# MATHEMATICAL MODEL OF ELECTRONIC DOCUMENT CIRCULATION SYSTEMS

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***Abstract****. The development of technologies for automated management and document flow of enterprises has led to the formation of a new area of information technology systems - electronic document management systems (EDMS). The current market for goods and services in Uzbekistan forces enterprises to pay serious attention to optimizing work flow management systems and increasing competitiveness. Moreover, these problems need to be solved quickly, which requires suppliers of corporate information systems to use new implementation methodologies - minimizing their risks and ensuring the rapid receipt of real results. At the same time, it should be noted that the problems of formalizing decision-making mechanisms in the execution of work flows and adapting the developed software systems to the specific features of the functioning of a particular organization remain open. In the conditions of the global economy and intense competition, the organization of production flows at industrial enterprises is characterized by great complexity and dynamism, and, consequently, an increase in the information load on management personnel. Managers poorly use the mathematical apparatus of decision-making when monitoring and executing work flows, which allows them to simulate problem situations and make effective decisions when they arise.*

***Keywords****: mathematical model, information processing, government, document, information technology, education, training, systemized management, automation.*

The task of converting information from one form to another must be solved in every electronic document management system and, moreover, this task is the main task of such systems. The purpose of using electronic document management software systems is to reduce the volume of paper document flow (which is carried out entirely in a human-readable form) by transferring some of the functions for exchanging documents to an automated system. Therefore, to achieve the goal, first of all, it is necessary to solve the problem of processing data into a form suitable for automated processing and back into a human-readable form. The processing of information from one form to another should be done automatically, that is, support for each specific format should not be associated with making changes and additions to the program code.

To solve this problem of information processing, the author proposes and justifies the general mathematical model of information flows in the electronic document management software package he developed. The model consists of four main components (modules) - storage, loader (data loading module), saver (data upload module), checker (automated verification module). The need to develop an internal format and a dedicated data storage is justified by the following considerations: • the electronic document management system presents the same information to different counterparties in different forms; • within the system, it is therefore necessary to maintain meta-information about all forms of representation of information circulating in the system; • parts of this meta-information related to different forms of information presentation are necessarily different, and necessarily have quite a lot in common; • external

formats are controlled by counterparties and serve their current needs and requirements, and therefore can be subject to significant changes over time; The internal storage of the system should remain as stable as possible[5],

The data warehouse must provide the following functionality:

• the ability to quickly traverse the entire data structure and obtain
its arbitrary subsets;

• the ability to quickly save and restore data;

• transaction support;

• support for information download and bypass interfaces.

In order to ensure that the storage is filled with incoming data
into the system from counterparties, a loading module is required, which is a buffer
between counterparties and the storage loading interface.

Loading module:

• accepts data of a certain format from an external source;

• accepts a format description from the storage;

• accepts boot parameters;

• carries out analysis of received data in accordance with
format, and converts them into a stream of values;

• limits (changes) the flow of values in accordance with
boot parameters;

• directs the resulting flow of values to the store via
download interface.

The upload module solves the problem of generating an external representation
data according to the internal representation contained in the repository. Thus, its function is the inverse of the load module function. Module
unload is a buffer between the storage bypass interface and external data consumers.

The task of the unloading module is as follows:

• Receive a task from the counterparty to download certain data;

• Convert this task into a bypass interface command system;

• Perform a bypass of the storage and receive a data stream, in
in accordance with the request of the counterparty, as well as meta-information necessary to present the requested data in a form accessible for processing by this counterparty;

• Represent the data stream as a perceivable file
format counterparty (if the counterparty is an automated
system or in a human-readable form (if the counterparty is a person, using meta-information obtained from the storage.

The repository contains all the information and metainformation available in the system in an internal format, and can interact with the outside world through modules for loading and unloading information. During these processes, the contents of the repository undergo constant changes. Therefore, the electronic document management system must contain a verification module responsible for maintaining the repository in accordance with the external requirements (constraints) existing in the system. The verification module: • is launched after changes are made, at a certain frequency, or upon request of the system user; • receives a formalized description of restrictions from the repository; • crawls the storage, receiving from it groups of details affected

by restrictions, and checking compliance with these restrictions; • corrects violations of restrictions in accordance with the instructions contained in the description of restrictions; • generates a protocol of its work describing the detected violations and returns it to the inspection customer.

