Increasing the Level of STP In Information Processing

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***Abstract*: The paper addresses the issue of increasing the level of STP in information processing. The factors that hinder the increase in the level of STP processes are investigated, and ways to increase the level of STP are researched, with the current state of information technologies considered. Factors are identified by a structural analysis of the process model, the construction of an STP level estimation algorithm, and a comparative analysis of the STP level for processes with low and high STP levels[1].**

***Index Terms*: Processes, STP level, process model, internal process environment, process template, process instances.**

I. INTRODUCTION

The processing of paper and electronic media information (hereinafter referred to as information) constitutes a significant part of the activities of many organizations (banks, insurance companies, pension funds, public institutions, etc.)[2]. The productivity and costs of such activities are directly dependent on the degree of use of human labor in the deployment of relevant processes. Organizations make significant efforts to automate processes using corporate information systems (CIS). Ideally, the transformation of process inputs into their outputs should be carried out fully automatically without human involvement. However, this is far from the case in reality: employees of organizations have to perform quite a lot of operations on inputting and processing information using CIS user interfaces.

Evaluation of the manual labor usage degree while performing operations related to information processing is often carried out within the framework of the STP concept (Straight Through Processing) [1, 2]. The term STP appeared in the early 1990s in the development of electronic systems is for confirming and calculating trade transactions in the financial market. James Karat, an employee of the London Stock Exchange, considered to be the author of this term. He used the STP term to denote a method of measuring the success of the continuous transfer of information about a transaction without human intervention (from the moment the transaction is entered into the system until the completion of settlements) [3]. Later, the term received broader interpretation and began to be used as a characteristic of the method of processing information when carrying out operations related to the conclusion and execution of transactions, carrying out settlements, making money transfers, etc. [4-7].

In this paper, the STP process is understood as end-to-end information processing, which is carried out automatically without human intervention. Accordingly, under the STP level, the end-to-end processing level, which determines the extent to which the processing is done in the automatic mode, and the extent of human labor usage, is understood. The paper examines the factors that hinder the increase in the level of STP in information processing, as well as examines ways to increase the STP level that are available with the current state of information technology considered. Factors are identified by a structural analysis of the process model, the construction of an STP level estimation algorithm and a comparative analysis of the STP level for processes with low and high STP levels.

II. METHODS

The methods used in this paper can be separated by type of analysis carried out in order to identify factors that hinder the increase in the level of STP in information processing, as well as ways to increase the level of STP that are available with the current state of information technologies considered (Figure 1). Note that the paper will use the assumption that the factors that obstruct the improvement of any activity primarily depend on the characteristics of the activity itself and the procedures for the improvement of such activity. Based on this assumption, the factors that obstruct the increase in the STP level of information processing will primarily depend on the characteristics of the selected process and the process improvement procedures (in this case, improvement is carried out by increasing the STP level).

At the first stage, the structure of the process will be analyzed. The structural analysis method will be applied to the process model and to real processes. In particular, the structural elements of the model and the mechanism

[1] The article was prepared based on the results of research carried out at the expense of budget funds according to the state task of the Financial University under the Government of the Russian Federation.

[2] In connection with the introduction of modern technologies, including those of the Industrial Internet of Things (IIOT), Big Data and Machine Learning, the share of information processing operations will constantly increase in all sectors of the economy, including the production of goods and services.

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for the deployment of process instances will be highlighted in accordance with the process template. This will allow determining the main structural elements of the external and internal environment of the process, which are necessary for identifying the factors hindering an increase in the STP level.

