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MEASURES FOR ESTIMATING TRANSPORT VESSELS OPERATORS' SUBJECTIVE PREFERENCES UNCERTAINTY

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The pseudo-entropy hybrid model is suggested as the measure of uncertainty of operators' subjective preferences. Because of the introduced relative prevailing preferences factor the proposed hybrid model has advantages comparatively to the traditional measures of uncertainty in the view of Boltzmann's or Shannon's entropy. According to the relative dominating preferences index the pseudo-entropy varies within [–1 ... 1] showing the sign and magnitude of the relative subjective assuredness. Analytical expressions have been achieved. The theoretical concept is illustrated with examples and graphs.
Keywords: pseudo-entropy, hybrid model, subjective analysis, prevailing preferences factor, dominating preferences index, ship propulsion, main engine, subjective preferences, multi-alternative situations.

Introduction. The process of operation of a ship's propulsion and her power plants (SPPP's) is connected with making managing decisions in multi-alternative operational situations. Uncertainty of operators' subjective preferences influences a lot the behavior of a transportation system, which, because of that, becomes an active one.

Moreover, it is not only the uncertainty that can induce dangerous situations on board ship during her operation, but also even the certainty in the operators' subjective preferences may provoke harmful or catastrophic events if these preferences are dictated by or directed to the wrong activities.

Urgency of researches. The problem of monitoring and supporting the proper technical state of marine ships' power plants and their propulsions of transport vessels in multi-alternative operational situations is a complex and actual one. It is always important to keep the issues of safe and reliable operations of SPPPs' and their main engines (MEs) in mind. Though, a hundred years passed after the Royal Mail Ship «Titanic» crash, the notorious «human factor» still has the same significance. For example, due to the ignorance of the down state of sensors of the computer controlled electrohydraulic control system of the ME, or, if operators neglect precaution measures preferring some private matters instead, there can also happen an accident or even a disaster.

Thus, the problem of modeling of the uncertainty measures that take into account both diversities in the preferences of alternatives, and their positive and negative aspects is an important one.

The given problem setting in the general view has a connection with the problem of elaboration of the entropy approach in application of the theory of subjective preferences to the issues of monitoring and supporting of SPPP technical state in multi-alternative operational situations.

Analysis of the latest researches and publications. The generally believed measure of uncertainty, the one of the subjective preferences, for instance, is the entropy of the Boltzmann's or Shannon's type [1-3]. The measures of uncertainty that are analogous to the Shannon's entropy, which is not the only function meeting the requirements stated for the entropy, are considered in [1, P. 104-108]. All of those pseudo-entropy functions measures estimate uncertainty in positive values, and that cannot show a researcher which way the active system is making certain to, positive or negative, i.e. to the right/good or to the wrong/bad.

Then, it will be logic, for such a measure, to be changed within the value interval of [–1 … 1]; with the marginal value of –1 indicating harmful certainty (negative/wrong assuredness), and the value of 1 is vice versa – the useful (positive/right) confidence. Instead of the zeroth entropy for the absolute certainty [1-7], which is incapable to depict the quality of the sureness, the zero point for the new estimation has the meaning of and evaluates the uncertainty.

The task setting. Thus, the purpose of this paper is to find a combined criterion that makes allowance for both the uncertainty/certainty, and the direction of that uncertainty/certainty; and would be a representative quantitative and qualitative value, which is convenient for using in applications of the subjective analysis.

The main content (material). On assessing the distribution of the active element's (subject's/decision making person's) of a system subjective preferences, let us consider and analyze advantages and disadvantages of different proposed below uncertainty measures in order to apply that one which suites peculiarities and meets requirements of a specific problem in the best way.

The problem formulation. Thus, first, we are suggesting analyzing the disadvantages of the traditional Shannon's type entropy in the view of [1, P. 98]

$$H_{\mathrm{p}} = -\sum_{i=1}^{N} \mathrm{p}(\mathrm{y}_i)\ln \mathrm{p}(\mathrm{y}_i); \quad \mathrm{y}_i \in S_a |_{\mathrm{y}_0}, \tag{1}$$

where H_p – entropy of subjective preferences of p; N – number of the achievable alternatives of σ; $\mathrm{p}(\mathrm{y}_i)$ – function of subjective preferences; y_i – i^th alternative; S_a – set of the achievable alternatives; y_0 – alternative of the initial state of the active system assessing the operational problem-resource situation; as the subjective entropy of individual preferences.

