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DEVELOPMENT OF AN OCCUPATIONAL SAFETY MANAGEMENT SYSTEM BASED ON THE PROCESS APPROACH

Vladimir A. FILIMONOV, **Larisa N. GORINA**
Togliatti State University, *Togliatti*, *Russia*

The article discusses the relevance and possibility of using the process approach in the development and implementation of occupational safety management systems based on GOST 12.0.230-2007, which is the main document in this area for all industrial enterprises and organisations of the Russian Federation. The system of occupational safety management in the organisation is considered taking into account all its internal communications and input-output parameters. It is shown that the process approach used in the design of the occupational safety management system in the organisation, allows categorising the list of works (processes), participants, resources (responsible, performers, documents, etc.), the control and correction processes.

The methodological substantiation of the process approach to the design of the occupational safety management system in the organisation is given, the basic issues of its applicability are considered. A context diagram of the process of an occupational safety management system is drawn in the IDEF0 graphical notation by means of the SADT structural analysis technology. The decomposition of the context diagram to the required levels of detail is presented and the balance factor of the models is calculated.

Key words: system; management; process approach; labour protection; diagram; decomposition; functional block; process resources; planning; improvement

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Introduction. In accordance with article 212 of the Labour Code of the Russian Federation (LC RF) with the amendments introduced by the Federal law of December 28, 2013 N 421-FZ, the requirements for employers have changed in terms of the mandatory need to create an occupational safety management system (OSMS) and ensure its continuous operation.

The article 209 of the LC RF defines the OSMS as follows: «An occupational safety management system is a set of interrelated and interacting elements that establish policies and objectives in the field of occupational safety in a particular employer and procedures to achieve these goals».

An occupational safety management system should be considered as part of the overall organisation management, providing risk management in the field of health and safety of employees.

The main document for the development and implementation of OSMS is the interstate standard GOST R 12.0.230-2007 Occupational safety standards system. Occupational safety and health management systems. General requirements, introduced as a national standard of the Russian Federation on July 1, 2009, The standard is based on the ILO-OSH 2001 Manual (ILO-OSH 2001 Guidelines on Occupational Safety and Health Management Systems).

The provisions of the order N 438 of the Ministry of Labour and Social Affairs of the Russian Federation on August 19, 2016, should also be taken into account when developing, implementing and ensuring the functioning of the OSMS; the requirements of the GOST R 12.0.007-2009, GOST R 12.0.008-2009, GOST R 12.0.009-2009 and GOST R 12.0.010-2009 should also be followed.

Problem statement. Development, implementation and maintenance of an OSMS in the organisation is a complex organisational engineering task that requires modern approaches and methods.

The OSMS design should be based on a systematic approach using a methodology known as PDCA (plan – do – check – act). Moreover, the systemic nature of the development and implementation of an OSMS can be ensured by the effective interaction of developers through numerous direct and backward linkages in parallel development of all the OSMS components, where possible.

These conditions allow considering the establishment of an OSMS as a process with the application of the basic principles of the process approach, which distinguishing feature is the transition from functional vertical to horizontal relationships within the created processes [5-8, 9, 11].

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The advantages of the process approach should include improving the management efficiency of an OSMS, integration and correlation of processes, focusing on results, transparency, minimum costs and reduced implementation time of an OSMS [2-4].

The process approach will allow development of an effective OSMS through establishing processes for key components of the occupational safety system, as well as the interconnection and synchronisation of them.

Methodology. Let's draw a matrix of GOST 12.0.230-2007, define the processes and sub-processes of the OSMS management system in accordance with the type and categorise their levels (Table 1).

Table 1

The matrix of processes and sub-processes of the GOST 12.0.230-2007

Processes and sub-processes	Level	A section according to the GOST 12.0.230-2007
1. OSMS management processes	1	–
Development of health and safety policy	2	4.1
Defining of duties and responsibilities of personnel	2	4.3
Planning, development and application of an occupational safety management system	2	4.8
Health and safety objectives	2	4.9
2. Processes of measurement, analysis and improvement of an OSMS	1	–
Check		4.13
Analysis of the effectiveness of an occupational safety management system by management. Actions to improve	2	4.14
Preventive and corrective actions	2	4.15
Continuous improvement		4.16
3. The main OSMS processes	1	–
Prevention of hazards	2	4.10
Preventive and control measures	3	4.10.1
Control of changes	3	4.10.2
Emergency prevention, preparedness and response	3	4.10.3
Supply	3	4.10.4
Contractual works	3	4.10.5
Observation and assessment of operation results	2	4.11
Investigation of occupational accidents, diseases and incidents and their impact on safety and health	2	4.12
4. OSMS resources management	1	–
Participation of employees and their representatives	2	4.2
Competence and training	2	4.4
OSMS record-keeping	2	4.5
Transmission and exchange of information	2	4.6

On the basis of the process matrix, we develop a graphical model of the first level of an OSMS (Fig.1). As can be seen from the figure, all processes are structured according to the recommendations set out in ISO/TC 176/SC 2/N 544R3:

- OSMS management processes;
- processes of measurement, analysis and improvement of an OSMS;
- the main OSMS processes;
- OSMS resources management.