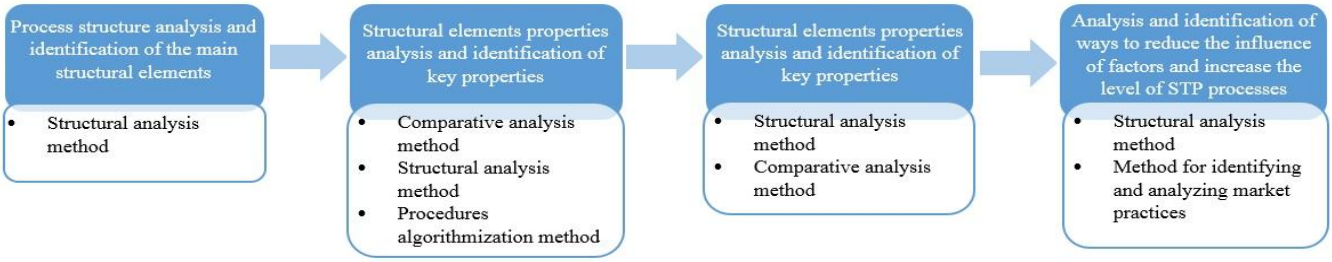

Fig. 1: Methods used in analyzing the factors that hinder the increase in the level of STP information processing, and ways of increasing the STP level

At the second stage, a comparative analysis of the properties of the structural elements of the processes with low and high STP levels will be carried out. In order to do that, the method of structuring the properties of structural elements, the method of comparative analysis of properties and the method of algorithmization of the procedure for assessing the level of STP process will be used. All of this will determine the key properties of the structural elements of the process that affect the STP process level. At the third stage, the analysis and identification of the main factors hindering the increase in the level of STP in information processing will be carried out. For this purpose, the method of structural analysis of factors will be used to group the factors into five groups and the method of comparative analysis of the properties of the structural elements of the process will be used within each group. At the last stage, ways to reduce the influence of inhibiting factors and to increase the level of STP process will be analyzed and identified. In order to do that, the method of structural analysis of methods will be applied to group the methods into three groups and the benchmarking method will be used to identify the best practices in each of those groups

III. RESULTS

Using the considered methods, the authors will identify the main structural elements of the process model, construct an algorithm for evaluating the STP level and identify the factors that hinder the increase in the level of STP in information processing.

A. The main structural elements of the process

The basis of the process model is made of the following assumptions:

1) the process is a form of movement, which is manifested in the performance of the process of actions by the subjects that change the state of the objects of the process;

2) the process can be represented as an open system with a boundary that separates the external and internal environment of the system;

3) the external environment includes the inputs and outputs of the process as well as factors affecting the process deployment, where:

- process inputs are objects of the external environment that are transformed into objects of the internal environment due to the actions of the subjects of the process;
- process outputs are objects of the external environment of the process, into which the objects of the internal environment are transformed due to the actions of the subjects of the process;
- external environmental factors are factors that can change the characteristics of the elements of the internal environment of the process;

4) the internal environment of the process includes the subjects of the process[3], the actions of the subjects, the objects of the process, the states of the objects and changes of those states and the process deployment mechanism;

5) the process deployment mechanism determines the rules for the implementation of actions by the subjects of the process and the technical means by which actions are performed; includes a policy, a technical system, and an interface of the mechanism, where:

- a policy is a set of rules for the implementation of actions by the subjects of the process;
- a technical system is a set of technical means to perform actions;
- an interface is a part of the mechanism with the help of which subjects of the process gain access to the policy rules and to the functions of the technical system.

Any structural element of the external and internal environment of the process can influence its STP level. The models of structural elements help to reveal this influence [8-10]:

- model of the subjects of the process (for example, in the form of a role model with the description of roles that subjects can perform within the framework of the process);
- action model of the process subjects (for example, in the form of a functional model in the IDEF0 format or in the form of a workflow diagram);
- model of process objects (for example, in the form of an "entity-relationship" ER-diagram with a description of the attribute composition of objects);
- model of the state of the process objects (for example, in the form of a state diagram in which objects can be
- located);
- model of the state changes of the process objects (for example, in the form of a diagram of objects' transitions from one state to another);
- model of the process

[3]Not only people and groups of people can be subjects of processes, but also computer systems. Within

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the framework of this model, the technical system of the process deployment mechanism claims the role of such a subject. Note that today this assumption is reasonably sufficient due to the emergence of a larger number of processes, the deployment of which is performed without participation or with minimal human involvement.

