Journal of Engineering and Applied Sciences 11 (4): 733-737, 2016
ISSN: 1816-949X

On the Use of Expert Evaluation Methods to Select the Electronic Document Management System

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Abstract: The study describes the multi-criteria approach to the choice of Electronic Document Management Systems (EDMS) based on the analytic hierarchy process. Given study presents the description of the subject area, highlights the criteria and defines relationships between them, also multi criteria evaluation of the most popular 9 EDMS was produced compared with the review which used a simple point scoring system on a dedicated functional circuits. As a result, the EDMS priorities were identified and the recommendations for the selection of the optimal EDMS depending on the characteristics of the enterprise and the requirements for it to a functional system were formulated.

Key words: Decision-making, multi criteria evaluation, analytic hierarchy process, the electronic document management system, Russia

INTRODUCTION

Workflow automation becomes a sign of a successful company which is interested in improving their business processes and hence, the competitiveness of the whole. The introduction of electronic document management system is important for any institution. Electronic document management allows you to reduce material and time costs significantly when working with documents, improve the quality of work and relieve some of the problems associated with remote parts of the organization or individual working places of employees.

The implementation of the system will increase the level of staff performance control and with it, the organization will get: the transparency of documents movement; common information space, information liaison between the department and contracting units; guaranteed availability of information and instant access to it; accelerated exchange of the documents and performance terms in the absence of the need for the physical reproduction and movement of the documents; managed and controlled flows of information. The effectiveness of the use of properly selected electronic document management system is quite high, so the actual problem is the selection of the optimal EDMS for the specific EDMS depending on the required functionality for not to overpay for the EDMS with the "plus" feature set or not to purchase the system which does not fully have the required characteristics (Sun, 2010).

Currently, there are a large number of electronic document management systems. The most common in Russia are the following EDMS: Directum; DocsVision; Globus Professional; PayDox; 1C: Documentooborot; Boss-referent; DELO; Euphrates; MOTIVE ().

Each of these systems has a certain unequal functionality, so when choosing the most appropriate EDMS it is necessary to consider which of the proposed functions are most important for a particular company and to carry out a comparison of systems from the perspective of elaboration of the functional (Zhilyakov *et al*., 2015). The most appropriate is to use multi criteria assessment for these purposes, taking into account the importance of unequal criteria comparison sites to achieve the purpose of comparison.

MATERIALS AND METHODS

To make a selection, it is necessary to describe the subject area and select the criteria to determine the relationship between them and then to implement the most appropriate choice of EDMS using the analytic hierarchy process.

Main part: When assessing the capabilities of individual electronic document management systems, you should pay special attention to the basic criteria characterizing the EDMS (Fig. 1). OS support; DBMS and DB; integration capabilities; licensing; areas of automation

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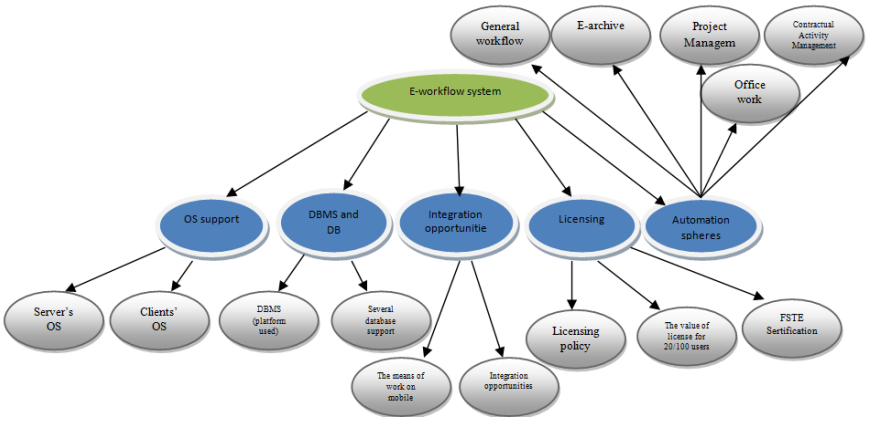

Fig. 1: Characteristics of electronic document management systems

refer to the criteria of the first level. These characteristics are fundamental when choosing an electronic document management system. Such information about EDMS as general workflow; electronic archive; paperwork; work with documents; registration and entry documents; workflow management (Workflow) and control; search and analysis of information; information security (Zaitseva *et al*., 2012) are more detailed description of EW system and thus they can be used to evaluate all of the functionality that has one or the other system.