The main task of the developers and the end result should be a fully functioning OSMS, including all the developed necessary processes presented in the graphical model (Fig.1), sub-processes, functions with their interrelations and quantitative assessment criteria of functioning and efficiency, and also meeting the policy, the purposes on labour protection and legislative requirements.

The general flow scheme of an OSMS using the SADT principles (Structured Analysis and Design Technique) and IDEF0-2000 methodology is presented in Fig.2.

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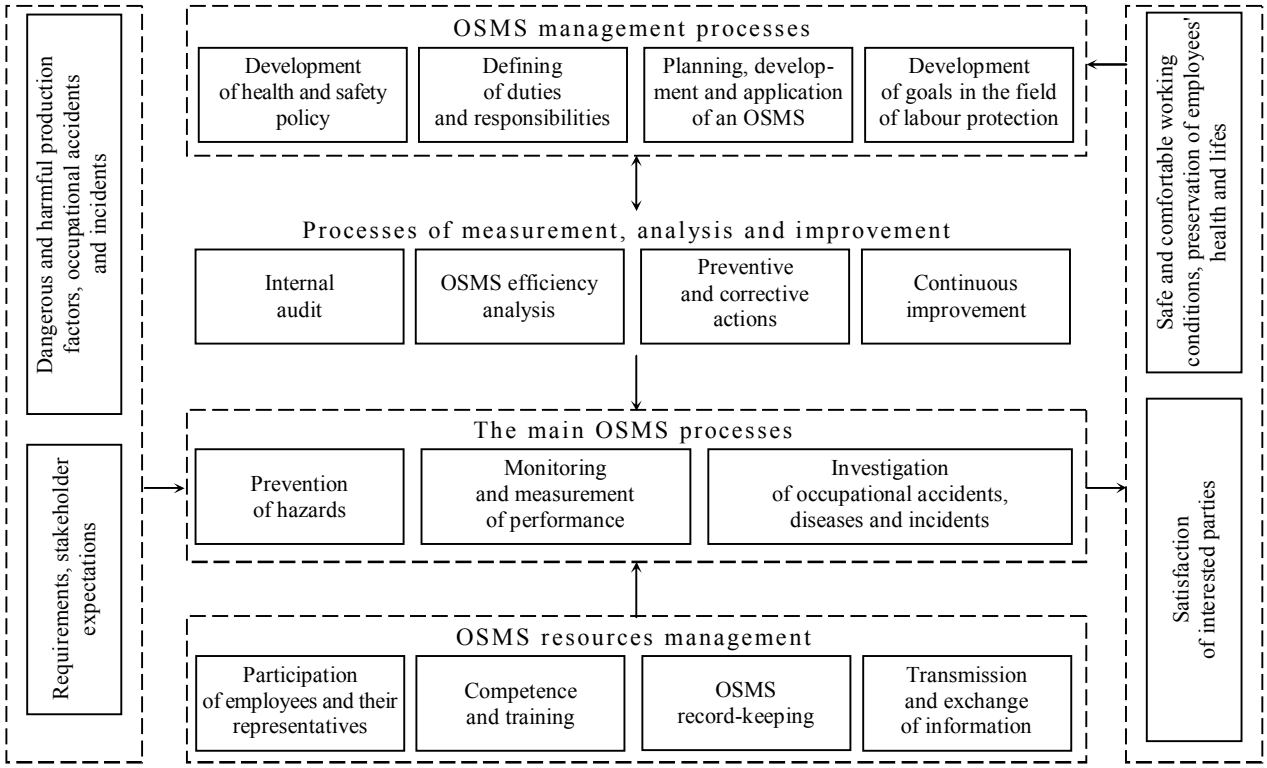