It is obviously, the uncertainty measure in the form of (1) being everywhere a positive value, as well as the functions of preferences themselves, does not illustrate anything except the mere fact of certainty/uncertainty with some magnitude of those values alone.

Then, in order to indicate the right or wrong intensions and desires of the system active element, we might prescribe just a positive or negative sign to his subjective preferences for positive y_j^+ and negative y_k^- alternatives correspondingly, hence obtaining

$$\mathrm{p}\left(\mathrm{y}_j^+\right) > 0; \quad \mathrm{p}\left(\mathrm{y}_k^-\right) < 0, \tag{2}$$

which illustrates the needed directions, but ruins the logarithms operations for (1) because of the second condition of the inequalities of (2), and the same to the normalizing condition of [1, P. 98, (3.2)]

$$\sum_{i=1}^{N} \mathrm{p}\left(\mathrm{y}_i\right) = 1. \tag{3}$$

Therefore, we will have to apply the absolute values for (1) and (3) in case of the conditions of (2)

$$H_{|\mathrm{p}|} = -\left[\sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^+\right)\ln \mathrm{p}\left(\mathrm{y}_j^+\right) + \sum_{k=1}^{L} \left|\mathrm{p}\left(\mathrm{y}_k^-\right)\right| \ln\left|\mathrm{p}\left(\mathrm{y}_k^-\right)\right|\right];$$
$$\sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^+\right) + \sum_{k=1}^{L} \left|\mathrm{p}\left(\mathrm{y}_k^-\right)\right| = 1, \tag{4}$$

where M – number of positive alternatives; L – number of negative alternatives correspondingly;

$$M + L = N; \tag{4'}$$

and that will indispensably lead us to the initially shaped representations of uncertainty because of denying the introduced above sign.

It might seem that the mentioned difficulty could be overcome by inserting the direction sign into the formula of (1), then instead of (1) or (4), we get

$$H_{\mathrm{p}_-^+} = -\left[\sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^+\right)\ln \mathrm{p}\left(\mathrm{y}_j^+\right) - \sum_{k=1}^{L} \mathrm{p}\left(\mathrm{y}_k^-\right)\ln \mathrm{p}\left(\mathrm{y}_k^-\right)\right]. \tag{5}$$

The condition of (4′) is the same for both (4), and (5), but the (2) acquires the view of

$$\mathrm{p}\left(\mathrm{y}_j^+\right) > 0; \quad \mathrm{p}\left(\mathrm{y}_k^-\right) > 0. \tag{6}$$

In the case of (5) implying (6), we need inevitably some additional extra researches because the sign of the pseudo-entropy does not necessarily show the righteousness of the subjective preferences; its magnitude does not monotonously correlate with the entropy (1). Moreover, the zero point of the pseudo-entropy (5) may be of the two kinds, namely: the first – the absolute or complete certainty for a singular distribution of the given subjective preferences; the second – the positive entropy member simply equals the negative one, i.e.

$$\sum_{j=1}^{M} p\left(y_j^+\right)\ln p\left(y_j^+\right) = \sum_{k=1}^{L} p\left(y_k^-\right)\ln p\left(y_k^-\right). \tag{7}$$

Manipulating with the negative sign for the entire values of (1, 4, 5) we may reflect the desired direction of preferences but cardinally gaining no clearness concerning the principle of good/bad certainty/uncertainty.

The same to the modifications of the entropy (1) to the rations of

$$\overline{H}_{\mathrm{p}_{-}^{+}} = \frac{H_{\mathrm{p}_{-}^{+}}}{H_{\max}} = -\frac{\sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^{+}\right)\ln \mathrm{p}\left(\mathrm{y}_j^{+}\right) - \sum_{k=1}^{L} \mathrm{p}\left(\mathrm{y}_k^{-}\right)\ln \mathrm{p}\left(\mathrm{y}_k^{-}\right)}{H_{\max}}; \quad (8)$$

$$\ldots 0 \ldots .. 0, \quad (9)$$

where $H_{\max}$ – maximal value of the entropy of the view of (1) [1, P. 100]

$$H_{\max} = \ln N. \quad (10)$$

Since the entropy in the view of (1) seems more attractive so far, we may modify it with the multiplier that takes into account the direction of preferences in the view of not the negative and positive entropy members like in (5, 7-9), but as the preferences prevailing/dominating factor/index

$$\text{Дp} = \sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^{+}\right) - \sum_{k=1}^{L} \mathrm{p}\left(\mathrm{y}_k^{-}\right). \quad (11)$$

This value has the sign of the prevailing good / right or bad / wrong preferences and varies from – 1 up to 1, with the zeroth point when there is no dominance of any of the total preferences, i.e. neither right nor wrong dominates in general.

