Analysis of methods of processing of expert information by optimization of administrative decisions

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Abstract. In the real operation the measure definition methodology in case of expert estimation of quality and reliability of application-oriented software products is offered. In operation methods of aggregation of expert estimates on the example of a collective choice of an instrumental control projects in case of software development of a special purpose for needs of institutions are described. Results of operation of dialogue decision making support system are given an algorithm of the decision of the task of a choice on the basis of a method of the analysis of hierarchies and also. The developed algorithm can be applied by development of expert systems to the solution of a wide class of the tasks anyway connected to a multicriteria choice.

1. Introduction

The efficiency of application of the software in the official activities of employees in many respects is defined by quality and reliability of the used automated means [1]. In the real operation the measure definition methodology in case of expert estimation of quality and reliability of application-oriented software products is offered. Results of operation of dialogue decision making support system are given an algorithm of the decision of the task of a choice on the basis of a method of the analysis of hierarchies and also.

Often by development of software of a special purpose for needs of penal correction systems institutions the situation when several employees are engaged in development of one general task meets.

At the same time the only form of control over the implementation of goals are meetings and plenary sessions. These circumstances result in need of use of specialized flexible and convenient software in use which would allow all members of the team to watch efficiency of performance of work, to reduce labor costs and to successfully finish the project in time.

Control systems of projects can be such effective tool. Now in the world the wide class of similar systems functions. In this regard before the project manager there is a problem of the choice of the most suitable means.
The choice of the platform of the automated system is defined by the criteria which are based on completeness, functionality, continuous development of system, integrability of decisions, availability of technical support, a technological basis.

Objective of this research is development of methods of support of decision-making during definition of the most suitable software.

2. Theoretical part

2.1. Comparative analysis of platforms

Identification of the criteria causing suitability of system requires a detailed research of advantages and shortcomings of concrete platforms [1]. During the research the following systems have been considered: YouTrack, Redmine, JIRA, Planiro, Wrike, Basecamp. In table 1a, b the main attention is paid to the main features of the considered control systems of projects.

| Opportunity/system     | YouTrack | Redmine | Jira | Planiro | Wrike | Basecamp |
|------------------------|----------|---------|------|---------|-------|----------|
| Schedule               | -        | +       | +    | -       | +     | +        |
| Reports                | +        | +       | +    | +       | +     | +        |
| Priorities             | +        | -       | +    | +       | +     | +        |
| Cloudy storage         | -        | unlimited| 10Gb | unlimited| 50Gb | 500Gb    |
| Comments to tasks      | +        | +       | +    | +       | +     | -        |
| Notices                | +        | +       | +    | +       | +     | +        |
| Investment of files    | +        | +       | +    | +       | +     | +        |
| Delegation of tasks    | +        | +       | +    | +       | +     | -        |
| Access control         | +        | +       | +    | +       | +     | +        |
| Templates of projects  | +        | +       | -    | +       | +     | +        |
| Deshborda              | +        | -       | +    | +       | +     | +        |
| Frequent questions     | +        | -       | +    | -       | -     | -        |
| Management of appointments | +    | -       | +    | +       | +     | -        |
| Tracking of time       | +        | -       | +    | +       | +     | -        |
| Management of tasks    | +        | -       | +    | +       | +     | -        |
| Management of access   | +        | -       | +    | -       | +     | -        |
| Discussions            | +        | -       | +    | +       | +     | -        |
| Statistics             | +        | -       | +    | +       | +     | -        |
| Management             | +        | -       | +    | -       | -     | -        |
| Agile-project          | +        | -       | +    | -       | -     | -        |
| Management of sprints  | +        | -       | +    | -       | -     | -        |
| Management of a backlog| +        | -       | +    | -       | -     | -        |
| Assessment conditions of the project | + | - | + | - | + | |
| Assessment of load of participants | + | - | - | + | - | - |
Proceeding from the revealed features of platforms during consultations with the staff of departments of administration and development, the possibility of determination of the most significant criteria for assessment of systems (table 2) appeared.

