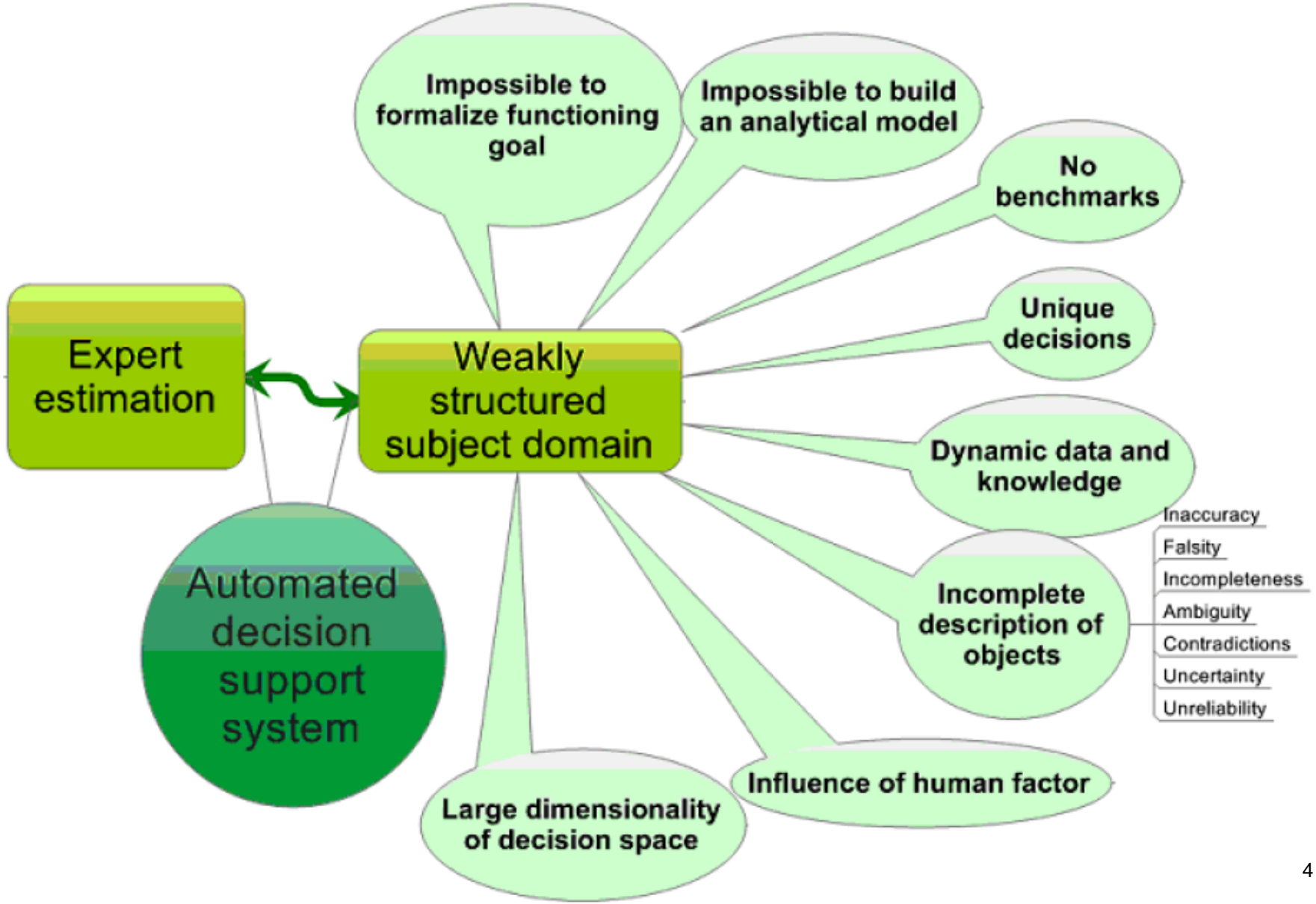
Presentation Outline

1. Intro: relevance of research on improvement of expert estimation credibility in DSS.
2. Quality of DSS recommendations in weakly-structured subejct domains.
3. Reduction of the number of expert pair-wise comparisons during estimation.
4. Expert pair-wise comparisons.
5. A method of expert pair-wise comparisons, taking the order of alternatives into consideration.
6. Experimental research of the method.