Combining the index of subjective preferences domination in the view of (11) with the subjective entropy of (1) into a common criterion we obtain

$$H_{\text{Дp}} = H_{\mathrm{p}}\text{Дp} = -\left[\sum_{i=1}^{N} \mathrm{p}\left(\mathrm{y}_i\right)\ln \mathrm{p}\left(\mathrm{y}_i\right)\right]\left[\sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^{+}\right) - \sum_{k=1}^{L} \mathrm{p}\left(\mathrm{y}_k^{-}\right)\right]. \quad (12)$$

$$H_{\max-\text{Дp}} = \left(H_{\max} - H_{\mathrm{p}}\right)\text{Дp} = \left[H_{\max} + \sum_{i=1}^{N} \mathrm{p}\left(\mathrm{y}_i\right)\ln \mathrm{p}\left(\mathrm{y}_i\right)\right]\left[\sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^{+}\right) - \sum_{k=1}^{L} \mathrm{p}\left(\mathrm{y}_k^{-}\right)\right]. \quad (12')$$

These values of (12, 12′) have the required sign, but unfortunately their magnitudes still do not demonstrate stability in showing the assessment of the system active element's certainty. The same to the compositions with the relative values of the type of (8, 9)

$$\overline{H}_{\text{Дp}} = \frac{H_{\mathrm{p}}}{H_{\max}}\text{Дp} = -\frac{\sum_{i=1}^{N} \mathrm{p}\left(\mathrm{y}_i\right)\ln \mathrm{p}\left(\mathrm{y}_i\right)}{H_{\max}}\left[\sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^{+}\right) - \sum_{k=1}^{L} \mathrm{p}\left(\mathrm{y}_k^{-}\right)\right]; \quad (13)$$

$$\overline{H}_{\max-\text{Дp}} = \frac{H_{\max} - H_{\mathrm{p}}}{H_{\max}}\text{Дp} = \frac{H_{\max} + \sum_{i=1}^{N} \mathrm{p}\left(\mathrm{y}_i\right)\ln \mathrm{p}\left(\mathrm{y}_i\right)}{H_{\max}}\left[\sum_{j=1}^{M} \mathrm{p}\left(\mathrm{y}_j^{+}\right) - \sum_{k=1}^{L} \mathrm{p}\left(\mathrm{y}_k^{-}\right)\right]. \quad (14)$$

The problem solution. Thus, the preferences prevailing/dominating factor/index of (11) introduced above into the expressions of (12-14) contains the necessary quality of the positive or negative intentions of the system's subject, but has a distortion influence upon the relative entropy measures. In order to avoid this disturbance we use the relative subjective preferences domination factor

$$\text{Др}_{|\text{Др}|}=\frac{\text{Др}}{|\text{Др}|}=\frac{\sum_{j=1}^{M}\text{p}(\text{y}_j^+)-\sum_{k=1}^{L}\text{p}(\text{y}_k^-)}{\left|\sum_{j=1}^{M}\text{p}(\text{y}_j^+)-\sum_{k=1}^{L}\text{p}(\text{y}_k^-)\right|}. \tag{15}$$

Then, the relative prevailing index of (15) is used in the hybrid composed pseudo-entropy functions of subjective preferences

$$H_{\frac{\text{Др}}{|\text{Др}|}}=H_{\text{p}}\frac{\text{Др}}{|\text{Др}|}=-\sum_{i=1}^{N}\text{p}(\text{y}_i)\ln\text{p}(\text{y}_i)\frac{\left[\sum_{j=1}^{M}\text{p}(\text{y}_j^+)-\sum_{k=1}^{L}\text{p}(\text{y}_k^-)\right]}{\left|\sum_{j=1}^{M}\text{p}(\text{y}_j^+)-\sum_{k=1}^{L}\text{p}(\text{y}_k^-)\right|}; \tag{16}$$