Table 2. The main criteria for evaluating systems.

| Criterion                          | Description                                                                 |
|------------------------------------|----------------------------------------------------------------------------|
| Existence of the user's guide      | Meeting of frequently asked questions and answers to them                  |
| Dashboard                          | Practicality of the user interface for the organization and information    |
| Convenience of the graphic user    | Representations by a method, simple for perception                          |
| interface                          | Attention is paid to clearness, convenience of use and friendliness of the  |
| Adjusted fields                    | interface of the user                                                       |
| Possibility of free use of the     | Possibility of adding of additional information to some data types          |
| platform                           |                                                                             |
| Accumulation of functionality      | Completely or open-source free software                                     |
| Management of access rights        | Possibility of customization for expansion of standard opportunities of     |
| File storage                       | Setting up the rules regulating conditions of access for the user to objects|
| Task management                    | The cloudy storage providing a possibility of file transfer                 |
|                                    | Convenience of planning, statement and control of tasks                     |

1. **YouTrack** – the service developed especially for programmers and teams of development by the JetBrains company. The system provides fast and convenient search by means of search queries,
maintains command syntax for editing several tasks at the same time, possesses flexible control of system under working processes of any complexity. Supports Scrum and Kanban, is localized into Russian, gives an opportunity of creation of a set of reports and carries out the accounting of time.

2. **Redmine** – the flexible web application for project management including the Gantt charts, the calendar, forums, setup of roles and the email notification.

3. **JIRA** – system which is suitable for tracking of mistakes and project management in the company of any size. This tool can be used by all employees in the team and project managers.

4. **Planiro** – the flexible and scalable web application intended for convenient project management and collaboration. Developers realized building block system that provides to users basic functionality and modules under its increase.

5. **Wrike** – control system of projects, including for creation of tasks, gathering of team, connection to already familiar services of collaboration, integration of mail.

6. **Basecamp** – one of the first platforms in the market for full project management created by the company 37 signals. Developers have provided work only with English. Differences between subscriptions to this service consist only in the volume of storage and number of active projects.

The method of the analysis of hierarchies can be applied to the solution of a problem of the optimum choice of system [2-14].

2.2. **Model on the basis of a set of the studied parameters**

We will enter into consideration of a set:

1) \( Q = \{Q_1, Q_2, \ldots, Q_i, \ldots, Q_j\} \) – alternatives of the chosen control systems of projects;

2) \( k = \{1, 2, \ldots, K\} \) – identifying numbers of criteria;

3) \( n = \{n_i, n_2, \ldots, n_k\} \) – set of coefficients of the relative importance (scales) of the entered criteria;

4) \( F_k = \{F_{1k}, F_{2k}, \ldots, F_{ik}, \ldots, F_{jk}\} \) – set of coefficients (scales) of alternatives at the choice of system on the basis of compliance to a certain criterion;

5) \( F = \{F_1, F_2, \ldots, F_i, \ldots, F_j\} \) – total set of coefficients of decisions (alternatives).

2.3. **The decision algorithm based on analytic hierarchy process**

1. In case of a choice of a project management system we install a finite set of criteria: \{user guide; task management; Dashboard; convenience of the graphic user interface; possibility of a tuning of fields; possibility of free use of the platform; possibility of increase in functionality; control of access rights, file storage\}.

|                | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    |
|----------------|------|------|------|------|------|------|------|------|------|
| User's guide   | 1    | 1    | 1/5  | 1/3  | 1/3  | 1    | 1/7  | 1    | 1/3  |
| Task management| 2    | 5    | 1    | 3    | 3    | 5    | 1/5  | 3    | 3    |
| Dashboard      | 3    | 3    | 1/3  | 1    | 1    | 3    | 1/5  | 3    | 1    |
| Convenience of the graphic user interface | 4 | 3 | 1/3 | 1 | 1 | 3 | 1/7 | 3 | 1 |
| Configuration field | 5 | 1 | 1/5 | 1/3 | 1/3 | 1 | 1/5 | 1 | 1/3 |
| Free use of the platform | 6 | 7 | 5 | 5 | 5 | 1 | 3 | 3 | 3 |
| Increase in functionality | 7 | 1 | 1/3 | 1/3 | 1/3 | 1 | 1/3 | 1 | 1/3 |
| Management of access rights | 8 | 3 | 1/3 | 1 | 1 | 3 | 1/3 | 3 | 1 |
| File storage   | 9    | 3    | 1/3  | 1    | 1    | 3    | 1/3  | 3    | 1    |
2. For formation of estimates of the relative importance of criteria we form a matrix of paired comparisons of criterion $N_{k,r} = k, r = 1, K$.