Choosing an electronic document management system, the entire list of criteria that characterize one or another system should be fully evaluated and choose the best set of options that are suitable for your organization. The review for a comparative analysis of all the possibilities of EDMS are divided into seven functional circuits: registration and entry documents; work with documents; workflow management (Workflow) and control; search and analysis of information; information security; support paper-based; standard configuration tool.

When comparing the functional capabilities of EDMS in the study the following situations are overviewed: the feature is implemented; feature is available as part of the limited functionality or the purchase of additional software is required; feature is not implemented. As shown by the comparative analysis carried out in the system motive on the criterion "optimal price/performance" has an optimal ratio of performance, it allows us to solve the real problems of electronic document management in the modern enterprise. Despite the presented advantages of the EDMS its significant drawback is that all the circuits are recognized as having equal importance when selecting an optimal system whereas for some particular enterprise functional characteristics are known to be more important than others. As many researchers have noted, when comparing and choosing alternative sites (options, scripts, etc.) you have to deal with their ambiguity on various evaluation parameters (criteria). In this case, while comparing EDMS based on a comparison of unequal importance criteria it is advisable to use the device of multi-criteria evaluation.

Currently, a lot of different approaches to multi criteria evaluation of alternatives and their ordering are offered. Most of the existing methods of decision-making in many criteria include identification of the decision-maker preferences "piecemeal" procedure in an attempt to get a complete assessment of alternatives for evaluating the results of individual or several criteria. Often, they are reduced to a linear or non-linear convolution, allowing supply to each element of the set to assess its value. The main methods of multi-criteria evaluation are: the Analytic Hierarchy Process (AHP); ELECTRE Methods; methods based on fuzzy preference relations experts; methods of verbal decision analysis (qualitative). Methods for each of the groups have a number of advantages and some disadvantages. The application of these methods to solve the same semi structured problems can lead to contradictory results. The analytic hierarchy method, methods of decision making based on fuzzy logic and qualitative methods of decision-making-ZAPROS, PARC, ORCLASS were compared with each other. The comparison showed that the most advantageous for the analysis of unstructured multi criteria problems is analytic hierarchy process. This method has several advantages, gives results close to the actual ponderability, allows taking into account the importance of unequal criteria. The main stages of the decision-making using AHP are Blumin and Shuikova:

- Construction of the hierarchy of the problem under discussion

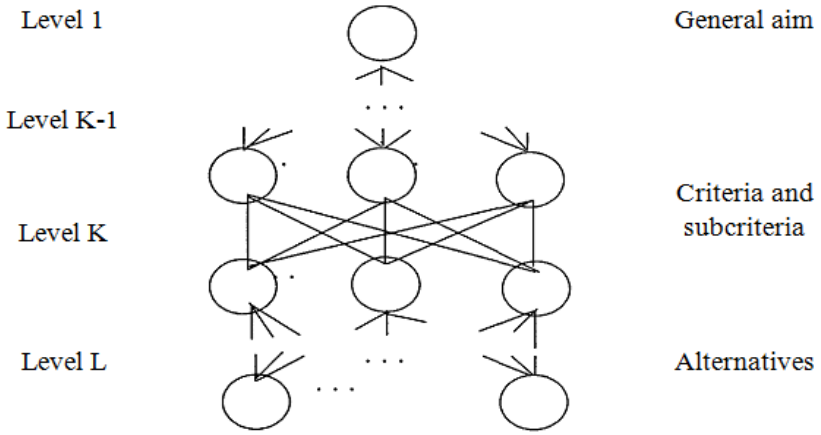

Fig. 2: General view of the hierarchy

- Paired comparison of hierarchy component
- Mathematical processing of expert information

In deciding to use the analytic hierarchy method, the group of experts produces decomposition of complex problems-defines its components and the relationships between them. The model of reality, constructed as a hierarchy appears (Fig. 2). In the simplest case, a three-level hierarchy consisting of levels: Dominant, criteria, alternatives is used.