The work shows that storage, upload and download modules are mandatory components of any properly designed electronic document management system. [6], The verification module is optional, but must be present if the data domain requirements impose certain restrictions that are not described only by machine-readable information representation formats. At the logical level, the work of a document flow system participant with its information processing and storage modules is limited to the following: • the user has the ability to transfer data to the loading module, report the parameters for loading this data into the storage, initialize the procedure for loading data into the storage and receive a protocol with the loading results; • the user is aware of the contents of the storage in terms of the data of which he is the owner and is confident that this data is stored unchanged between work sessions; • the user has the ability to initiate a check of the storage status and receive a protocol with the results of the check; • the user has the ability to initiate the launch of the upload module, report the parameters of data upload and the data recipient.

Research result Mathematical model of electronic document circulation systems for the principles of designing software systems for secure and legally significant electronic document management, it is thus determined by the fact that

• thanks to the use of such systems, it becomes possible to increase the efficiency of public administration by accelerating the flow of information into automated information systems of government bodies;

• the actual implementation of systems will occur in conditions of rapid growth in the number of subscribers and the development of the capabilities of the software systems themselves, therefore it is necessary to predict in advance the vector of development of the information model and give theoretical estimates of the limits of the capabilities of these systems;

• at the same time, the introduction of a number of document management systems is required (for example, in Uzbek, information consumers are the tax service, social and health insurance funds, state statistics service, customs service, Pension Fund, tariff service, financial monitoring service, environmental monitoring service, regional financial budget services - all with their own requirements for information processing procedures), and, therefore, there is a need to generalize the principles of their design, and to build a universal data processing model, on the basis of which the integration of these systems would be possible; • volumes of document circulation (in Russia - up to 2.5 billion documents per year) and requirements for the availability of historical versions of documents (storage period for certain types of documents - up to 75 years) represent a challenge to the performance and scalability of information systems, equal to which the history of software development has not yet been achieved dont know.

Models of this category imply the representation of objects as elements of sets, and their interaction as operations on sets or individual elements. The construction of a mathematical model is necessary to form a unified structure for representing the initial information associated with document flow, which will simplify the modeling process with significant amounts of data. The mathematical model is constructed in terms of set theory.

To model flows between departments, the authors of [9] use interaction matrices. The matrix is compiled for each department and division separately and contains data on input and output information, indicating the functions of each structural unit.

The proposed approach, according to the authors, allows us to consider organizational units as multi-channel systems with a queue for service. Interaction matrices are used as input data for modeling, making it possible to obtain such flow parameters as the intensity of receipt, and the average time of working with a document in the system is chosen as an indicator of efficiency.

The advantage of the proposed model is its sufficient versatility and completeness, the ability to assess and optimize document flow in departments based on the given performance indicators. The work does not describe in sufficient detail the objects of document flow and the operations of interaction with objects and subjects. In addition, the model does not take into account the role of EDMS users and restrictions on the performance of various operations on data by users with different access levels [10-14].

Thus, the works provide an extensive and detailed mathematical description of metadata as a means of representing document flow objects, which can be used to build an EDMS in various subject areas, including educational institutions. In our opinion, in the proposed model too much emphasis is placed directly on metadata, while the mathematical support of the EDMS as a whole is not described in sufficient detail. The model also pays little attention to the interaction of objects and subjects, the transition of documents from one state to another.

The main task of modeling control systems for technological processes, including heat and power processes, is to ensure that the resulting models are as close as possible to their real prototypes. One of the main obstacles is the fact that real systems are usually subject to disturbances that are non-deterministic functions of time (random processes). Thus, one of the important tasks in modeling control systems is the modeling of random disturbance processes. The operating principle of existing algorithms for modeling such processes is to form a discrete sequence at the output of the algorithm, which in one way or another depends on the initially given input discrete sequence, distributed according to one or another law. The work examines three algorithms for modeling random processes: the interpolation algorithm, the Pugachev algorithm and the recurrent algorithm. The interpolation generation algorithm is built on the principle of interpolation of sections of the output process located between points from the original sequence, a cosine wave segment between its two neighboring extrema, shifted inward relative to the latter to a user-specified degree. This parameter allows you to influence the degree of nonlinearity of intermediate sections. The implementation of the algorithm proposed in the work includes a transition to the first element of the original sequence if the values in it are not enough to calculate the output process. Pugachev's algorithm allows you to generate a random process with a given correlation function (spectral density) [13],

Each component of the canonical series representing the output process in the algorithm is implemented through two random variables (therefore, twice the volume of the original sample is required). For each component of a random process, the variance is calculated from the corresponding frequency range in a given spectral density. As the duration of the random process increases, the number of elements of the series increases, because the number of frequency intervals into which the area under the spectral density graph is divided increases, and the number of these intervals is proportional to the time of implementation of the process.