We choose intuitively reasonable scale of preferences of a look: 1, 3, 5, 7, 9, where:

a) 1 – criteria are equivalent;
b) 3 – insignificant importance of criterion $k$ over $r$;
c) 5 – existence of considerable importance of criterion $k$ over $r$;
d) 7 – criterion $k$ it is obvious more important than criterion $r$;
e) 9 – the absolute importance of criterion $k$ in comparison $r$.

At the choice of this scale the following values of estimates are possible: $1/9, 1/7, 1/5, 1/3, 1, 3, 5, 7, 9$, at the same time $N_{k,r} = 1/N_{r,k}, k, r = 1, K$.

We form matrixes of pair comparisons on the basis of the analysis of the possibilities of the considered systems and also results of interviewing of experts.

3. We create matrixes of paired comparisons of preference of alternatives of the chosen systems depending on the chosen criterion $T_{i,z,k}$. For this purpose, we compare quality of the chosen systems $i$ and $z$ by various criteria $k, k = 1, i, T_{z,i,k} = 1/T_{i,z,k}$, $i, z = 1, K$.

Paired comparisons are made according to a scale:

a) 1 – equivalence of alternatives;
b) 3 – existence of insignificant preference of an alternative $i$ over $z$;
c) 5 – considerable preference of an alternative $i$ in comparison with $z$;
d) 7 – alternative of $i$ it is obvious more important than an alternative $z$;
e) 9 – absolute preference of an alternative of $i$ in comparison $z$.

Results are given in tables 4-12.

Table 4. Matrix of pair comparisons of systems by criterion «the user's guide» ($T_{i,d,1}$).

|        | 1    | 2    | 3    | 4    | 5    | 6    |
|--------|------|------|------|------|------|------|
| YouTrack | 1    | 1    | 3    | 1/3  | 5    | 3    | 3    |
| Redmine | 2    | 3    | 1    | 1/5  | 5    | 1    | 1    |
| Jira    | 3    | 3    | 5    | 1    | 5    | 3    | 3    |
| Planiro | 4    | 1/5  | 1/5  | 1/5  | 1    | 1/3  | 1    |
| Wrike   | 5    | 1/3  | 1    | 1/3  | 1    | 1    | 1    |
| Basecamp| 6    | 1/3  | 1    | 1/3  | 3    | 1    | 1    |

Table 5. Matrix of pair comparisons by criterion «management of tasks» ($T_{i,d,2}$).

|        | 1    | 2    | 3    | 4    | 5    | 6    |
|--------|------|------|------|------|------|------|
| YouTrack | 1    | 1    | 5    | 1    | 3    | 3    | 5    |
| Redmine | 2    | 1/5  | 1    | 1/5  | 1/3  | 1/3  | 1    |
| Jira    | 3    | 1    | 5    | 1    | 3    | 3    | 5    |
| Planiro | 4    | 1/3  | 3    | 1/3  | 1    | 1    | 3    |
| Wrike   | 5    | 1/3  | 3    | 1/3  | 1/3  | 1    | 3    |
| Basecamp| 6    | 1/5  | 1    | 1/3  | 1/3  | 1/3  | 1    |
Table 6. Matrix of pair comparisons by criterion «Dashboard» ($T_{c,1,3}$).

|       | 1 | 2 | 3 | 4 | 5 | 6 |
|-------|---|---|---|---|---|---|
| YouTrack | 1 | 1 | 5 | 1 | 5 | 1 |
| Redmine   | 2 | 1/5 | 1 | 1/3 | 1 | 1/3 | 3 |
| Jira      | 3 | 1 | 3 | 1 | 5 | 1 | 7 |
| Planiro   | 4 | 1/5 | 1 | 1/5 | 1 | 1/5 | 3 |
| Wrike     | 5 | 1 | 3 | 1 | 5 | 1 | 5 |
| Basecamp  | 6 | 1/7 | 1/3 | 1/7 | 1/3 | 1/5 | 1 |

Table 7. Matrix of paired comparisons by criterion «convenience of the graphic user interface» ($T_{c,1,4}$).