Fig.1. Graphical model of the first level of an OSMS

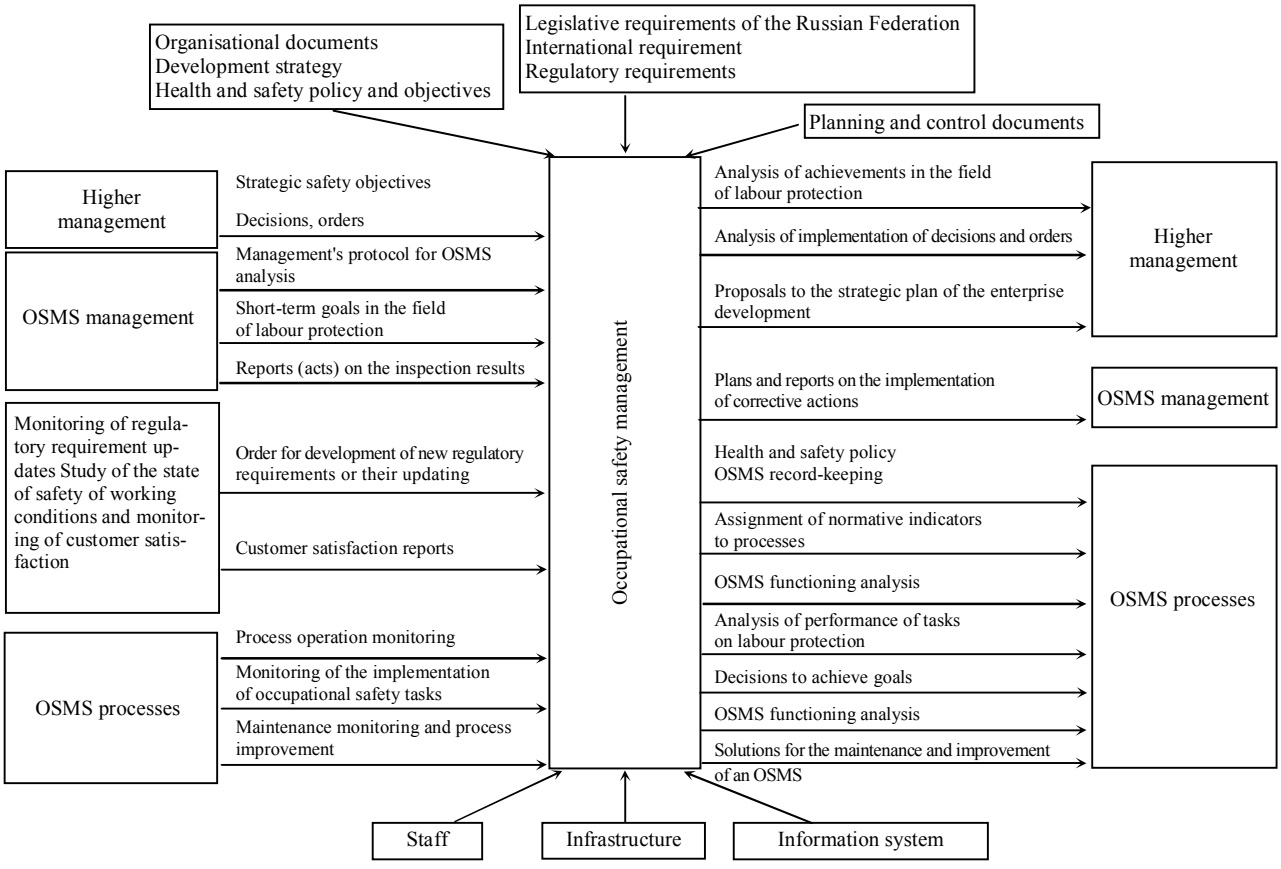

Fig.2. General OSMS scheme

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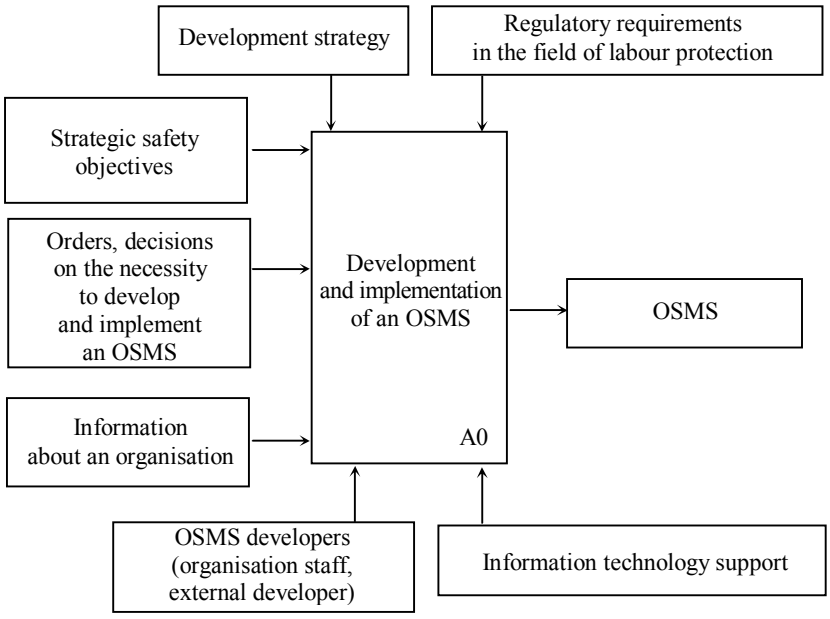

Fig.3. Context diagram of the process of development and implementation of ans OSMS A-0

Next, we apply the same technologies at the stage of development and implementation of an OSMS. At the same time, it is necessary to strive to ensure that the processes developed at creation and implementation stages maximally correlate with the future OSMS functioning processes on an ongoing basis.

Let's consider the creation process of an OSMS using the SADT Structured Analysis and Design Technique and IDEF0 methodology that allows description of a system as a set of interconnected functions in the form of diagrams (functional blocks).