To manage metainformation, a set of auxiliary components is used, combined in Fig. 5 logical block Schema. All components of the KDOM model process information using format descriptions written in a specialized language. The language is built on top of the eXtensible Markup Language XML, which is currently the industry standard for representing metadata. The

meta-description language of the KDOM model allows you to describe syntactic rules for recognizing data elements in a machine-readable file, syntactic rules for generating machine-readable and human-readable data in accordance with the formats of external information consumers, as well as describe comprehensive rules for format and logical-arithmetic control of the validity of information in the system storage.

The most important properties of the KDOM system are its • extensibility - the developer has the ability to create his own implementations of the Saver and Scanner components to connect the finished internal KDOM architecture with any external applications and user interfaces;

• flexibility - all descriptions of formats, checks, custom types, additional integrity constraints can be made in the form of XML schemas; the data type management mechanism allows you to describe domains of arbitrary structure and conduct automated checks of whether a property belongs to a domain;

• centralization - all data and metadata are consolidated in a single internal storage, which ensures speed and completeness of information processing;

• reliability - procedures for saving, restoring, integrity monitoring and checking external restrictions are used, providing intelligent control of the state of the internal storage, as well as a transaction mechanism that protects the storage from violations of the data structure during system operation.

Thus, the KDOM component model is a highly customizable software environment that can be used as a universal object model for developing any system for processing and checking information presented in the form of formalized documents [8-9], The final work contains a summary of the practice of implementing the electronic document management system designed by the author. The internal architecture of the Kontur-Extern system server is completely built on the KDOM model. The data storage in the system memory, during information processing, is organized as a chronological forest, and for long-term storage it is packaged in a DBMS as a corresponding relational table. Data exchange between the system server and subscriber terminals is built using the protocol and document package format described in Chapter. Thus, the goals of the dissertation work are achieved: the constructed theoretical models and algorithms for converting and processing data in electronic document management software systems stand the test of practice, and make it possible to create an application system that has no analogues in terms of document flow volumes, scalability and flexibility.

Thus, all criteria for optimizing electronic document management are reduced to two categories: economic indicators of the EDMS and indicators of the efficiency of its operation.

The easiest way to set up an optimization problem is to use any of the above criteria, but, in our opinion, EDMS optimization carried out in this way will be incomplete, and the result will be far from ideal. Indeed, ignoring economic costs, you can get a very expensive system, and at a minimum cost it is impossible to implement all the necessary functions at the proper level. Therefore, the most correct solution in this case is to find the extrema according to both criteria. Naturally, this is not always possible, since we are dealing with a multicriteria problem, but with the help of various methods for solving this kind of problem, it is possible to achieve values of the system parameters that are quite close to optimal.

Also, despite the fact that most authors reduce EDMS optimization to either minimizing economic costs or increasing productivity, there is another optimization component. We are talking about a qualitative assessment of the implemented system; this criterion takes place when

solving the problem of optimizing information systems, but in the context of EDMS it has not yet been considered.

This direction also seems promising to us, since in the modern world the quality of a software product cannot be reduced only to numbers and costs; an important characteristic of modern information systems is their convenience, intuitiveness of use, speed, stability, etc. As part of setting the optimization problem and determining the optimization criteria for the EDMS, this aspect will also be considered and taken into account to provide the most comprehensive approach to building an optimal EDMS. Thus, most authors use only one criterion when solving the problem of EDMS optimization, which makes such a problem incomplete and the resulting information system suboptimal.

Thus, the analysis carried out leads us to the development of our own mathematical apparatus for synthesizing the EDMS of a scientific and educational institution, the selection of criteria and the formulation of an optimization problem.

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