RESULTS AND DISCUSSION

Pairwise comparisons are made in terms of the dominance of one element over another. This judgment is then attributed to the quantitative superiority of force, expressed by an integer or the inverse to it according to the following rules. If the element A_i dominates the element A_j, the matrix cell corresponding to the row A_i and column A_j, is filled integer and the cell corresponding to the row A_i and column A_j, filled with its inverse number (fraction). The AHP (Saaty, 1980) a scale of superiority/losses element hierarchy is proposed (Table 1).

Let's denote the Matrix of Paired Comparisons (MPC) which compares the criteria placed on the following for the purpose of hierarchy level $C = \{c_{ij}\}$. The matrix is the inverse of a symmetric, i.e., $c_{ij} = 1/c_{ji}$. Along the main diagonal of the matrix units are set in advance as an alternative is equivalent to itself. To make each matrix of NxN size it is enough to produce N(N-1)/2 judgments.

Preparation of such matrices is carried out at all levels and groups in the hierarchy. And the resulting matrix should be agreed for reliable solutions. Consistency is shown in transitivity. For a perfect calibration $f_{ij}(\varpi) \cdot f_{jk}(\varpi) = f_{ik}(\varpi)$. Since, ideally $c_{ij} = \omega_i/\omega_j$ and then $c_{ij} \cdot c_{jk} = c_{ik}$.

Table 1: Saaty's scale of superiority/losses

	Scale of superiority/losses	
No.	Proposition S_k	Power x_k
S_0	Equal importance	1
S_1	Between 1 and 3	2
S_2	Moderate superiority of one over the other	3
S_3	Between 3 and 5	4
S_4	A significant or strong superiority	5
S_5	Between 5 and 7	6
S_6	Significant superiority	7
S_7	Between 7 and 9	8
S_8	Very strong superiority	9
Reciprocal quantities of the given above numbers	If the comparison of one parameter with another one gives one of the above numbers that when comparing the second parameter to the first we get the reciprocal quantity	

After filling in the matrices of paired comparisons the next step is to calculate the ponderability vector for this matrix. Let's specify $\vec{R} = \{R_k\}, k = 1, \ldots, K$ ponderability criteria vector. For the calculation of ponderability vector:

$$\vec{R} = \{R_k\}, R_k > 0, \sum_{k=1}^{K} R_k = 1$$

for each matrix of pair wise comparisons K elements of each row are multiplied and Kth degree root is extracted, after which the resulting numbers are normalized (Table 2). After calculating the ponderability vector is necessary to determine the degree of coherence of experts when completing their matrix. Saaty proposes to assess the deviation from the following formula consistency (Saaty, 1980):

$$CI = \frac{\lambda_{max} - N}{N - 1}$$

and calls this value the Consistency Index (CI). The own number is proposed to estimate by finding the eigenvector or follows:

$$\lambda R_i = \sum_j c_{ij} R_j$$

Table 2: Calculating the ponderability vector

Aim	Criterion 1	Criterion 2	Criterion 3	…	Criterion K	Ponderability vector $R_k, k = \overline{1, K}$
Criterion 1	1	c_{12}	c_{13}	…	c_{1K}	$\sqrt[K]{\prod_{j=1}^{K} c_{1j}} \Big/ \sum_{i=1}^{K} \sqrt[K]{\prod_{j=1}^{K} c_{ij}}$
Criterion 2	$c_{21} = 1/c_{12}$	1	c_{23}	…	c_{2K}	$\sqrt[K]{\prod_{j=1}^{K} c_{2j}} \Big/ \sum_{i=1}^{K} \sqrt[K]{\prod_{j=1}^{K} c_{ij}}$
Criterion 3	$1/c_{13}$	…	1	…	…	…
…	…	…	…	1	…	…
Criterion K	$1/c_{1K}$	…	…	…	1	$\sqrt[K]{\prod_{j=1}^{K} c_{Kj}} \Big/ \sum_{i=1}^{K} \sqrt[K]{\prod_{j=1}^{K} c_{ij}}$

Table 3: The values of the random consistency for MPC of different order

Matrix size	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SI	0.00	0.00	0.55	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.53	1.56	1.57	1.59