The basis of the IDEF0 methodology is the representation of the analysed system by means of interacting and interrelated blocks representing processes, operations and actions taking place in this system.

The modelling process starts with a top-level contextual chart, where the analysed system is displayed in a single block with interface arrows. A context diagram identifies the scope of the simulation and its boundary, and the arrows show the connections of the model with the environment (Fig.3).

The contextual diagram clearly reflects all the surroundings in which an OSMS will be created, including the necessary inputs (strategic goals in the field of labour protection, orders, decisions on the need for the development and implementation of the OSMS, information about an organisation), outputs of the process (the created system of labour protection management) as a result of the process, as well as restrictions or control inputs (enterprise development strategy, regulations in the field of labour protection) and mechanisms or resource inputs (developers of an OSMS – personnel of an organisation, external developer, information technology support).

The OSMS creation consists of the following steps or stages: preliminary analysis of the state of labour protection in an organisation (planning of development and implementation); development and implementation (check of functioning and adjustment if necessary); analysis of functioning. Stages can be considered as interrelated processes and developed in parallel to minimise the time spent on development in general, subject to the necessary restrictions in the form of inputs from the dominant processes.

In accordance with the IDEF0 methodology, the whole process of system development and implementation will be displayed as a tree of basic processes with the decomposition of these processes to the required levels. Process decomposition allows visualisation and tracking of all the relationships and inputs and outputs of sub-processes throughout a system. In addition, each diagram contains functional blocks that reflect the activity of a specific function of the OSMS development. The tree of processes and sub-processes of development and implementation of an OSMS is shown in Fig.4.

The decomposition of the context diagram A0 is shown in Fig.5. The diagram shows the five main processes of the second level, which need to be decomposed into another level and to conduct a qualitative and quantitative assessment of the obtained diagrams. The dominant processes in this diagram are blocks A1 and A2, the outputs of which are used in the inputs of other blocks.

Let's decompose the A1 process – Preliminary analysis of the state of labour protection. Decomposition processes are presented in the shape of four sub-processes, which names and relationships are shown in the diagram of sub-processes of the third level in Fig.6.

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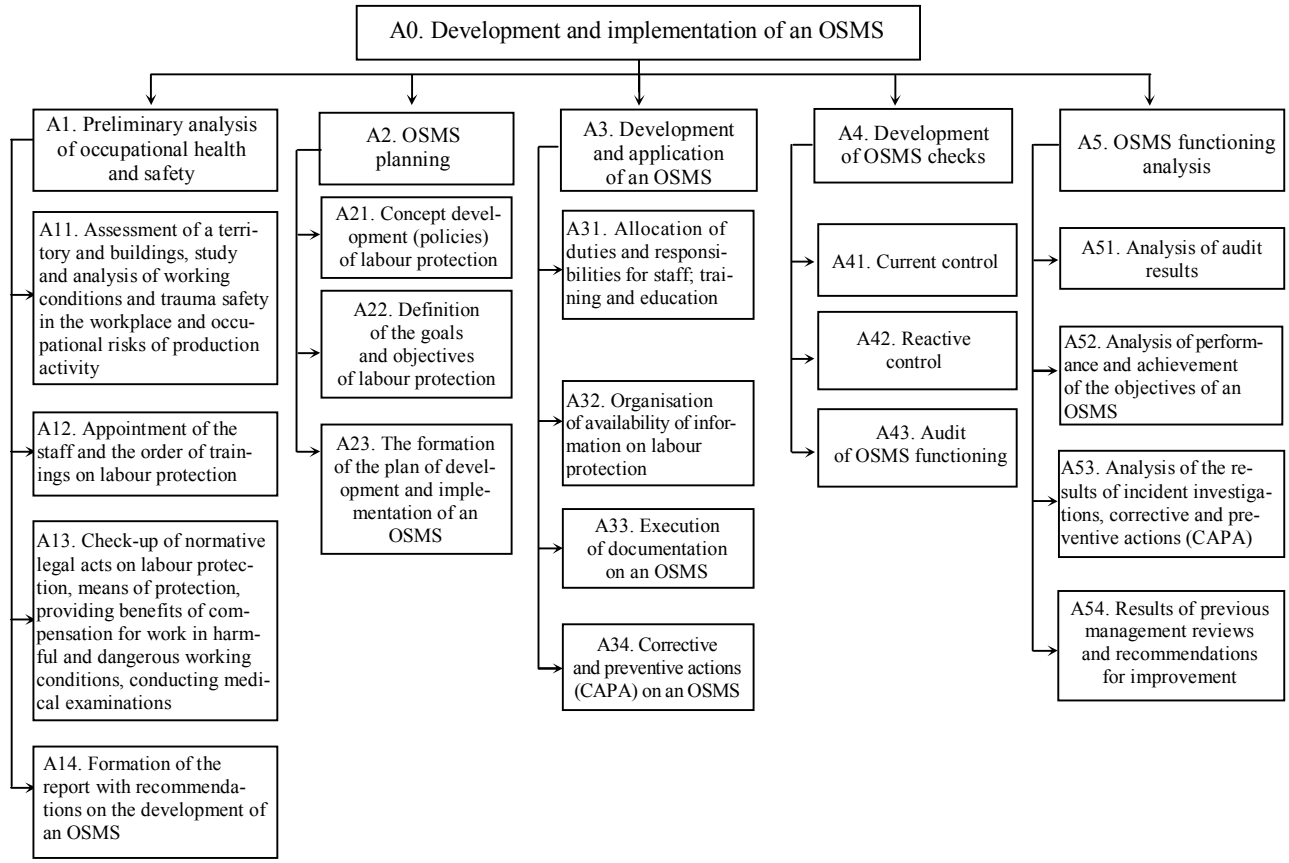