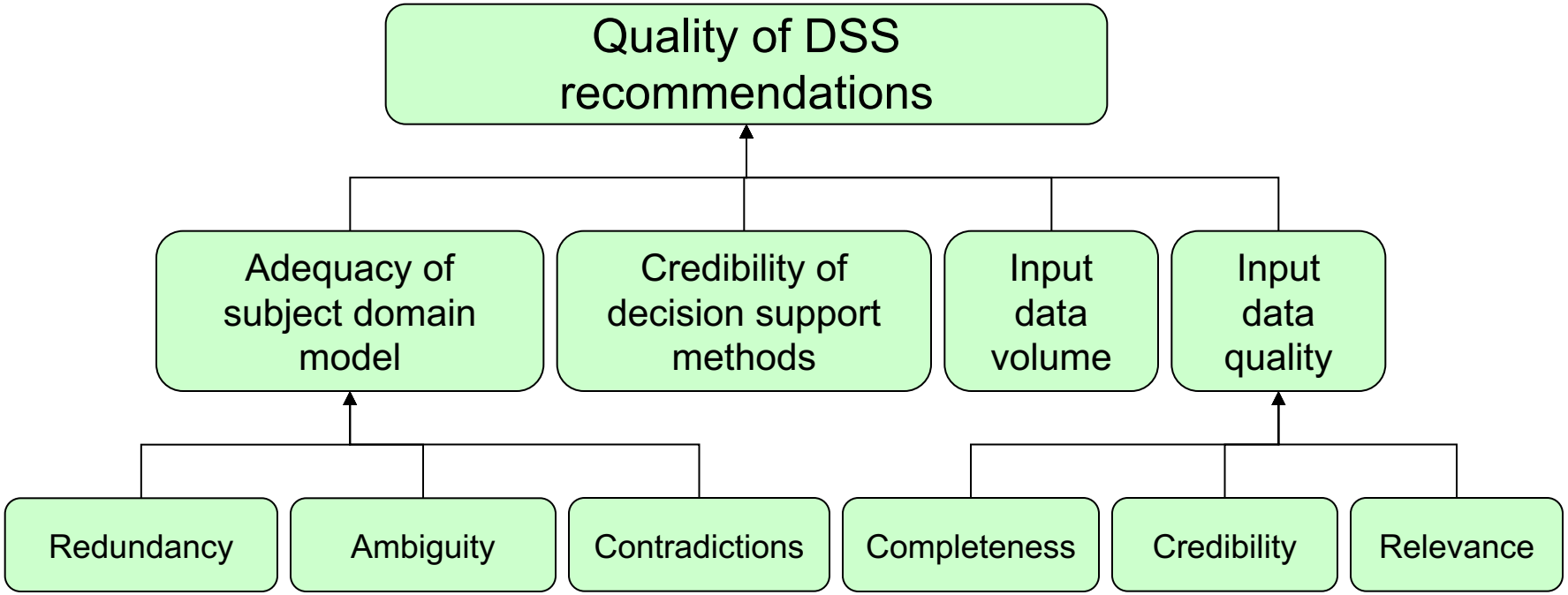
Decision-making using expert DSS



Weakly Structured Domains



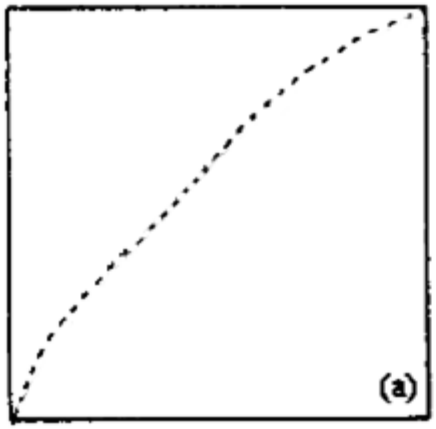
Factors, that influence the quality of DSS recommendations



