Functional model of activity of the fire and rescue unit

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Abstract. The article is devoted to the issue of effective management in fire rescue units of the Ministry of Emergency Situations of Russia based on application of functional modeling. Data on functional model of activity of standard fire rescue unit are given. The example of application of functional modeling and business process management in day-to-day operations of fire rescue units, which allows increasing efficiency of management, is considered. The method of assessing the day-to-day activities of the fire rescue unit based on functional modeling described. Problems in the increase of enhancement of the efficiency in the activity of the fire and rescue units related to the Ministry of Emergency Situations (MES) of Russia as well as similar units that are not involved in the federal group of forces and assets is an ultimately burning problem.

1. Introduction
The units of the Federal fire-rescue service at MES of Russia annually save from death and injuries more than 90000 of people and material assets in more than 120 billions of roubles. Besides fire extinguishing of the natural and anthropogenic fires the fire and rescue units annually perform more than 65 thousands of departures for the road-traffic incidents.

At the average employees of MES leave to each of the third road-traffic incident rendering aid to more than 46 thousands of the injured and employing more than 74 thousands of working jobs [1].

Activities of the fire and rescue units are strictly regulated by a number of normative legal documents and normative acts. As a whole, they define an algorithm of the units’ work from the moment of the message entry up to a complete elimination of the accident and returning to the permanent location. Departure of the fire and rescue units for the fire extinguishing and performing of wrecking in the population aggregates and organizations according to the current legislation is accomplished in the unconditional manner.

Thus, taking into account, the problems and tasks assigned to the fire and rescue units the main events for them will be fires and other incidents as well as emergency situations taking place from time to time where it is necessary to perform wrecking works. An event is conventionally implied as the change in status measured by a discrete variable possessing countable quantity of mutually exclusive values.
2. Decomposition of the processes

An event of the “Fire” is considered in the report in details. Generally, this event can be found in two states \{0, 1\}. The state \{1\}, from the viewpoint of the fire and rescue unit generates the process “Extinguish the fire”.

Context diagram of this process in its notation of IDEF0 is shown in figure 1.

![Figure 1. Contextual diagram of the process “Extinguish a fire”](image)

Normative documents [2] determine the main business processes connected with the activities of the fire and rescue units during fire extinguishing.

Basing on these documents decomposition of the process “Extinguish the fire” is performed that is presented in figure 2.

At this stage of investigations let us restrain with the only presented level of detailing the processes. Basing on the elaborated functional model one can see that extinguishing of the fire is a complicated logistical process. The most “loaded” blocks are attributed to the business processes “Surveying of the point of fire” and “Execution of the works related to the rescue of people and extinguishing of the fire”.

Majority of the works in the functional model is weakly subjected to the automation and they should be performed directly performed by the personnel of the unit. One else challenge is a great number of the control actions and informational data flows which form a basis for the required managerial decisions under a strict lack of time [4-6].
One can for sure assume that the elaboration of the systems for decision-making support for the chief of fire extinguishing enables him to make decisions during the fire extinguishing more efficiently and qualitatively. Surely, it stands to reason that the elaborated systems should be mounted on the mobile platform and involve a flexible set of the templates enabling to organize the work according to the concept of “three clicks”. Note that all of the mobile entities should be synchronized with the work station of the dispatcher.

In addition, it seems rather prospective to design imitational simulators on the basis of the elaborated models enabling to perform practices of different situations in the considered process. Attempts to measure efficiency are not new in the work of fire and rescue service. Measurements of efficiency are based on the estimations of the achieved results as compared with the desired ones. A desired result for the fire and rescue service is a required level of the fire protection which is not so easy to evaluate. It is comprised of the prevented fires or extinguished fires and, ultimately, the rescued and kept human lives and property.

Currently, as it was noted above, fire and rescue units are assigned not only with the functions of fire extinguishing but also they ought to fight with the emergency situations and threats to the national security, leakages of hazardous substances and other emergency and non-emergency calls, for example, a call to the traffic accidents. In addition to these charges fire and rescue units sometimes realize preventive functions, for example, examination of the plans in the buildings and some other works that are not directly connected with the fire extinguishing. Facilities for the fire detection and extinguishing are now required during construction of the new objects. New, more stringent requirements concerned with the fire resistance appear in the construction and contents of the buildings such as soft furniture, mattresses and furnishing.

Household heaters and other domestic technique such as irons or coffee-machines obey the requirements on the automatic power disconnection if they stay in operation for a long period of time. All of these items should be accounted while elaboration of the measures and examinations of the efficiency for the long periods of time.

But why it is necessary to measure efficiency? It is well known that “no one act of measuring efficiency is not valuable on its own account; if only somebody utilize these results in some way they become somehow valuable”. Moreover, state managers see the final goal as the use of the measures in

Figure 2. Decomposition of the process “Extinguish a fire”.

