ASSESSMENT OF INFORMATION ADVANTAGE

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The article analyzes the information advantage of one object to the other. The basis of the analysis is the information situation. The article considers two types of relationships between the compared objects, "one to one" and "one to many". This article describes the rules for assessing the benefits when comparing two objects. This article describes the different types of information advantages and methods of assessment. The article introduces the concept of "information exchange ratio" This concept simplifies the evaluation of the benefits of information. Article formulates the rules for assessing the benefits of the information. The article offers a method for estimating an information advantage in relation to "one to many". This method uses a matrix of pairwise comparisons. This article contains an example of using this method. The article discusses the problems of using the method of evaluation of the benefits of the information.

Keywords: Information, news, situation, information flows, information, communication, information state, an informational advantage

Information advantage creates competitive advantage. Information advantage is necessary for survival of a system or a subject. Information advantage is a desired state when making decisions. In practice, it is important to assess presence or absence of information advantage. An information situation is necessary for assessment of information advantage [1]. Creation of an information situation model is a prerequisite for assessment of information advantage. Information advantage [2, 3] is considered as a relation. The information advantage model determines the area, in which an information advantage occurs. Being a relation, information advantage has two qualitative implementations. The first implementation of assessment of information advantage is built on "one-to-one" relation. The second implementation of assessment of information advantage is built on "one-to-many" relation. This approach enables you to use a methodology for hierarchical relationships [4] for analysis and assessment of information advantage.

Materials and methods of research

Research methodology is based on application of systems analysis, paradigmatic relations [5] and dichotomous analysis [3, 6].

Basic concepts

We apply the following basic concepts to make an assessment: "information situation" [1], "information state" [7, 8], "information awareness" [9, 10]. We determine information advantage as a relation of one object to another object in an information situation ("one-to-one" relation), or as a relation of an object to many objects in an information situation ("one-to-many" relation). These two types of relations define two methods of assessment of information advantage. Information situation is an information model, which characterizes the information environment [11, 12] of the analysis object or its local information environment [11].

Information situation may contain a set of states for different objects. This gives the grounds for comparison of objects by their states. Information state of an object is defined as a set of current parameters for a particular information situation. Information state is assessed with a part of a set of parameters, which are included into a description of an information situation. Information state is a comparative characteristic. Information state of A_i object at the current point of time t_i can be assessed on the basis of the following factors:

1. State of A_{i-1} object at the previous point of time t_{i-1};

2. State of B_i object at the current point of time t_i;

3. Purpose T sought to be reached by A object.

4. Information awareness possessed by A object.

5. Resources owned by A object.

6. Information flows, which come to A object.

Factors 1 and 3 allow you to trace the trend of development of the object over time. Factors of 2, 4, 5, 6 allow to compare the state of A object with other objects and to determine the presence or absence of an information advantage.

Information awareness [9, 10] often means quantity and quality of information resources, which are possessed by A object. Information awareness is characterized by the level of information awareness [13, 14].

Information awareness by internal relative assessment means comparison of information distribution with the level which is required to

achieve the stated objectives. It is called information awareness "by objective" since it characterizes the possibility of achievement of an objective.

Information awareness by external relative assessment can be determined when comparing information indicators of different objects. It is called information awareness "by comparison object". Such information awareness allows to assess information advantage or absence thereof.

In addition to information resources, there may be other resources: technical, technological, organizational, cognitive and intellectual. They are all included in factor 4. If they affect the object state in the information situation, they can also create information advantage. In order to build formal models, we will use the paradigmatic relations [5].

Results of research and their discussion

"One-to-One" Relation

Let's study assessment of information advantage in case of "one-to-one" relation. In this case we refer to two objects. We will consistently use factors 4, 5, 6. Let's start with factor 3 – information awareness.

Consider an information situation, in which information awareness of two objects can be compared. To denote relations between the states of objects by information awareness, you can use "more-than", "less-than" relation signs. This allows you to create a simple description of objects relation by information awareness.

$$Ia > Ib \rightarrow A(I) > B(I), \qquad (1)$$

$$Ia < Ib \rightarrow A(I) < B(I). \qquad (2)$$

Expression (1) defines information advantage of A object over *B* object by information awareness. It is interpreted as follows. Presence of information resources of better quality *Ia* of *A* object when compared with information resources *Ib* of *B* object entails information advantage "by information awareness" of *A* object over *B* object, all other conditions being equal.