$$H_{\max-\frac{\text{Др}}{|\text{Др}|}}=(H_{\max}-H_{\text{p}})\frac{\text{Др}}{|\text{Др}|}=\left(H_{\max}+\sum_{i=1}^{N}\text{p}(\text{y}_i)\ln\text{p}(\text{y}_i)\right)\frac{\left[\sum_{j=1}^{M}\text{p}(\text{y}_j^+)-\sum_{k=1}^{L}\text{p}(\text{y}_k^-)\right]}{\left|\sum_{j=1}^{M}\text{p}(\text{y}_j^+)-\sum_{k=1}^{L}\text{p}(\text{y}_k^-)\right|} \tag{17}$$

.

The values of the expressions of (16, 17) have the absolute magnitudes the same as the entropy (1) and the difference between (1) and maximal value of entropy (10) correspondingly. The sign of the expressions of (16, 17) will depend upon the magnitude of the prevailing/dominating preferences. The equation of (16) is the measure of uncertainty; at the certainty situation it has the zero value, thus, no one can say whether it is the right or wrong certainty, therefore its representativeness is incomplete. The value of (17) shows the certainty to the positive or negative direction.

And at last the relative values from (16, 17)

$$\overline{H}_{\frac{\text{Др}}{|\text{Др}|}}=\frac{H_{\text{p}}}{H_{\max}}\frac{\text{Др}}{|\text{Др}|}=-\frac{\sum_{i=1}^{N}\text{p}(\text{y}_i)\ln\text{p}(\text{y}_i)}{H_{\max}}\frac{\left[\sum_{j=1}^{M}\text{p}(\text{y}_j^+)-\sum_{k=1}^{L}\text{p}(\text{y}_k^-)\right]}{\left|\sum_{j=1}^{M}\text{p}(\text{y}_j^+)-\sum_{k=1}^{L}\text{p}(\text{y}_k^-)\right|}; \tag{18}$$

$$\overline{H}_{\max - \frac{Др}{|Др|}} = \frac{H_{\max} - H_{p}}{H_{\max}} \frac{Др}{|Др|} = \frac{H_{\max} + \sum_{i=1}^{N} p(y_i) \ln p(y_i)}{H_{\max}} \frac{\left[\sum_{j=1}^{M} p(y_j^{+}) - \sum_{k=1}^{L} p(y_k^{-})\right]}{\left|\sum_{j=1}^{M} p(y_j^{+}) - \sum_{k=1}^{L} p(y_k^{-})\right|} \quad (19)$$

.

The measure of certainty of (19) has the sign of the prevailing preferences and varies within the wanted diapason from – 1, which means the negative certainty, up to 1 – the positive certainty. The certainty measure of (19) has the zeroth value as the point of uncertainty. Accordingly to the hybrid model of (19), the uncertainty of the first kind is when the entropy of subjective preferences has the maximal value of (10). The uncertainty of the second kind is when the total positive subjective preferences equal the total negative ones, like for the zero value of the formula of (11). In its turn, the zero value of the prevailing index of (11) breaks the relative subjective preferences domination index of (15), and, therefore, the hybrid functions of (16 - 19), and the breakage, in its turn, can also be of its own first and second kind.

The expression of (18) like (16) is the measure of uncertainty. Its value has the necessary sign, but the value of it depicts the uncertainty alone, which makes it unclear whether it is a right or wrong situation when the hybrid function of (18) has the zeroth value of the first kind. The zeroth value of the second kind does not mean certainty, but the second kind of uncertainty, like for the hybrid model of (19).

Practical application of the problem solution. Let us consider, for example, a multi-alternative operational situation when the operators neglecting their duties are doing something else or whatever they want. For instance, radio operators of the Royal Mail Ship Titanic» had been warned several times through the wireless about floating icebergs all around, but they ignored even reporting that crucial information to the navigation bridge, preferring transmitting radiograms and being tipped. The officers on duty ignored giving binoculars to sailors to watch the sea carefully. The fatal results of that are well known. The same notorious «human factor» in present days sometimes leads to the similar consequences. In 2005, in the modern electronically controlled ME, in the electrohydraulic control system, the four sensors went out of order one by one. Engineers decided, thus, step by step preferred to ignore the absence of the sensors, and on July 19, the ME of one of the world's largest container carrier «Savannah Express» failed during maneuvering at Southampton. There was a serious damage. One more example is the aircrash of the Polish government aircraft at Smolensk in April 2010. A few times the captain was warned about dense fog, but each time he neglected the risk of landing at Smolensk and recommendations to land at the other airport, thus each time he preferred wrong.