- mechanism (for example, in the form of a description of the policy rules, functions of the technical system and protocols for using the process interface);
- model of external environmental factors of the process (for example, in the form of PEST diagrams).

By using the process model, it is possible to analyze the structural elements of the external and internal environment of the process, as well as the relationships between them. Such an analysis makes it possible to identify shortcomings, defects, and vulnerabilities of the process, which in turn makes it possible to improve it (including improvement with the aim of optimizing, automating and raising the level of the STP process).

Based on the process model, one can build a process template [11] in order to deploy process instances. Directly deploying an instance of a process will be the execution by the subjects of the process of a sequence of actions specified by the template, all of which will be deployed according to one pattern. When building a template, it is necessary to consider the conditions and factors affecting the deployment of instances, including the conditions on the compliance of the template:

- with key characteristics of the process model;
- with the competencies and skills of the subjects of the process;
- with national laws and regulations;
- with internal regulatory documents of the organization;
- with real capabilities of information systems, etc.

Note that, in accordance with the same template, significantly different instances of the process can be deployed. In particular, this is determined by the number of branch points of the workflow in the process template. For example, using only three points of bifurcation of the workflow of the "exclusive OR" type will lead to the possibility of deploying four different sequences of actions, and therefore four different types of instances. This fact must be taken into account when analyzing and evaluating the level of the STP process.

B. STP process level estimation algorithm

Usually, the quantitative determination of the STP level indicator is carried out [3, 6]:

1) as the ratio of the number of transactions performed in the automatic mode to the total number of transactions;

2) as the ratio of the number of documents processed in the automatic mode to the total number of documents.

These methods are not always applicable to specific processes, since transactions can be performed within different processes, different process instances can be deployed within the same template, and during the deployment of one process instance, some transactions (transitions between transactions) can be performed automatically, and the other ones – in the manual mode.

Let us change the way STP is measured as follows.

First of all, the STP level of the process will be determined as the weighted sum of the STP levels of process instances deployed over the selected time period:

$$P = \sum_{i=1}^{N} \alpha_i \cdot PI_i,$$

where P is the STP level of the process, α_i is the weighting coefficient of the *i*-th process instance, PI_i is the STP level of the *i*-th process instance, and *N* is the number of process instances. In this case, the $\alpha_i = 1/N$ value is taken as a weighting factor.

Consider two options:

1) all actions within the process instance are performed automatically. In this case, one can assume that the main influence on the STP level of the process instance is provided by the method of launching actions to execute (automatic or manual). The STP level of such an instance of the process will be defined as:

$$PI_i = \left(1 - \frac{HA_i}{A_i}\right) \cdot 100\%,$$

where HA_i is the number of actions within the *i*-th instance that are started manually, and A_i is the total number of actions performed by the subjects of the process within the *i*-th instance. It can be seen that with a decrease in the number of actions to be executed manually, the level of STP instance will increase.

2) actions within the process instance are performed in the automatic and manual modes. In this case, the STP level of the *i*-th instance of the process will be represented as a weighted sum of two STP levels that correspond to groups of actions performed in the automatic PI_i^A and manual PI_i^H modes:

$$PI_i = \gamma_i^A \cdot PI_i^A + \gamma_i^H \cdot PI_i^H,$$

where γ_i^A is the weighting factor for the STP level by the group of actions performed in the automatic mode, and γ_i^H is the weighting factor for the STP level by the group of actions performed in the manual mode. The STP level corresponding to the group of actions performed in the manual mode will be assumed to be zero $PI_i^H = 0$, so the formula for the STP level of the process instance can be simplified:

$$PI_i = \gamma_i^A \cdot PI_i^A.$$

The calculation of PI_i^A is similar to the case discussed above (performing all actions within single instance in the automatic mode):