Fig.4. Tree of processes and sub-processes of the OSMS development and implementation

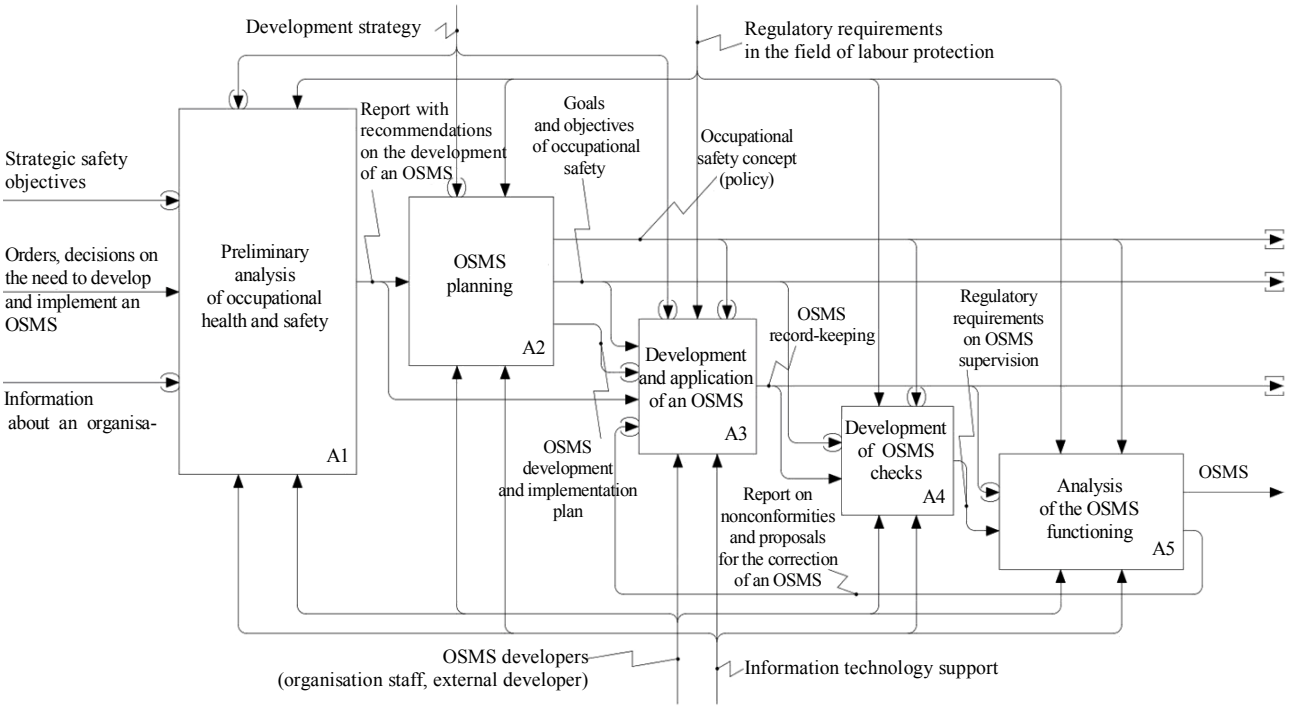

Fig.5. Diagram of processes of development and implementation of an OSMS of the second A0 level

