MODEL OF THE OPTIMAL CONSUMPTION OF THE PSYCHO EMOTIONAL RESOURCE OF THE NAVIGATOR IN CRITICAL SITUATIONS

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Introduction. The study sets the task of formalizing the management of the stock of psychoemotional resources. This task presents a hypothesis that determining the optimal balance plan when performing navigation tasks will significantly increase the safety of navigation. It is known that the human factor has a decisive influence on transport processes [1–7], therefore, this study is relevant. The boatmaster's behavior model makes it possible to determine thresholds indicating that the resource of forces is running out. This does not make it possible to make effective management decisions. In the course of experiments with the use of navigation simulators, it becomes possible to accurately determine these thresholds [8–10].

Main material. Let us consider a formal description of the problem of distribution of the psychoemotional resource of the navigator based on the solution of the M-problem by the algorithm of the simplex method.

A canonical linear programming problem is considered. Let *X* be a basic plan with a basis $\mathbf{A}_x = (A_{s_1},...,A_{s_m})$. All parameters necessary for evaluating the plan for optimality and moving to the best plan can be obtained by transforming the elements of the matrix from step to step $\mathbf{A}_x^{-1} = (\rho_1,...,\rho_m) = (\rho_{ij})_{mxm}$.

Indeed, knowing the inverse matrix $\mathbf{A}_x^{-1}$, you can get the basic components of the reference plan:

$$(x_{s_1}, x_{s_2},..., x_{s_m})^T = \mathbf{A}_x^{-1}\mathbf{B}$$

and calculate the estimates of the vectors of conditions relative to the current basis:

$$\Delta_j = Y\mathbf{A}_j - \mathbf{C}_j = \sum_{i=1}^{m} a_{ij} y_i - c_j \ (j = \overline{1,n}), \tag{1}$$

having previously defined the row vector $Y = (y_1,...,y_m)$ by the formula:

$$Y = \mathbf{C}_x \mathbf{A}_x^{-1}$$

or

$$y_j = \mathbf{C}_x \rho_j = \sum_{i=1}^{m} C_{s_i} \rho_{ij} \ (j = \overline{1,m}). \tag{2}$$

Here $\mathbf{C}_x = (C_{s_1},...,C_{s_m})$ is the row vector of the coefficients of the linear form corresponding to the basic variables.

The estimates Δ_j make it possible to establish the optimality of the considered baseline plan and to determine the vector $A_к$ introduced into the basis. The expansion coefficients x_{ik} of the vector $A_к$ in the current basis are calculated by the formula:

$$(x_{1k}, x_{2k},..., x_{mk})^T = \mathbf{A}_x^{-1}\mathbf{A}_k .$$

The vector to be excluded from the basis is determined by the value: $t_0 = \min\limits_{\substack{1 \le i \le m \\ x_{ik} > 0}} \frac{x_{s_i}}{x_{ik}} = \frac{x_{s_l}}{x_{lk}}$.

Thus, in the second algorithm, at each step, the basis components $x_{s_i}\ (i=\overline{1,m})$, the inverse matrix Θ_x^{-1}, the value of the linear form *F(X)* and the vector *Y* corresponding to the current reference plan *X* are memorized.

It is convenient to consider the elements of the columns of the matrix Θ_x^{-1} as the coefficients ρ_{ij} of the expansion of unit vectors $e_j\ (j=\overline{1,n})$ in terms of the basis vectors. Recurrent formulas connecting the parameters of two successive iterations:

$$\rho_{lj}^{(\nu+1)}=\frac{\rho_{lj}^{(\nu)}}{x_{lk}^{(\nu)}}\ (j=\overline{0,m}); \tag{3}$$

$$\rho_{ij}^{(\nu+1)}=\rho_{ij}^{(\nu)}-\frac{\rho_{lj}^{(\nu)}}{x_{lk}^{(\nu)}}x_{ik}^{(\nu)}=\rho_{ij}^{(\nu)}-\rho_{lj}^{(\nu+1)}x_{ik}^{(\nu)}\ (j=\overline{0,m};\ i=\overline{1,m+1};\ i\neq l). \tag{4}$$

Here:

$$\rho_{i0}=x_{s_i}\ (i=\overline{1,m}),\ \rho_{m+1,0}=F(X),\ \rho_{m+1,j}=y_j\ (j=\overline{1,m}),\ x_{m+1,k}=\Delta_k .$$

The calculation results are summarized in the main tables (of the form of Table 1) and an auxiliary table (of the form of Table 2); columns B, e_1, …, e_m of the main tables (all m+1 positions) are called the main part of these tables. Column A_k is the resolving column, row *l* is the resolving row.