Expression (2) is interpreted in the opposite sense. Information awareness of *B* object is more than information awareness of *A* object, which entails information advantage of *A* object over *B* object, all other conditions being equal. Relations *Ia > Ib* or *Ia < Ib* also describe an information asymmetry situation [16].

If inequality signs in expressions (1–2) are replaced with equality signs, "information correspondence" [15] by information awareness,

absence of information advantage and absence of information asymmetry will take place.

"Information awareness" indicator I (factor 4) may be replaced with "resources" *R* indicator (factor 5). This gives the opportunity to assess information advantage "by resources" in this information situation.

$$Ra > Rb \rightarrow A(R) > B(R), \qquad (3)$$

$$Ra < Rb \rightarrow A(R) < B(R). \qquad (4)$$

Expression (3) defines information advantage of A object over B object by resources. It is interpreted as follows. Presence of *Ra* resources of better quality of *A* object when compared with *Rb* resources of *B* object entails information advantage "by resources" of *A* object over *B* object, all other conditions being equal. Expression (4) is interpreted in the opposite sense. Note that only those resources, which affect the information situation, are taken into account.

There can also be an information situation, when objects *A* and *B* receive information flows from external sources (factor 6). Information flows can have different intensity. This situation allows to assess information advantage by "information flows". This is shown in expression (5).

$$(F_{S1} \rightarrow I_B > F_{S2} \rightarrow I_A) \rightarrow B(F) > A(F). \quad (5)$$

Expression (5) is interpreted as follows. Information flow F_{S1}, directed to *B* object, surpasses information flow F_{S2}, directed to *A* object, which entails information advantage of *B* object over *A* object by information flows, all other conditions being equal. The opposite situation is possible (6), when *A* object has advantage by flows over *B* object.

$$(F_{S1} \rightarrow I_B < F_{S2} \rightarrow I_A) \rightarrow B(F) < A(F). \quad (6)$$

Such information situation is called as flow information situation. This information situation is procedural, as it characterizes the process. We define relative coefficient of information flow K_{FB} to B object as follows

$$K_{FB} = F_{S1} / (F_{S1} + F_{S2}). \qquad (7)$$

We define relative coefficient of information flow K_{FA} to A object as follows

$$K_{FA} = F_{S2} / (F_{S1} + F_{S2}). \qquad (8)$$

Relative coefficients of information flow K_{FA} and K_{FB} have values from 0 to 1. Input coefficients belong to the relative scale and are normalized. This simplifies the process of flows analysis.

Informational advantage by flows is possible in case of information exchange between

two objects. It occurs when there are mutual differently directed information flows. Flows perform the functions of provision of information to objects. This information situation is called procedural, as it is determined by the process. Information exchange changes the amount of information possessed by objects and can also create information advantage by information exchange.

$$(F_A: I_A \rightarrow I_B > F_B: I_B \rightarrow I_A) \rightarrow B(F) > A(F). \quad (9)$$

Expression (9) is interpreted as follows. Information flow F_A, directed from A to B, surpasses information flow F_B directed from B to A, which results in information advantage of B object over A object by information exchange. We define information exchange coefficient KA_{EXC} from source A to source B as follows:

$$KA_{EXC} = F_A / (F_B + F_A). \quad (10)$$

In the opposite direction

$$KB_{EXC} = F_B / (F_B + F_A). \quad (11)$$

Here F_A is an intensity of flow from A to B, F_B is an intensity of flow from B object to A object. Coefficients KA_{EXC} and KB_{EXC} can be compared with each other. They are normalized from 0 to 1. Application of coefficients allows to describe informational advantage (9) for information communication using expression (12)

$$(KA_{EXC} > KB_{EXC}) \rightarrow B(F) > A(F). \quad (12)$$

Expression (12) is interpreted as follows. Information exchange coefficient KA_{EXC} from A to B, surpasses information exchange coefficient KA_{EXC} from B to A, which entails information advantage of B object over A object by information exchange.

Expression (12) helps to define a general rule: the object which communicates more information than it gets loses relation of equality by information awareness and creates informational advantage for another object.