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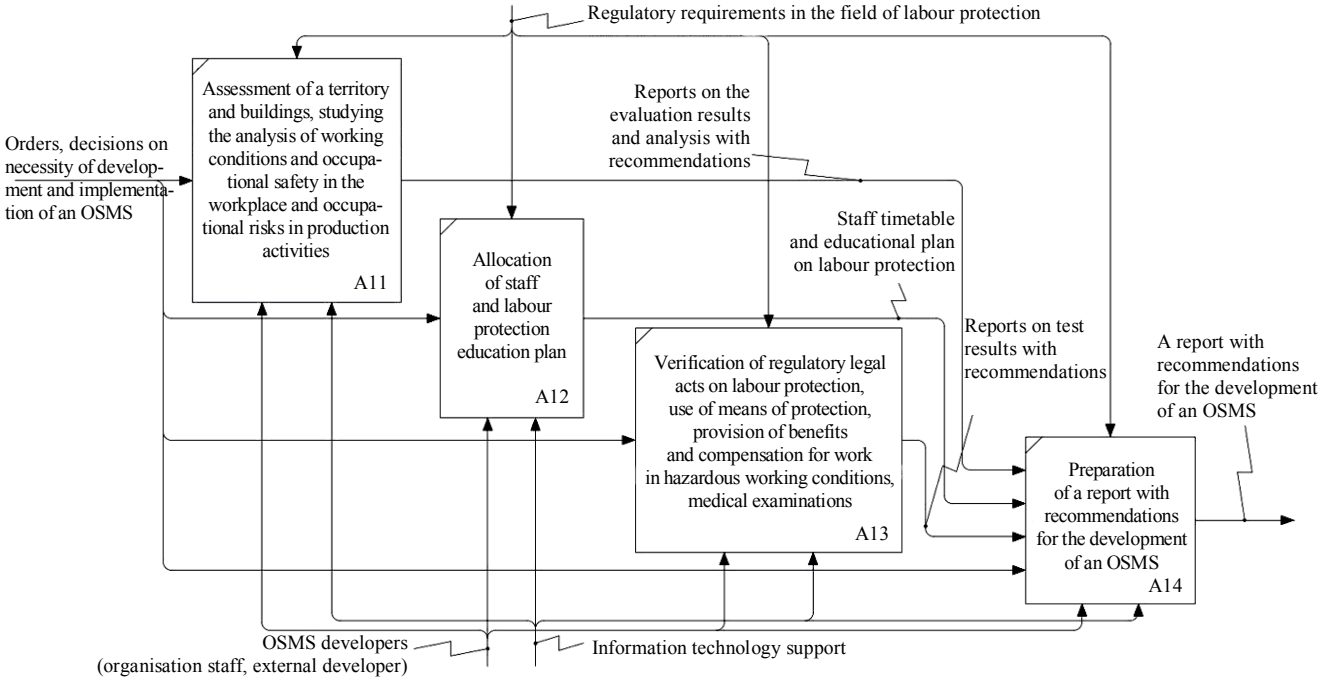

Fig.6. Diagram of sub-processes of the third A1 level

Table 2

The inputs and outputs of sub-processes on the third A1 level

Processes and sub-processes of the OSMS development and implementation	Inputs	Control (control inputs)	Mechanisms (resource inputs)	Outputs
A1. Preliminary analysis of the organisation's labour protection	Strategic safety objectives Orders, decisions on development and implementation of an OSMS Data on an organisation	Development strategy Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	A report with recommendations for the development of an OSMS
A11. Assessment of territory and buildings, study and analysis of working conditions and occupational safety and occupational risks	Orders, decisions on the need to develop and implement an OSMS	Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	Reports on evaluation results and analysis with recommendations
A12. Allocation of staff and labour protection education plan	Orders, decisions on the need to develop and implement an OSMS	Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	Staff schedule and training plan for employees on labour protection
A13. Verification of regulatory legal acts on labour protection, use of means of protection, provision of benefits and compensation for work in hazardous working conditions, medical examinations	Orders, decisions on the need to develop and implement an OSMS	Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	Audit reports with recommendations
A14. Formation of the report with recommendations on the development of an OSMS	Orders, decisions on the need to develop and implement an OSMS	Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	A report with recommendations for the development of an OSMS

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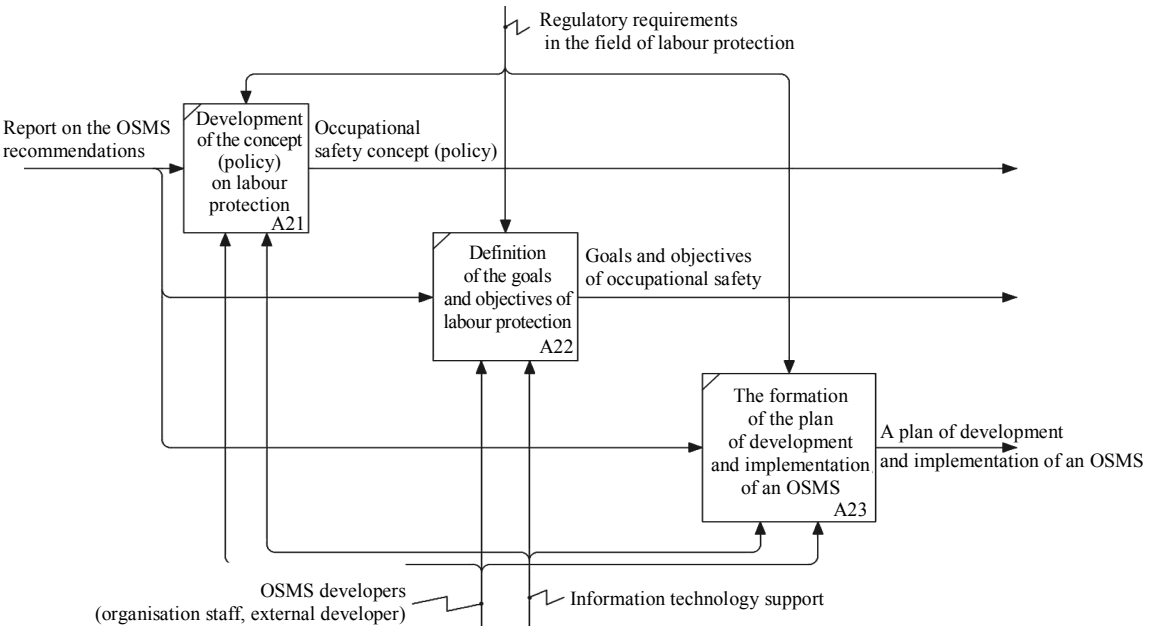