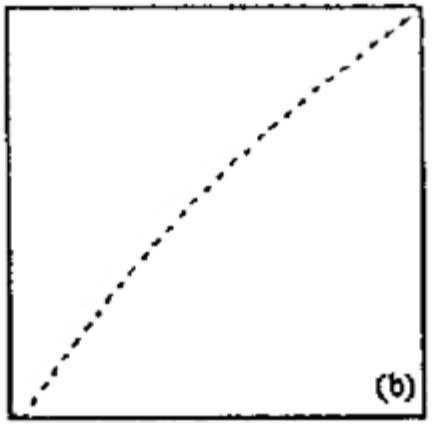
Reduction of the number of expert pair-wise comparisons during estimation

- One of the ways of expert estimation accuracy improvement is reduction of the number of pair-wise comparisons. Similar research was conducted for estimation of "tangible factors". It indicated that when *n* alternatives were estimated, after the minimum number of pair-wise comparisons (*n-1),* was reached, the level of consistency started to gradually decrease, while the level of accuracy was, initially, growing, but then declined. At the same time, these studies did not take the order of pair-wise comparisons into consideration.
- Alongside this approach, we propose to use the described above method of expert pair-wise comparisons, taking the order of alternative presentation into account, and, thus, further increase the level of accuracy, while reducing the minimum necessary number of pair-wise comparisons.

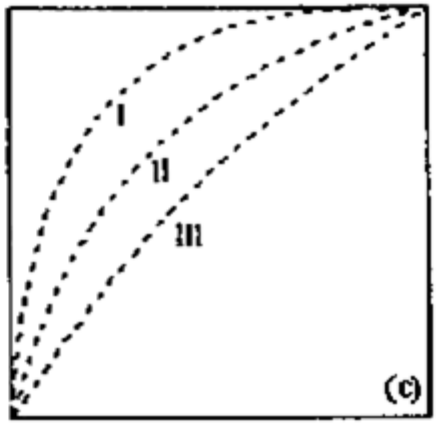
Experimental research by Stevens and Galanter



Estimation of length of 17 steel cores evenly distributed on length from 4 cm to 111 cm



Estimation of 16 time intervals (on a seven-point scale), evenly distributed over the duration of 0.25 s to 4 s



Estimation of the area of 9 rectangles on a five-point scale (I - the sizes are shifted towards the minimum area, II - the sizes are distributed evenly, III - the sizes are shifted towards the maximum area)

A method of expert pair-wise comparisons, taking the order of alternatives into consideration

Let the alternatives be numbered according to their strict ranking (as follows):

$$a_1 > a_2 > \cdots > a_n$$

a_i – is the alternative number *i*, $i = \overline{1,n}$

n – is the total number of alternatives

Suggested the following sequence of alternative pairs:

1st turn : (a_1, a_n)

2nd turn : (a_1, a_{n-1}) or (a_2, a_n)

3rd turn : (a_1, a_{n-2}) or (a_2, a_{n-1}) or (a_3, a_n)