Flow information situation changes the object information awareness and can result in information asymmetry [17, 18] in case of prior information correspondence. Information asymmetry is a sign of information advantage. Semantic gap is another sign of information advantage [19, 20].

At the same time, not every information flow situation results in information asymmetry. It can reduce asymmetry. If there is a semantic gap [20], direction of flows may decrease or increase the semantic gap.

Consequence. Information flow situation can increase or decrease information advantage and creating or decreasing information asymmetry.

Information situation occurring in the course of situation analysis [21] is also possible. Assume that A object is in S_1 situation, which is characterized with the set of parameters P_1. B object is in S_2 situation, which is characterized with the set of parameters P_2. Using preference theory [22] or another criterion [23], we can conclude (conditionally) that P_1 is more preferable than P_2 when using preference criterion (PC) [24].

$$(PC: P_1 \Rightarrow P_2) \rightarrow A(PC) > B(PC). \quad (13)$$

Expression (13) means that situation S_1 of A object is more preferable by PC criterion than situation S_2 of B object, which entails information advantage of A object over B object "by situation".

"One-to-Many" Relation

Expressions (1–13) implied comparison of relations between A and B objects. Such relation can be defined as "one-to-one" relation. If A object is compared with N objects, "one-to-many" relation occurs.

In this case, information advantage is determined by means of integral expert assessment or attributive detailed assessment.

In both cases, pairwise comparison matrix should be used. In case of integral assessment, an expert compares each two objects pairwise and enters the result of comparison into pairwise comparison matrix (table).

Pairwise Comparison Matrix

	A	B	C	D	Σ	Rating
A		1	1	1	3	1
B	0		1	0	1	3
C	0	0		0	0	4
D	0	1	1		2	2

Table is an example of comparison of four objects. Object advantage is indicated by 1 in the line, which describes this object. According to table 1, the expert has found advantage of A object over other objects and put ones into its line. Absence of advantage is denoted with 0. A object has scored the maximum number of "advantages", which is denoted with the sum (Σ) of scores 3. All comparison objects are ranked by the number of "advantages". Ranking result is placed in the "rating" column (Rating). Table can be a criterion of competitiveness of objects within a group.

Attributive detailed assessment requires application of pairwise comparison matrix for each attribute of all objects with further

consolidation of the advantage sums into a single assessment with application of weight coefficients for every attribute.

Above expressions (1–6) included restriction "all other conditions being equal". If conditions are not equal, i.e. difference by information awareness, by resources or by information flows (attribute three) takes place, and there are many objects, advantage is assessed by means of three pairwise comparison matrices. Then the results are consolidated into a single assessment as shown in [22]. There can be any (however, finite) number of objects.

First version of advantage assessment based on "one-to-one" relation (1–6, 9, 12, 13) allows to assess not just advantage or competitiveness of two objects.

The first version of advantage assessment based on "one-to-many" relation (table) allows to compare many objects in the overall information situation.

Information advantage is a comparative characteristic. It is close to the concept of information asymmetry, being wider. It is also possible to make a comparison between different objects and between an object and an objective reached by it. The above assessment methods include qualitative and quantitative analysis.

Expressions (1–6), (9), (12), (13) are based on qualitative-quantitative assessments and require expert assessments. Such assessments are mostly of comparative nature. This means that in case of any change to the number of parameters used for assessment, the result of assessment of information advantage can differ.

Information advantage may be natural and artificial. For example, in case of teaching, all teachers have natural information advantage. Flow action and information interaction between a teacher and a student removes such advantage and information asymmetry. The subject's awareness of the absence of information advantage and of the presence of information asymmetry creates an information need for obtaining of education or receipt of information.

Conclusion

This paper does not make a distinction between the object and the subject. This means that the results are applicable for assessment of information advantage between information systems and between subjects. Analytical expressions shown in this article are applicable for assessment of information advantage. Competitiveness of groups and objects can be assessed on the basis of the above expressions. Results of the research allow to obtain an integral "information advantage" characteristic of one object over another object. Results of the research allow to assess the possibility of achievement of the goal by the object "by situation" or "by information awareness". Results of the research allow to assess "object resources availability" indicator.

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