Table 1 – Basic calculations 1

N	C_x	Θ_x	**B**	e_1	…	e_m	A_k	t
1	C_{s_1}	A_{s_1}	$x_{s_1}^{(\nu)}$	$\rho_{11}^{(\nu)}$	…	$\rho_{1m}^{(\nu)}$	$x_{1k}^{(\nu)}$	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
l	C_{s_l}	A_{s_l}	$x_{s_l}^{(\nu)}$	$\rho_{l1}^{(\nu)}$	…	$\rho_{lm}^{(\nu)}$	$x_{lk}^{(\nu)}$	t_0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
M	C_{s_m}	A_{s_m}	$x_{s_m}^{(\nu)}$	$\rho_{m1}^{(\nu)}$	…	$\rho_{mm}^{(\nu)}$	$x_{mk}^{(\nu)}$	
m	–	–	$F^{(\nu)}$	$y_1^{(\nu)}$	…	$y_m^{(\nu)}$	Δ_k	–

Table 2 – Auxiliary calculations

N	**B**	A_1	A_2	…	A_n
1	b_1	a_{11}	a_{12}	…	a_{1n}
⋮	⋮	⋮	⋮	⋮	⋮
m	b_m	a_{m1}	a_{m2}	…	a_{mn}
m+1	C	C_1	C_2	…	C_n
0	Δ	Δ_1	Δ_2	…	Δ_n
1	$\Delta^{(1)}$	$\Delta_1^{(1)}$	$\Delta_2^{(1)}$	…	$\Delta_n^{(1)}$
2	$\Delta^{(2)}$	$\Delta_1^{(2)}$	$\Delta_2^{(2)}$	…	$\Delta_n^{(2)}$
…	…	…	…	…	…

Description of the algorithm.

1. Zero iteration:

a) an auxiliary table is drawn up. 2, in which the parameters of the task are entered; an additional row of the table with number ν is filled in as the νth iteration is performed;

b) the main table is drawn up. 1 with number 0, in which the first m rows are filled, except for the last two columns A_k and *t*. Elements $y_j^{(0)}$ and $F^{(0)}$ are defined by scalar products (C_x, e_j) and (C_x, *B*), respectively. The zero iteration ends with the filling of an additional zero row in the auxiliary table with estimates.

2. (ν + 1) –th iteration.

Let the *ν*–th iteration be completed. As a result, the *ν*–th main table is filled, except for the last two columns, and the *ν*–th additional row of the auxiliary table. This line is being scanned. If that's all $\Delta_j^{(\nu)}\geq 0$, then the baseline X_ν is the solution to the problem. If at least one, then the vector A_k, $\Delta_k<0$ (usually $\Delta_k=\min\limits_j \Delta_j$) is introduced into the basis. After that $(A_k^{(\nu)})$, the column of the main table is filled. In the position (m+1) of this column, the estimate of the $\Delta_k^{(\nu)}$ vector A_k is entered. The rest of the elements of this column are equal

$$x_{ik}^{(\nu)} = \sum \rho_{ij}^{(\nu)} a_{jk} \; (i = \overline{1,m}).$$

Two cases are possible:

1) everything $x_{ik} \le 0 \; (i = \overline{1,m})$ – the problem is unsolvable;

2) $x_{ik} > 0$ for at least one *i*. In this case, as well as in the first algorithm, the column *(t)* of the main table *v* is filled, and the resolving element $x_{lk} > 0$ is determined. The main part is filled in according to the recurrent formula (6.3). The *(v +1)*– th additional row of the auxiliary table is being filled. This ends the *(v +1)*– th iteration.

Conclusion. Thus, based on formal calculations, it can be assumed that this mathematical model will allow for individual planning and distribution of psycho-emotional resources. Given the complexity of the implementation of this approach in the practice of navigation, it is proposed to use it in individual training [11–15]. In the context of the analysis of the psychological characteristics of each individual navigator [16–19], it is possible to refine the proposed model. At the same time, there remains an unresolved issue of its evolution and the dynamic characteristics of development or degradation. However, this context requires more in-depth study.

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