Let the distribution of actual subjective preferences at some moment in time would have been

$$\mathrm{p}_{ia} = 0.05, \quad \mathrm{p}_{ta} = 0.8, \quad \mathrm{p}_{0\mathrm{a}} = 0.15, \tag{20}$$

where π_{ia} – preference of right; π_{ta} – wrong; $\pi_{0\mathrm{a}}$ – neutral alternative correspondingly. The normalizing condition

$$\mathrm{p}_{ia} + \mathrm{p}_{ta} + \mathrm{p}_{0\mathrm{a}} = 1. \tag{21}$$

The actual entropy of the subjective preferences (1) and maximal entropy of (10) are correspondingly

$$H_{\pi a} = 0.613, \quad H_{\max} = \ln 3 = 1.099. \tag{22}$$

Let the needed distribution and corresponding entropy of subjective preferences

$$\mathrm{p}_{in} = 0.995, \quad \mathrm{p}_{tn} = 0.0025, \quad \mathrm{p}_{0\mathrm{n}} = 2.5 \cdot 10^{-3}, \quad H_{\pi n} = 0.035. \tag{23}$$

Suppose the required distribution of subjective preferences and corresponding entropy

$$\mathrm{p}_{ir} = 0.8, \quad \mathrm{p}_{tr} = 0.1, \quad \mathrm{p}_{\mathrm{r}} = 0.1, \quad H_{\pi r} = 0.639. \tag{24}$$

These values after the first warning

$$\mathrm{p}_{ip1} = 0.2, \quad \mathrm{p}_{tp1} = 0.675, \quad \mathrm{p}_{0\mathrm{p}1} = 0.125, \quad H_{\pi p1} = 0.847. \tag{25}$$

After the second warning

$$\mathrm{p}_{ip2} = 0.1, \quad \mathrm{p}_{tp2} = 0.75, \quad \mathrm{p}_{2} = 0.15, \quad H_{\mathrm{p}p2} = 0.731. \tag{26}$$

After the third warning

$$\mathrm{p}_{p3} = 0.075, \quad \mathrm{p}_{p3} = 0.85, \quad \mathrm{p}_{3} = 0.075, \quad H_{\mathrm{p}p3} = 0.527. \tag{27}$$

After the fourth warning

$$\mathrm{p}_{p4} = 0.0025, \quad \mathrm{p}_{p4} = 0.995, \quad \mathrm{p}_{0\mathrm{p}4} = 2.5 \cdot 10^{-3}, \quad H_{\mathrm{p}p4} = 0.035. \tag{28}$$

The system is gradually getting certain to the wrong alternative, i.e. preferring negative, but the subjective entropy getting closer to zero does not show that.

Applying the hybrid model of the pseudo-entropy of (19) we obtain the result shown in the fig. 1.

The researches results. If the distributions of subjective preferences are given in the canonical form [1, P. 124, (3.56), 125, (3.58)]

$$\mathrm{p}_i(x) = \frac{e^{\text{в}F_i}}{\sum_{j=1}^{N} e^{\text{в}F_j}}, \tag{29}$$

where x – independent variable associated with each alternative; β – structural parameter, which can be considered in different situations as Lagrange coefficient, weight coefficient or endogenical parameter that reflects certain psychic properties

[1, P. 119]; F_i – efficiency function; then for a case with two alternatives, the mathematical modeling gives the following results.

Having the functions of subjective preferences, let us say, in the view of

$$\mathrm{p}_1(x)=\frac{xe^{\text{в}x}}{xe^{\text{в}x}+e^{\text{бв}x}},\quad \mathrm{p}_2(x)=\frac{e^{\text{бв}x}}{xe^{\text{в}x}+e^{\text{бв}x}}, \qquad (30)$$

where α – multiplier coefficient for the second alternative efficiency function, with the values of the coefficients and maximal entropy

$$\text{б} = 2.7,\quad \beta = 0.05,\quad H_{\max} = \ln 2 = 0.693, \qquad (31)$$

the results of modeling are represented in the fig. 2.