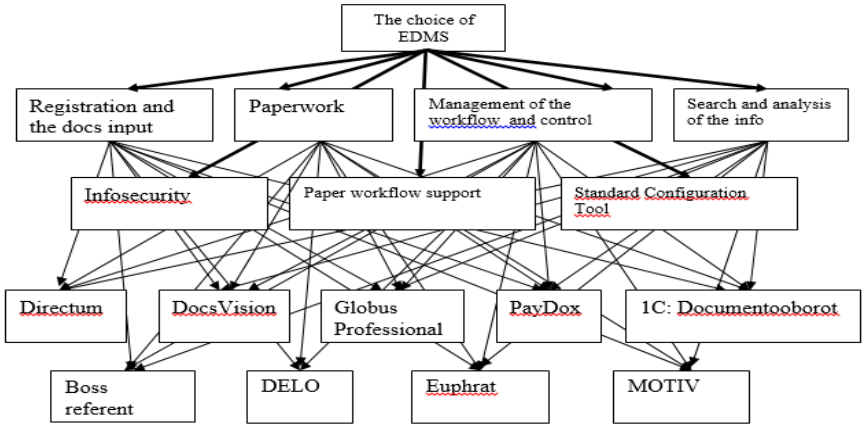

Fig. 3: EDMS select hierarchy

The proportion of CI to average SI for the back-symmetric matrix of the same order, generated randomly is called the Proportion of Consistency (PC). The PC value which is less than or equal to 0.10 is acceptable (Table 3):

$$PC = CI/SI$$

Further, MPC are filled where alternatives are compared in pairs with respect to each of the comparison criteria. So many matrices are filled as many criteria are used and ponderability vectors of alternatives are calculated for each of the criteria. V_{ik} the ponderability of the i-alternatives in terms of k-test comparisons:

$$\sum_{i=1}^{N} V_{ik} = 1$$

To calculate the ponder ability alternative A_i linear convolution is produced:

$$\omega_i = \sum_{k=1}^{K} R_k V_{ik}, \sum_{i=1}^{N} \omega_i = 1, i = 1, \ldots, N$$

Also the assessment of the hierarchy consistency is computed on the last stage:

$$BID = M/M^{-}$$

$$M = CI_{krit} + \sum_{k=1}^{K} CI_k \cdot R_k,\ M^{-} = SI_{krit} + \sum_{k=1}^{K} SI_k \cdot R_k$$

Where:

Ci_{krit} = A consistency index value for MPC of criteria with respect to the target

Ci_k = Consistency indices for MPC of alternatives for each of the K criteria

Si_{krit} = The expectation of consistency for randomly filled MPC of criteria in relation to the purpose of dimension m

Si_k = The expectation of consistency for randomly filled MPC of alternatives for each of the K criteria

The hierarchy is considered to be consistent if the BID of 0.1 (10%), although in practice the allowed threshold of 0.2 for the solution of complex problems. Let's compare the above EDMS on the specified criteria. The hierarchy for selecting the system has the form shown in Fig. 3.

Table 4: Vector of global priorities alternatives

Directum	Docs vision	Globus professional	PayDox	1C:Dokumentooborot	Boss-referent	DELO	EUPHRAT	MOTIV
0.0886	0.2132	0.0632	0.0544	0.0334	0.0917	0.0950	0.1486	0.2120

Thus, when choosing EDMS the greatest importance have the criteria for "management and control of work flow" and "information security".

CONCLUSION

After processing MPC considered EDMS for each of the criteria vectors for the local EDMS criteria priorities were received. Applying them additive convolution, we obtain the vector of global priorities alternatives EDMS (Table 4). Thus, in this example, DocsVision and MOTIV are optimal, so the choice as EDMS is sufficiently justified and appropriate if we compare not only the global indicators of preference options but also the comparison of MOTIV with other EDMS on most comparison criteria. After analyzing the results, you can also make the following conclusions:

- If your company is small and requires only workflow automation, Globus system is suitable for this company
- If your organization is public, the most appropriate systems are EDMS "Euphrates", Globus and MOTIV
- DocsVision and MOTIV belong to systems that do not require powerful hardware and software park with high performance are
- The most suitable systems for the companies which in addition to the conduct of electronic document management need to automate complex business processes will be Globus and DocsVision
- Well implemented feature of the documents storage is presented in the EDMS "Euphrates" BOSS-Referent

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