|       | 1 | 2 | 3 | 4 | 5 | 6 |
|-------|---|---|---|---|---|---|
| YouTrack | 1 | 1 | 1 | 1/5 | 1/3 | 1/5 | 1/3 |
| Redmine   | 2 | 1 | 1 | 1/5 | 1/3 | 1/5 | 1/3 |
| Jira      | 3 | 5 | 5 | 1 | 3 | 1 | 3 |
| Planiro   | 4 | 3 | 3 | 1/3 | 1 | 1/3 | 1 |
| Wrike     | 5 | 5 | 5 | 1 | 3 | 1 | 3 |
| Basecamp  | 6 | 3 | 3 | 1/3 | 1 | 1/3 | 1 |

Table 8. Matrix of pair comparisons by criterion «configurability of fields» ($T_{c,1,5}$).

|       | 1 | 2 | 3 | 4 | 5 | 6 |
|-------|---|---|---|---|---|---|
| YouTrack | 1 | 1 | 3 | 3 | 5 | 5 |
| Redmine   | 2 | 1/3 | 1 | 1 | 3 | 3 |
| Jira      | 3 | 1/3 | 1 | 1 | 3 | 3 |
| Planiro   | 4 | 1/5 | 1/3 | 1/3 | 1 | 1 |
| Wrike     | 5 | 1/5 | 1/3 | 1/3 | 1 | 1 |
| Basecamp  | 6 | 1/5 | 1/3 | 1/3 | 1 | 1 |

Table 9. Matrix of pair comparisons by criterion «cost» ($T_{c,1,6}$).

|       | 1 | 2 | 3 | 4 | 5 | 6 |
|-------|---|---|---|---|---|---|
| YouTrack | 1 | 1 | 1 | 3 | 5 | 5 |
| Redmine   | 2 | 1 | 1 | 3 | 5 | 5 |
| Jira      | 3 | 1/3 | 1/3 | 1 | 3 | 3 |
| Planiro   | 4 | 1/5 | 1/5 | 1/3 | 1 | 1 |
| Wrike     | 5 | 1/5 | 1/5 | 1/3 | 1 | 1 |
| Basecamp  | 6 | 1/3 | 1/3 | 1 | 3 | 3 |
Table 10. Matrix of pair comparisons by criterion «increase in functionality» \( (T_{z,d,y}) \).

|       | 1   | 2   | 3   | 4   | 5   | 6   |
|-------|-----|-----|-----|-----|-----|-----|
| YouTrack | 1   | 1   | 1   | 3   | 3   | 3   |
| Redmine   | 2   | 1   | 1   | 3   | 3   | 3   |
| Jira       | 3   | 1   | 1   | 3   | 3   | 3   |
| Planiro    | 4   | 1/3 | 1/3 | 1/3 | 1   | 1   |
| Wrike      | 5   | 1/3 | 1/3 | 1/3 | 1   | 1   |
| Basecamp   | 6   | 1/3 | 1/3 | 1/3 | 1   | 1   |

Table 11. Matrix of pair comparisons by criterion «management of access» \( (T_{z,d,k}) \).

|       | 1   | 2   | 3   | 4   | 5   | 6   |
|-------|-----|-----|-----|-----|-----|-----|
| YouTrack | 1   | 1   | 3   | 3   | 3   | 3   |
| Redmine   | 2   | 1/3 | 1   | 1   | 1   | 1   |
| Jira       | 3   | 1/3 | 1   | 1   | 1   | 1   |
| Planiro    | 4   | 1/3 | 1   | 1   | 1   | 1   |
| Wrike      | 5   | 1/3 | 1   | 1   | 1   | 1   |
| Basecamp   | 6   | 1/3 | 1   | 1   | 1   | 1   |

Table 12. Matrix of pair comparisons by criterion «file storage» \( (T_{z,d,g}) \).

|       | 1   | 2   | 3   | 4   | 5   | 6   |
|-------|-----|-----|-----|-----|-----|-----|
| YouTrack | 1   | 1   | 1/7 | 1/5 | 1/7 | 1/3 | 1/5 |
| Redmine   | 2   | 7   | 1   | 3   | 1   | 5   | 3   |
| Jira       | 3   | 5   | 1/3 | 1   | 1/3 | 3   | 1   |
| Planiro    | 4   | 7   | 1   | 3   | 1   | 5   | 3   |
| Wrike      | 5   | 3   | 1/5 | 1/3 | 1/5 | 1   | 1/3 |
| Basecamp   | 6   | 5   | 1/3 | 1   | 1/3 | 3   | 1   |

4. For a matrix of pair comparisons of criteria we find the vector \( \overline{n_{max}} \) equal to the maximum own value: \( \overline{n_{max}} = (n_{max1}, n_{max2}, \ldots, n_{maxK}) \) \( \lambda_{max K} \) – maximum own value of a matrix of paired comparisons of criteria.