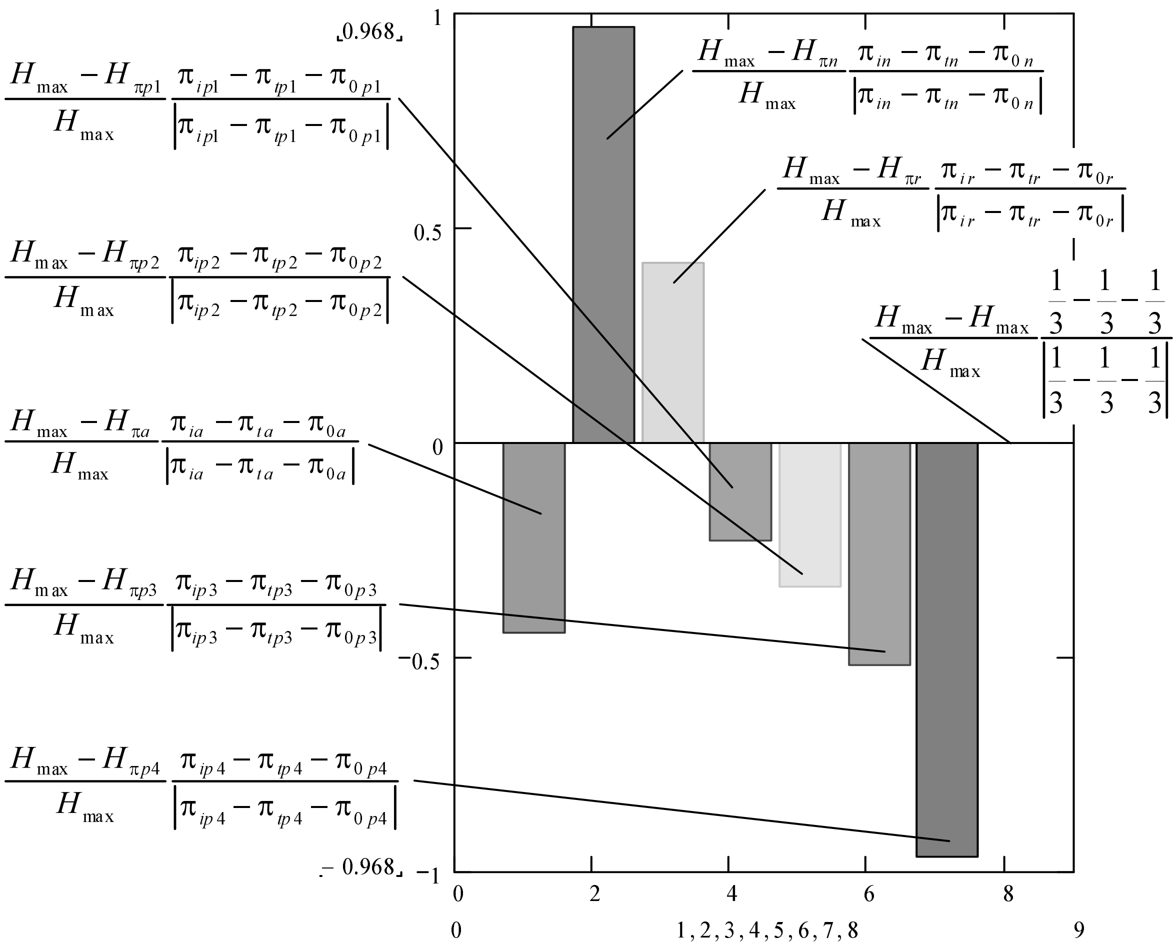

Figure 1 – Pseudo-entropy varying in the interval of [–1 … 1] for discrete preferences

In case of three achievable alternatives, the mathematical modeling gives the following results.

Supposedly, functions of subjective preferences

$$\mathrm{p}_1(x)=\frac{xe^{\text{в}x}}{xe^{\text{в}x}+e^{\text{бв}x}+e^{\text{бвг}x}},\quad \mathrm{p}_2(x)=\frac{e^{\text{бв}x}}{xe^{\text{в}x}+e^{\text{бв}x}+e^{\text{бвг}x}}, \qquad (32)$$

$$p_3(x) = \frac{e^{\text{бвг}x}}{xe^{\text{в}x} + e^{\text{бв}x} + e^{\text{бвг}x}},$$

where г – multiplier coefficient for the third alternative efficiency function.