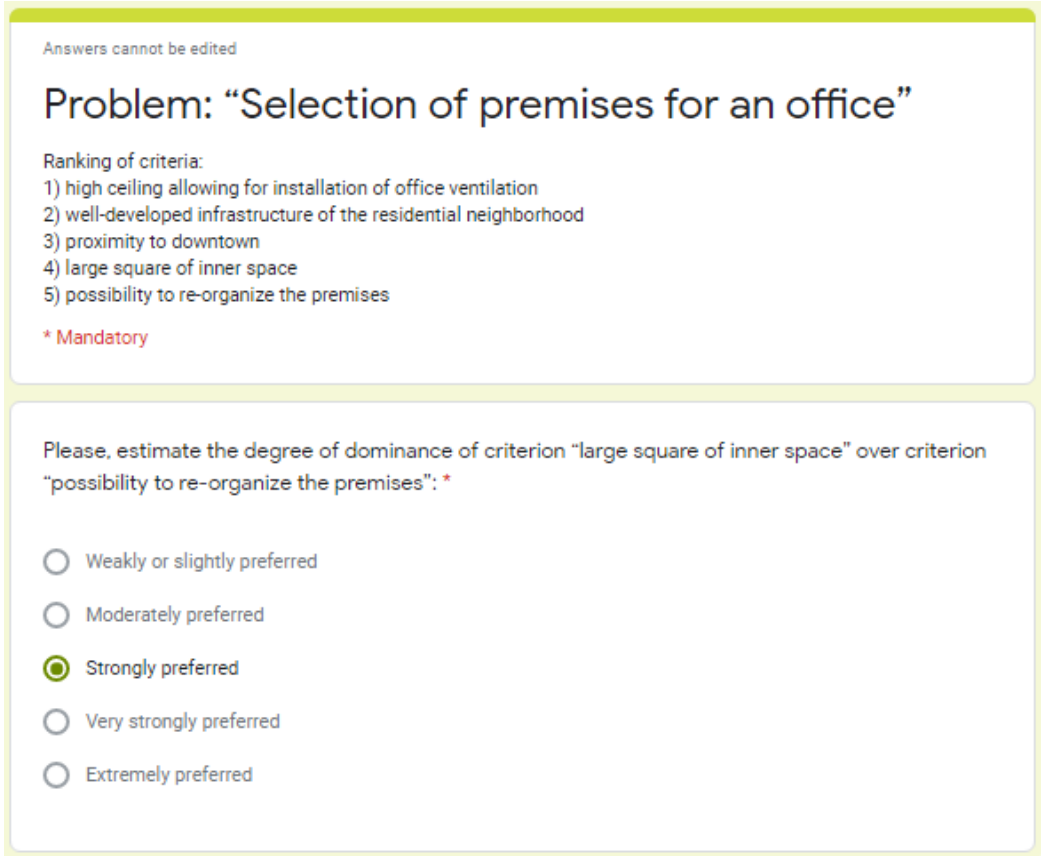
…

n-1 turn : (a_1, a_2) or (a_2, a_3) or … or (a_{n-1}, a_n)

Stages of the experimental study

1. Definition of the problem, goal, or object.
2. Decomposition of the specified problem into 5-7 criteria (independent factors).
3. Ranking of the formulated criteria according to their importance.
4. Individual expert pair-wise comparisons of importance of criteria.
5. Calculation of alternative ratings according to their relative significance for every sequence of expert pair-wise comparisons.
6. Histogram choice: the expert chooses one of the three histograms of relative alternative significance.

Expert pair-wise comparison form



Answers cannot be edited

Problem: “Selection of premises for an office”

Ranking of criteria:
1) high ceiling allowing for installation of office ventilation
2) well-developed infrastructure of the residential neighborhood
3) proximity to downtown
4) large square of inner space
5) possibility to re-organize the premises

* Mandatory

Please, estimate the degree of dominance of criterion “large square of inner space” over criterion “possibility to re-organize the premises”: *

- ○ Weakly or slightly preferred
- ○ Moderately preferred
- ◉ Strongly preferred
- ○ Very strongly preferred
- ○ Extremely preferred