$$PI_i^A = \left(1 - \frac{HA_i^A}{A_i^A}\right) \cdot 100\%,$$

where HA_i^A is the number of automatically executed actions that are launched for execution manually within the *i*-th instance, and A_i^A is the total number of automatically performed actions within the *i*-th instance. In order to determine the γ_i^A coefficient, it is necessary to

compare the effect on the STP level of the *i*-th instance of the process of action groups performed in the automatic and manual modes. In general, it is difficult to accomplish, but a rough estimate can be made on the assumption that the contribution of both groups of *actions* differs little from the case of performing all actions in the manual mode (all actions being equal in extent, for example, by a scale of labor costs). In this case, γ_i^A can be estimated as:

$$\gamma_i^A = \frac{A_i^A}{A_i^A + A_i^H},$$

where A_i^A is the total number of automatically performed actions, and A_i^H is the total number of actions performed in the manual mode within the *i*-th instance.

C. Factors hindering the increase in the level of STP

A comparative analysis of the structural elements of the process model in processes with low and high STP levels shows that the factors that hinder an increase in the level of STP may be related to the internal or external environment of the processes. In the first case, obstacles arise due to the properties of the structural elements of the internal environment of the process and the connections between the elements. For example, a technical system of a process deployment mechanism may not have a function that launches (or performs) an action in the automatic mode. Or there is a function, but its use is not reflected in the mechanism regulation rules.In the second case, obstacles arise due to the external and internal environment of the process interaction defects, for example, when transforming the paper inputs of a process into objects of the internal environment of a process or transforming objects of the internal environment into paper outputs. Another example is the negative impact of external environmental factors on the structural elements of the internal environment of the process, for example, in case the legislation is changed. Structural elements of the external and internal environment of information processing analysis, as well as the analysis of the models of structural elements, have made it possible to identify a number of factors that hinder the increase in the level of STP processes, which are given below in the context of five groups of factors: the inputs and outputs of the process; process objects, their states and state changes; subjects and actions of the subjects of the process; process deployment mechanism; external environmental factors.

The inputs and outputs of processes. The implementation of STP actions is usually hampered by the difficulty of converting inputs (orders, proposals, reports, etc.) into electronic structured data, which is caused by shortcomings and the form and/or content of inputs. As a result, the process deployment mechanism cannot process the inputs in the automatic mode and transfers them to manual processing. For example, inputs can be represented as:

- poorly structured documents;
- documents in a non-electronic form;
- documents in an unknown format;
- documents with ambiguous or uncertain content, etc;

There are other difficulties with the process outputs. Information systems can easily convert electronic structured data to electronic (poorly) structured documents. However, the transfer of documents in the automatic mode may be impossible due to the presence of requirements for the presentation of documents on paper with a handwritten signature of the Director and/or stamp of the organization. Therefore, after the automatic printing of documents, their processing will be carried out manually.

Process objects, their states, and state changes. The factors typical to this group are similar to the factors listed above. In particular, if information systems are fragmented, information can be transferred between departments by e-mail or from hand to hand on electronic or paper media within one process. In this case, there may appear many points in the process where manual labor is used to transfer data from one information system segment to another. At the same time, the data formats in different segments of the system may not coincide, there may or may not be possibilities to reflect the states and state changes of objects, etc. All this further increases the amount of manual labor.

Subjects and actions of subjects. Participation in the deployment of information processing (as subjects of the process) indicates the presence of factors that hinder the increase in the STP level. At the same time, in many cases, the participation of people is inevitable, since the mechanisms for the deployment of processes are not sufficiently developed to replace people for certain actions they perform. Factors that hinder an increase in the level of STP in information processing are associated with actions that people perform faster and/or better than modern technical systems:

- handwriting recognition;
- semantic text analysis;
- image and video recognition;
- expert assessment in conditions of uncertainty;
- forecasting in conditions of uncertainty;
- generation of opinions, judgments, and ideas;
- adaptation to changing conditions, etc.