The value of the γ coefficient

$$\gamma = 1.215. \tag{33}$$

The rest of the coefficients are the same and the maximal entropy has the magnitude calculated above in the expression of (22). The results of modeling are represented in the fig. 3.

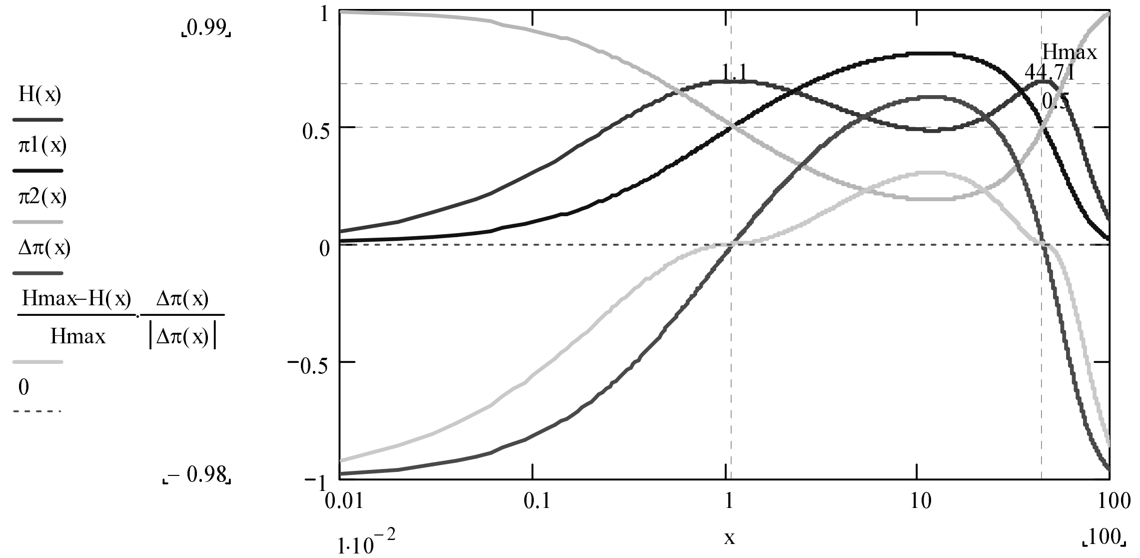

Figure 2 – Pseudo-entropy varying in the interval of [–1 … 1] and other parameters for canonical distribution of subjective preferences in case of two alternatives