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order to increase productivity by using other seven aims as a capability to achieve it. Other seven aims include evaluation, management, budgeting, motivation, assistance, ranking, and training [7,8]. You can not measure the program without explicitly ascertained goal and task of this program, in other words, the desired result. It is the first step to estimate the efficiency. After formulation of the assigned goals one should determine the functions or actions that will be necessary to perform in order to achieve the goal. It is also required to account for the available resources – finances, equipment or human resources in man-hours. Indicators of the activity are the quantitative representation of the activity and resources that can help to estimate if the assigned goal would be achieved. The simplest and best way of the application of the quantitative indicators of activity for the qualitative goal of the statement is a specified definition of the guide price or percent indicators for every goal.

For example, the qualitative goal in the losses from the fire can imply “the control of the fire area on arrival of the fire unit”. The fire and rescue unit can apply the following measure: percentage of the fires that did not propagate beyond the limits of detected area after arriving of the fire brigade.

Another possible approach to the determination of the targeted indicators is a conditional degree fighting capacity of the unit. It is a complicated integral indicator representing capabilities of the unit for the actions during various tasks performance in accordance with its assignment. The indicator of fighting capacity can also include such elements as the availability of engineering, fire-technical equipment, personnel (for example, a percentage of staffing), level of preparedness of the personnel and other indicators. Estimation of the fighting capacity for the unit nowadays is performed as a rule in accordance with the formalistic criteria and quite often, it is reduced to the check-up of the correspondence of the documentation in the unit to the normative regulations. However, practical experience shows that a complete correspondence of the documentation cannot be a real criterion of the problem-free state of affairs in the unit. On the contrary, usually this should be a sign of alert and stimulate a necessity of more detailed non-formal checkup. Since the aim of this work is the study of performance of the fire and rescue unit as a part of the whole system. Therefore, using the guideline documents let us design a contextual diagram of the process “Performance of the work of the fire and rescue unit of MES in Russia” (figure 3).

![Figure 3. Contextual diagram of the process “Organize and execute the work for the State fire and rescue unit of the MES of Russia”](image)
Let us define “Message on the fire”, “Operative environment”, “Message on emergency situation” as the input parameters. The main result of the unit activity at the output will be summary documents. Note that the model is composed from the viewpoint of the guideline documents.

This contextual diagram is decomposed into three blocks: “Support of performance and maintain readiness”, “Extinguish the fire” (considered above) and “Carry out wrecking”. Thus, one can distinguish three macro directions in the activity of the fire and rescue unit. Decomposition is presented in figure 4.

![Figure 4. Decomposition of the process “Leading of the work for the State fire and rescue unit of the MES of Russia.”](image_url)

Functional modeling of the process together with detailed study of regulatory documents regulating the system activity, as well as analysis of service activities of officials of fire rescue units of the Ministry of Emergencies of Russia allows highlighting key elements, both in solving tasks of day-to-day management, as well as operational management, firing fighting.

In addition to the main operational functions, so-called functions or tasks of day-to-day management carried out in fire protection bodies and units: financial and planning, logistics, personnel and office management. The decomposition of "Maintain Operation and Maintain Readiness process" shown in figure 5.

The quality and completeness of this process and its elements is the main condition of personnel readiness to perform the main task - successful firefighting and rescue operations. Unit readiness is a day-to-day activity and carried out regardless of the presence of challenges.
In the process of analyzing the main directions of service activities of officials of fire and rescue units of the Ministry of Emergencies of Russia, with the help of functional modeling tools, the main assessed directions characterizing the completeness of the process "Ensure functioning and maintain readiness" have been identified.

Based on the information obtained because of the simulation, a methodology proposed to assess the daily performance of the heads of fire and rescue units of the GPS of the Ministry of Emergencies of Russia. Based on the integrated assessment of daily performance, it is proposed to adopt 7 areas:

1. Occupational safety;
2. Organization of guard service;
3. Training and human resources;
4. Organization of operation of gas-smoke protection service;
5. Organization of work with external fire-fighting water supply in the area of departure;
6. Organization of operation and control of technical condition of fire equipment;
7. Business planning, analysis and office management in the unit.

For each activity, a system of indicators to evaluate in the methodology developed (figure 6). In addition, it proposed to assess the direction characterizing the personal indicator of the official, namely his professional level and training.

Figure 5. "Maintain Operation and Maintain Readiness" Process Decomposition.
The evaluation procedure consists in the successive filling in of the proposed evaluation sheets with a deterministic evaluation of each final element of the system, based on parameters based on normative and regulatory documents the structure of the methodology shown in figure 7.

![Diagram](image-url)

**Figure 6.** Indicators evaluated in the method.

**Figure 7.** Structure of a technique constructed based on model.
3. Conclusions

The methodology developed based on functional modeling allows approaching the performance assessment of the official of the fire and rescuing unit in an integrated manner. Allows you to identify places where the employee has shortcomings in his/her activities in order to eliminate them. It also provides for the possibility reasonably compare the official activities of equivalent officials of fire rescue units, taking into account the difference in the intensity of operational work.

The application of mathematical modeling and business process management in the day-to-day operations of fire rescue units will make it possible to improve the efficiency of management, i.e. to find the optimal balance of resources and management results.

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