In addition, in some situations, people are less exposed to external environmental factors that can disrupt the uninterrupted deployment of processes. For example, people are faster than computers adapting to changes in the economic situation, the emergence of new legal acts, changes in people's behavior, etc.

Process deployment mechanism. This group of factors hindering the increase in the level of STP in information processing includes factors related to the policy, technical system and interface of the process deployment mechanism.

Factors associated with the deployment mechanism policy are due to the properties of the policy rules (rules of actions taken by the process subjects and rules of transition from one action to another) and the mechanism for making changes to the rules. Factors related to the properties of the rules and the mechanism for making changes to the rules interfere with the deployment of process instances in the automatic mode due to the low degree (insufficient capabilities) of:

- compliance of rules with external and internal regulatory acts;
- formalization and algorithmization of rules;
- presentation of rules in an electronic structured form;

- maintaining the hierarchical structure of rules;
- prompt changes to rules and their structure;
- maintaining versions and expiration terms of rules and rule structures.

Factors associated with the technical system of the mechanism are due to the properties of the Program Apparatus Complex (PAC) and the mechanism for applying changes to the PAC. Factors related to the properties of the PAC and the mechanism for applying changes to the PAC in the automatic mode hinder the implementation of the following:

- data entry and storage in an electronic structured format about entities that reflect a process model (structural elements and models of structural elements, a template and process instances, etc.);
- input, storage, and execution of algorithms provided for by the process instance deployment template (processing of structured and unstructured information, processing of action sequences, etc.);
- interactions of fragments and modules of the PAC (application and system software, hardware, etc.);
- making operational changes in formats and data structures, algorithms, formats and structures of algorithms, including automatic replacement of formats and data structures, algorithms, formats and structures of algorithms;
- maintaining versions and expiration dates of formats and data structures, algorithms, formats and structures of algorithms, etc.

Factors related to the interface of the process deployment mechanism are due to the properties of the protocols and channels of interaction with information systems of interested parties, as well as the quality of the mechanism for making changes to the protocols and channels of interaction. Factors related to the properties of protocols, channels and the mechanism for making changes to them in the automatic mode hinder the implementation of the following:

- data exchange between the process deployment mechanism and the information systems of the organization ' s concerned parties;
- prompt changes in protocols and channels of interaction, including automatic replacement of protocols and channels;
- maintaining versions and expiration dates of protocols and channels of interaction, etc.

External environmental factors. External environmental factors are associated with the negative influence of the external environment on the structural elements of the internal environment of information processing. These factors include:

- change of legal norms;
- change of activity standards;
- change of protocols and/or interaction channels;
- fires, floods, collapses, power outages, etc.;
- external processes with low level of STP, with which internal processes are integrated (in this case, external and internal STP can be distinguished [1, 2, 12]);
- implementation of external attacks on information systems, etc.

Knowledge of external environmental factors can provide significant assistance to the company. First, the negative influence of factors may depend on the vulnerabilities of the elements of the internal environment of the process, the elimination of which is within the competence of the organization. Secondly, knowing the key factor, the organization can monitor and predictively analyze such factors on an ongoing basis, which will allow taking early measures to mitigate their negative impact.

IV. DISCUSSION

Analysis of the properties of the structural elements of the process model and the related factors that hinder the increase in the level of STP allows concluding that the main ways of increasing the level of STP in information processing lie in the following directions:

- increasing the share of information in a structured electronic format;
- increasing the proportion of actions performed in the automatic mode;
- increasing the proportion of sequences of actions performed in the continuous automatic mode.