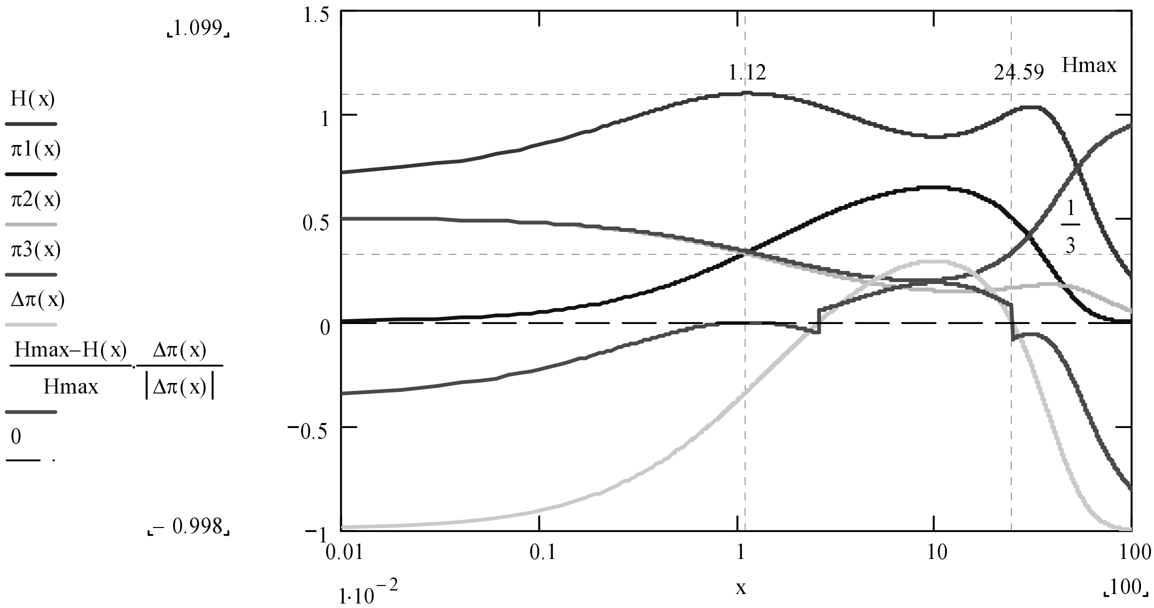

Figure 3 – Pseudo-entropy varying in the interval of [–1 … 1] and other parameters for canonical distribution of subjective preferences in case of three alternatives

Conclusions. Accordingly to the peculiarities and meeting the requirements of a specific problem, the suggested hybrid models of combined pseudo-entropy of subjective preferences in the view of the expression of (19), varying in the interval of [–1 … 1], suit in the best way.

Principally, the vast majority of alternatives in a certain problem-resource situation can be divided into two or three groups. Namely, for problem settings with the two main groups of achievable alternatives: right and wrong; and in the case with the three: right, wrong, and neutral. Then, there are applicable the methods of (1-19). The mathematical modeling of (29-33), also the results illustrated in fig. 1-3, demonstrate the advantages of the suggested uncertainty measure, the pseudo-entropy function (19), comparatively with the traditional entropy of the Boltzmann's or Shannon's type, the example of (20-28).

Prospects of further researches. After determination the positive and negative certainty/uncertainty, there can be conducted further researches in the each of the separate subdivisions. Applying the entropy approach, it is a kind of a scientific interest to investigate the value of the subjective information behavior and postulated in the subjective analysis variation principle with the functional hybrid models that involves the threshold entropy, Kasyanian of an active system, and Bayesian risk at making decisions.

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Гончаренко А.В. МІРИ ДЛЯ ОЦІНЮВАННЯ НЕВИЗНАЧЕНОСТІ СУБ'ЄКТИВНИХ ПЕРЕВАГ ЕКСПЛУАТАЦІЙНИКІВ ТРАНСПОРТНИХ СУДЕН
Запропоновано псевдоентропійну гібридну модель у якості міри невизначеності суб'єктивних переваг експлуатаційників. Завдяки введеному відносному показникові переваг, що превалюють, запропонована гібридна модель має переваги порівняно до традиційних мір невизначеності у вигляді Больцманівської або Шеннонівської ентропії. Відповідно до відносного індексу домінуючих переваг, псевдоентропія змінюється у межах [–1 ... 1], показуючи знак та величину відносної суб'єктивної упевненості. Отримано аналітичні вирази. Теоретичну концепцію проілюстровано прикладами та графіками.
Ключові слова: псевдоентропія, гібридна модель, суб'єктивний аналіз, показник переваг, що превалюють, індекс домінуючих переваг, суднова пропульсивна установка, головний двигун, суб'єктивні переваги, багатоальтернативні ситуації.

Гончаренко А.В. МЕРЫ ДЛЯ ОЦЕНИВАНИЯ НЕОПРЕДЕЛЕННОСТИ СУБЪЕКТИВНЫХ ПРЕДПОЧТЕНИЙ ЭКСПЛУАТАЦИОННИКОВ ТРАНСПОРТНЫХ СУДОВ
Предложена псевдоэнтропийная гибридная модель в качестве меры неопределенности субъективных предпочтений эксплуатационников. Благодаря введенному показателю превалирующих предпочтений предложенная гибридная модель имеет преимущества по сравнению с традиционными мерами неопределенности в виде Больцмановской либо Шенноновской энтропии. Соответственно относительному индексу доминирующих предпочтений псевдоэнтропия изменяется в пределах [–1 ... 1], показывая знак и величину относительной субъективной уверенности. Получены аналитические выражения. Теоретическая концепция проиллюстрирована примерами и графиками.
Ключевые слова: псевдоэнтропия, гибридная модель, субъективный анализ, показатель превалирующих предпочтений, индекс доминирующих предпочтений, судовая пропульсивная установка, главный двигатель, субъективные предпочтения, многоальтернативные ситуации.