5. We carry out transformation of the received vector according to the rule:

\[
n_{max k} = \frac{n_{max k}}{\sum_k n_{max k}} .
\] (1)

6. For all matrices of paired comparisons of preference of alternatives of the chosen control system of projects we calculate a vector \( \overline{T_{max k}} \) which corresponds to the maximum own values of matrices: \( \overline{T_{max k}} = (T_{max 1 k}, T_{max 2 k}, \ldots, T_{max K k}) \) where \( \lambda_{max ik} \) – maximum ownvalues of matrixes of paired comparisons of preference of alternatives of the chosen control system of projects depending on the chosen criterion.

7. We carry out transformation of elements of the received vector \( \overline{T_{max k}} \) by the rule:

\[
T_{ik} = \frac{T_{max ik}}{\sum_k T_{max ik}} .
\] (2)
8. We calculate coefficients of decisions (alternatives) on a formula:

\[ F_i = \sum_k T_{ik} \cdot n_k. \] (3)

9. We order versions of decisions \( F_i \). The greatest value of coefficient corresponds to the most preferable version of the decision. Sort the solutions variants \( F_i \).

10. End of an algorithm.

This method is the basis for freely distributed software of \textit{Mpriority} representing dialogue decision making support system in the most different spheres of human activities [8-14].

We will apply the possibilities of this system for the decision of the considered task. In the \textit{Mpriority} interface the researched model has the appearance provided in a figure 1.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{The scheme of a problem of the choice of a control system of projects in \textit{Mpriority}.}
\end{figure}

The matrix of paired comparisons of criteria is entered into system (see the figure 2).

The matrixes of paired comparisons of alternatives presented in drawings are entered 3-11.

\begin{figure}[h]
\centering
\includegraphics[width=0.4\textwidth]{figure2.png}
\includegraphics[width=0.4\textwidth]{figure3.png}
\caption{Figure 2. Matrix \( N_{k,i} \). \quad Figure 3. Matrix \( T_{c,j,i} \).}
\end{figure}
Figure 4. Matrix $T_{z,i,2}$.

Figure 5. Matrix $T_{z,i,3}$.

Figure 6. Matrix $T_{z,i,4}$.

Figure 7. Matrix $T_{z,i,5}$.

Figure 8. Matrix $T_{z,i,6}$.

Figure 9. Matrix $T_{z,i,7}$.
The result of the solution of a task in the $M_{priority}$ system is presented in the figure 12.

Taking into account the entered values as a result of work of $M_{priority}$ of the most preferable there is a control system of projects of YouTrack. It should be noted that this software for several years is actively used in office activity of staff of the center of information technology development Research Institute of Information Technologies, in particular, at team development of an information system of the personified account and personnel office-work in institutions and bodies of a penal correction system (IS PCS). At the same time, considering insignificant lag of the received values of the priorities corresponding to alternatives of Jira and Redmine from YouTrack value it is possible to draw a conclusion on expediency of possible use of any of this software. Thus, $M_{priority}$ appears the effective tool of hierarchy of alternatives realizing the algorithm given above. However, apparent defect of this system is restriction for amount of the criteria entered for processing (no more than 9 names, see the figure 13).

These restrictions essentially influence a possibility of use of this software in activity of employees Federal state institution "Research Institute of Information Technologies of the Federal Penitentiary Service", as in practice at adoption of administrative decisions the amount of criteria or alternatives is considerably big. Therefore, development of the specialized software realizing the developed algorithm of a method of the analysis of hierarchies is expedient.
Figure 13. The message about restriction of amount of criteria in Mpriority.

Thus, during the research the algorithm of selection of an optimum control facility projects based on a method of the analysis of hierarchies Saati is constructed. It is shown that in office activity of employees Research Institute of Information Technologies the most effective use of the YouTrack system also perhaps application of Redmine or Jira. The developed algorithm can be applied in the solution of a wide class of the tasks of multicriteria choice (for example, at staff recruitment, software, drawing up ratings, etc.).

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