This has allowed identifying for each of these areas (by analyzing the practices available in the market) the following methods for increasing the level of STP in information processing:

1) increasing the share of information in a structured electronic format:

a) regular auditing of processes for the receipt of information in an electronic structured format. Determining the reasons for the receipt of information being in a non-electronic or unstructured form and the impact of such information on the level of STP processes. Development and implementation of measures to increase the share of information received in an electronic structured format;

b) the implementation of contractual regulation and tariff incentives for document circulation with customers (counterparties), aimed at the provision of information via electronic channels in an electronic structured format [6];

c) the introduction of formal rules and the modernization of CIS in order to conclude and maintain contracts in an electronic structured format. Ensuring automatic download of contracts in the CIS. The use of an electronic structured form of contracts for execution and control of execution of contracts in the automatic mode;

d) the introduction of formal rules and the modernization of the CIS for the purpose of preparing the decisions of the management bodies in an electronic structured format. Ensuring the availability of automatic loading decisions in the CIS. The use of electronic structured solutions for the execution and control of the execution of decisions in the automatic mode;

e) implementation of fragments and modules of the CIS integration for the purpose of seamless processing of electronic structured documents within the organization as part of the end-to-end information processing;

e) use of the opportunities existing in the framework of remote customer (counterparties) service

systems to expand the list of documents exchanged in an electronic structured format;

g) implementation of an open software interface (Open API) technology for data exchange with concerned parties in an electronic structured format by integrating CIS and concerned parties' information systems;

h) implementation of software developed with the use of Machine Learning and Big Data technologies, which allows converting non-electronic or unstructured documents into electronic structured data;

2) increasing the proportion of actions performed in the automatic mode:

a) regular auditing of processes in order to identify actions performed with the involvement of manual labor. Determining the reasons for performing actions involving manual labor and the effect of such actions on the level of STP in information processing. Development and implementation of measures to increase the proportion of actions performed in the automatic mode;

b) the introduction of a constantly functioning process of identifying, algorithmizing and computerizing actions performed with the involvement of manual labor;

c) the use of available means to increase the proportion of actions performed in the automatic mode. For example, checking information on checklists, identifying incoming payments on waiting registers, making payments according to registers of targeted use of loans, etc.;

d) the introduction of formal rules and modernization of the CIS for the purpose of concluding and maintaining the terms of contracts in an electronic structured format. Ensuring the automatic conversion of the conditions of electronic structured contracts into algorithms, automatic loading of algorithms into the CIS, the use of algorithms in the automatic mode;

e) redesigning processes in order to reduce the proportion of actions that are difficult to formalize (decision making, preparation of expert assessments and forecasts, etc.);

f) implementation of contractual regulation and tariff incentives for relations with clients (counterparties) aimed at the use of predominantly formalized rules executed in the automatic mode;

g) implementation of software that ensures rapid design and redesign of formalized rules, maintenance of versions, rules and terms for the application of rules management and automatic application of rules when performing actions;

h) implementation of software developed with the use of Machine Learning and Big Data technologies, which allows performing poorly algorithm-driven actions (forecasts, expert assessments, decision making, etc.) in the automatic mode.

3) increasing the proportion of sequences of actions performed in the continuous automatic mode:

a) regularly conducting an audit of processes in order to identify sequences of actions that are deployed using manual labor. Determining the reasons why the deployment of sequences of actions is carried out using manual labor, as well as the impact of such sequences on the level of STP in information processing. Development of measures to increase the level of STP processes;

b) implementation of the Workflow class software for the deployment of actions in the continuous automatic mode [9];

c) integration of fragments and creation of a single workflow for the deployment of end-to-end information processing;

d) extending the functionality of the Workflow class software in order to quickly redesign the information processing templates.

V. CONCLUSION

This paper examines the factors that hinder the increase in the level of STP in information processing and also considers ways to increase the level of STP available with the current state of information technologies considered. Factors are identified by structural analysis of the process model, construction of the STP level assessment algorithm and comparative analysis of the STP level for processes with low and high STP levels. Within the process model, 11 main structural elements of the external and internal process environment are identified, including the process deployment mechanism with a process template. A procedure is proposed for measuring the level of STP, taking into account the possibility of deploying various instances of the process. There are five groups of factors that hinder the increase in the level of STP and three groups of ways to increase the level of STP in information processing.

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