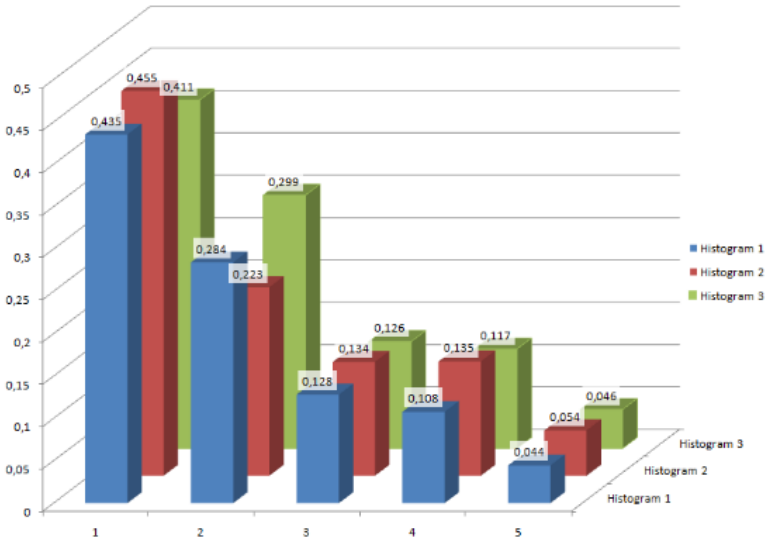
Answers cannot be edited

Problem: “Selection of premises for an office”

Ranking of criteria:
1) high ceiling allowing for installation of office ventilation
2) well-developed infrastructure of the residential neighborhood
3) proximity to downtown
4) large square of inner space
5) possibility to re-organize the premises

* Mandatory

Once you perform the comparisons, the priorities you set among criteria, are shown in bar diagrams of relative importance (numbers on abscissa axle show criterion ranks: 1 – the most important criterion; 2 – second important criterion etc.):



Please, select the option that most accurately reflects your understanding of relative importance of criteria. By the way, the order of lines is not the same as the order of phases 2, 3, and 4. You are also requested to explain, why you are choosing this particular option, in an e-mail sent to: dss-lab@ukr.net. *

- (●) Histogram 1
- ( ) Histogram 2
- ( ) Histogram 3

A form, where an expert selects a histogram of relative alternative importance rating

Statistical credibility of the research

$P_\beta = 0.9$ $\beta = 0.1$ $n \geq \frac{p \cdot (1-p)}{\beta^2} \left(F^{-1}\left(P_\beta\right)\right)^2$

Test experiment series:

Name of the sequence of expert pair-wise comparisons of alternatives	Number of respondents, that assigned the specified rank to the given sequence of expert pair-wise comparisons of alternatives		
	"1"	"2"	"3"
A	18	9	6
B	6	19	8
C	9	5	19

Frequencies, defined based on the 1st line of the table:

{18/33≈0.55; 9/33≈0.27; 6/33≈0.18}

Minimum number of instances of the experiment

$$F^{-1}(0.9) \approx 1.65$$

$$\left(F^{-1}(0.9)\right)^2 \approx 2.72$$

$$n \geq \frac{0.55 \cdot (1 - 0.55)}{(0.1)^2} 2.72 = 67.32$$

Experiment results

Name of the sequence of expert pair-wise comparisons of alternatives	Number of respondents, that assigned the specified rank to the given sequence of expert pair-wise comparisons of alternatives		
	"1"	"2"	"3"
A	43	20	14
B	13	38	26
C	21	19	37

The sequence of pair-wise comparisons A was ranked “first” in 56% of cases, “second” – in 26% of cases, and “third” – in 18% of cases.

Summary

- We substantiated the relevance of research on improvement of expert estimation credibility in DSS.
- We presented the results of theoretical studies of human psychophysiological features, influencing the credibility of expert estimates (namely: the equilibrium principle, the simplicity principle, and previous estimation experience).
- We suggested the respective ways of improving this credibility within DSS (particularly, through taking of the listed peculiarities into consideration when developing expert interface of DSS, as well as when defining the order, in which alternative pairs are presented to the expert for comparisons).
- The conducted experimental research confirmed the adequacy and practical value of the suggested method of expert pair-wise comparisons, taking the order of alternatives into account.

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Thank you for attention!