Fig.7. Diagram of sub-processes of development and implementation of an A2 OSMS

A preliminary analysis of the current system of labour protection in an organisation is a highly important and responsible stage of work, as at this stage the assessment of the territory and buildings, the study and analysis of working conditions and occupational safety and occupational risks of production activities are conducted. In addition, the necessary staff is determined and their training is conducted, all components of the current system of labour protection are analysed and a detailed report with recommendations for the development of an OSMS is formed.

The inputs and outputs of the sub-processes on the third level of A1 are given in Table 2.

Similarly, we conduct a decomposition of the A2 process – OSMS planning. The diagram of sub-processes of the third A2 level in the shape of three blocks is shown in Fig.7.

The functional block A21 develops, formulates and documents the concept (policy) of labour protection of an organisation, which establishes obligations to comply with legal requirements and continuous improvement of an OSMS.

The A22 sub-process define goals and objectives in the field of occupational safety. In order to further monitor the implementation and achievement of the goals, they should be quantified.

The process (A23) of developing and adopting a plan for the development and implementation of an OSMS should take into account the resource capacity of an organisation and establish a realistic timeline for the implementation of all items of the plan.

The inputs and outputs of the sub-processes on the third level of A2 are given in Table 3.

Let's consider the key functional block A3 –Development and application of an OSMS, in which there is a practical development of the main processes (components) of the future safety management system (Table 4).

Let's decompose the A3 process –Development and application of an OSMS in the shape of four sub-processes, the names and relationships of which are shown in Fig.8.

In the functional block A31, the matrix of responsibility for activities in the system of labour protection of an organisation is developed. The A32 sub-process is responsible for developing information blocks on health policies, goals, work plans and improvements and ensures that this information is available to all staff of an organisation.

The development of the main processes of an OSMS – Hazard Prevention, Performance Monitoring and Measurement, Investigation of Occupational Accidents, Diseases and Incidents – and their application are provided in the A33 block. In the same block, the necessary documentation package for the operation of an OSMS is presented.

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Table 3

The inputs and outputs of sub-processes on the A2 level

Processes and sub-processes of the OSMS development and implementation	Inputs	Control (control inputs)	Mechanisms (resource inputs)	Outputs
A2. OSMS planning	A report with recommendations for the development of an OSMS	Development strategy Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	OSMS concept (policy) Labour protection policy and objectives
A21. Development of the concept (policy) on labour protection	A report with recommendations for the development of an OSMS	Development strategy Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	OSMS concept (policy)
A22. Definition of the goals and objectives of labour protection	A report with recommendations for the development of an OSMS	Development strategy Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	Labour protection policy and objectives
A23. The formation of the plan of development and implementation of an OSMS	A report with recommendations for the development of an OSMS	Regulatory requirements in the field of labour protection	OSMS developers (organisation staff, external developer) Information technology support	A plan of development and implementation of an OSMS

Table 4

The inputs and outputs of A3

Process	Inputs	Control (control inputs)	Mechanisms (resource inputs)	Outputs
A3. Development and application of an OSMS	Labour protection policy and objectives A plan of development and implementation of an OSMS A report with recommendations for the development of an OSMS Non-conformance report and proposals for adjustment of an OSMS	Development strategy Regulatory requirements in the field of labour protection OSMS concept (policy)	OSMS developers (organisation staff, external developer) Information technology support	OSMS record-keeping

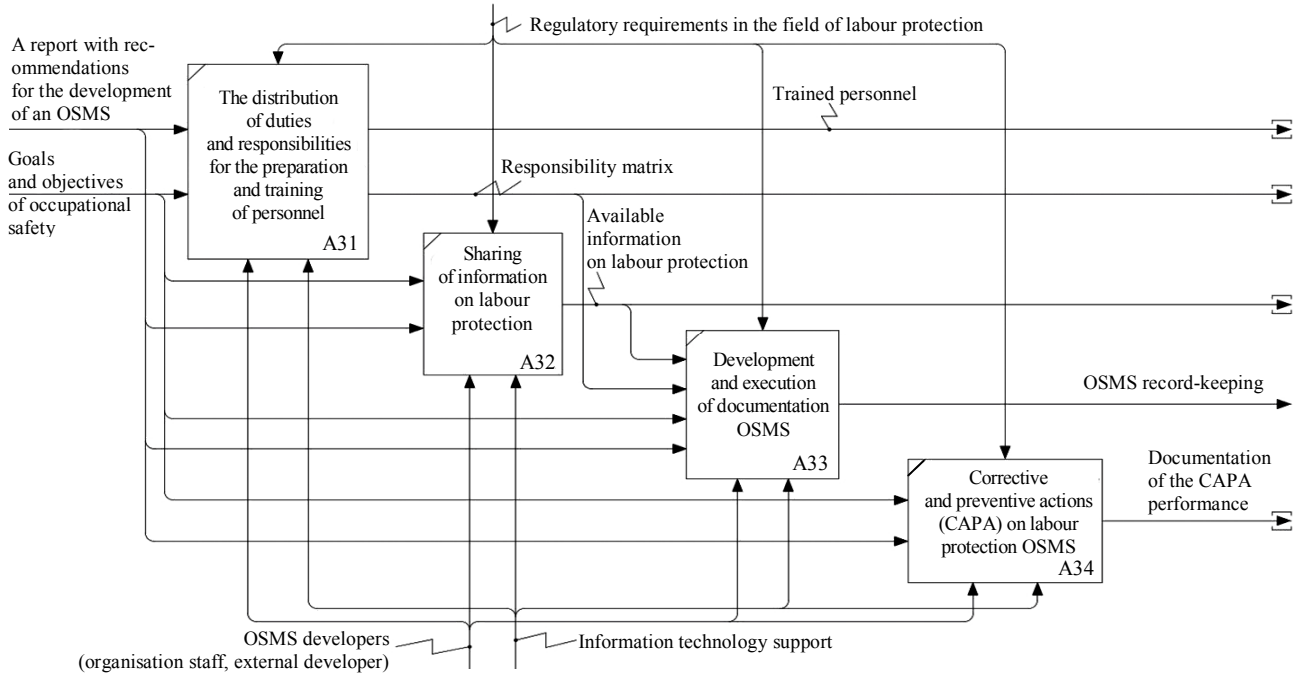

Fig.8. Diagram of sub-processes of the third A3 level

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In block A34 the procedure of registration of the plan of the preventive and corrective actions and control of its performance by results of audits is developed and documented.

For quantitative analysis of the obtained diagrams, we consider the behaviour of the decomposition factor of the models presented in Fig.3-5. The decomposition factor $d = N/L$, where N is the number of blocks in a diagram and L is the decomposition level of the analysed diagram.

In A0, the factor is $5/2 = 2.5$; and in the decomposition diagram in Fig. 6 the factor is $4/3 = 1.33$, and in Fig. 7 the factor is $3/3 = 1$. A decrease in the factor value indicates a simplification of the models with a decrease in the decomposition level.

The balance factor of the diagram is determined by the formula

$$K_b = \left| \frac{\sum_{i=1}^{N} A_i}{N} - \max_{i=1}^{N} (A_i) \right|,$$

where A is the number of arrows connected to a single block. It is necessary to strive for the balance factor to be as small as possible for the chart, and in the model to remain constant or decrease with the decomposition of the model.

Let's calculate the behaviour of the balance factor of the models presented in Fig.3-5:

- for the A0 parent diagram (Fig.3) $K_b = 41/5\text{-}10 = 1.8$;
- for the A1 model (Fig.4) $K_b = 23/4\text{-}7 = 1.25$;
- for the A21 model (Fig.5) $K_b = 17/3\text{-}6 = 0.33$.

The K_b factor decreases with the decreasing level of the model, therefore, the requirement of the balance of the diagram is maintained, and no further decomposition of the model is necessary.

Conclusions

1. The possibility of applying the process approach in the development and implementation of an OSMS based on the system approach using the well-known PDCA principle (plan – do – check – act) is shown.

2. In accordance with the requirements of GOST R 12.0.230-2007, a graphical model of the first level of an OSMS was developed and a general OSMS scheme is presented.

3. The process of OSMS creation using the SADT (Structured Analysis and Design Technique) and the IDEF0 methodology is described.

4. A contextual diagram of the process of development and implementation of an OSMS in the IDEF0 notation, as well as its decomposition of the second and third levels and describes all the interface relationships of functional blocks, are developed. The quantitative analysis of diagrams is carried out and the balance of the developed models is confirmed.

5. This methodology allows achievement of a positive result in terms of efficiency of the OSMS creation management, concentration on efficiency, transparency of activities, cost minimisation and reduction of terms of implementation of an OSMS.

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Authors: **Vladimir A. Filimonov**, *Candidate of Engineering Sciences*, *Associate Professor*, *vaf110@yandex.ru* (*Togliatti State University*, *Togliatti*, *Russia*), **Larisa N. Gorina**, *Doctor of Pedagogical Sciences*, *Professor*, *gorina@tltsu.ru* (*Togliatti State University*, *Togliatti*, *Russia*).

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