CLASSIFICATION OF ACTIVITY PROCESSES

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Abstract. Nowadays, methodology—the general theory of activity organization and control—continues to develop. This paper introduces a classification system for processes, determining the place of any process and establishing the presence of interrelations with other processes. Several classification attributes are identified, and a corresponding classification scheme of elementary processes is proposed. The concept of a complex process is considered, and its division into elementary processes in accordance with the classification scheme is demonstrated. An example of a complex process of motor vehicle repair is given; its functional and behavioral schemes are presented, and the corresponding elementary processes of various types are described in detail, namely, supporting processes (the processes of its life cycle), organizational and management processes (business processes), as well as informational and computational processes.

Keywords: process, activity, methodology, classification, life cycle.

INTRODUCTION

In recent years, within the framework of interdisciplinary research, a new scientific direction has been formed to unify the description and formalization of various types of human activity. (*Activity* is a goal-oriented active effort of an individual.) This direction, devoted to developing a unified theory of activity as an aggregate of general and universal models, is represented by the works of A.M. Novikov and D.A. Novikov and their colleagues [1–5]. The corresponding doctrine (theory) of the general regularities of activity organization is called *methodology*.

Methodology includes general methodology (the methodology of elementary activity) [1], the methodologies of various types of human activity (the so-called partial methodologies: research methodology [5], the methodology of practical activity, including control methodology [4] as its variant, as well as the methodologies of educational, artistic, and play activities) [2, 6], and the methodology of complex activity, generalizing the above methodologies to the case of non-elementary activity. The concept of complex activity was defined as "a goal-oriented active effort of an individual that has a nontrivial internal structure, multiple and/or varying subject, technology and role of the object of activity in its goal context" [1]. Of course, these types of human activity are not exhaustive; in particular, philosophical and religious activities were mentioned in [1–5]. This list can probably be enlarged.

Since methodology is regarded as the doctrine of activity organization [2], the concept of organization should be explained. The Philosophical Encyclopedic Dictionary [7] provides three meanings of this concept. For the purposes of this paper, we will use the following: organization is an aggregate of processes or actions that form and improve the interrelations between the parts of a whole. In other words, to organize an activity, one should arrange it into a complete system with clearly defined characteristics, logical structure, and implementation process [2]. In the monograph [1], the process structure of activity was treated as an integral part of it, along with the logical and cause-effect (causal) structures.

1. THE PROCESS STRUCTURE OF ACTIVITY AND PROCESS THEORY

The concept of "process" is used to describe natural phenomena and is widespread in various fields of human activity. We can talk about physical, chemical, technical, technological, computational, organizational, and many other processes. The process semantics in these contexts differ, but there are some common features: a temporal character and a definite internal structure. The German *prozess* came *from Latin prōcēdēre*, meaning "to go forward, to proceed, to ad-

vance" (*prō* – "forward" + *cēdēre* "to go", as one of their meanings).

The most general definition of a process is given in the Philosophical Encyclopedic Dictionary [7]: a process is a category of philosophy characterizing an aggregate of irreversible, interrelated, long-term changes, both spontaneous and controlled, both self-organized and organized, that result in some kind of novelty or innovation (new morphological forms of organisms, new varieties, social, scientific, cultural, etc. innovations).

Processes can be divided into *natural* and *artificial* (goal-oriented). The first ones run in accordance with the laws of nature regardless of one's will; examples are physical, chemical, biological, etc., processes. Goal-oriented processes are the subject, result, or content of some human activity.

The processes of various categories are studied by the corresponding branches of science; see their simplest correlation diagram in Fig. 1.

In this paper, a process is considered exclusively in the context of the methodology of human activity: natural processes are not studied below.

National and international standards (GOST R ISO 9000, ISO/IEC 12207, and ISO/IEC 15288) define a *process* as an aggregate of interrelated or interconnected actions that transforms inputs into outputs [8–10]. However, this definition reflects only the functional and informational aspects of a process, neglecting its behavioral aspect.

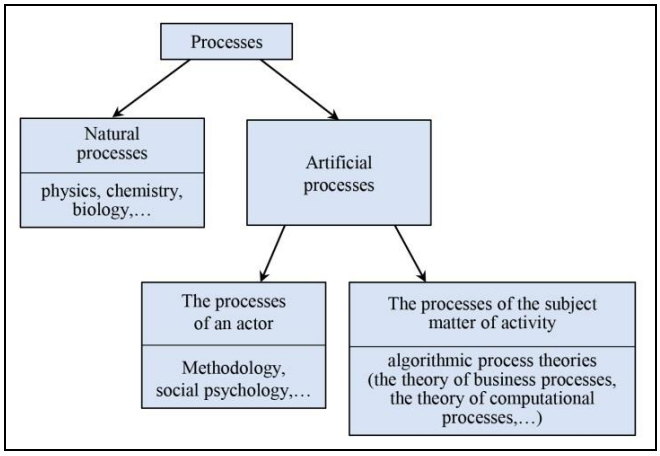

Fig. 1. Processes as an object of research.

For the purposes of this paper, we will use the following definition, going back to the definitions from the Modern Encyclopedic Dictionary and the Great Soviet Encyclopedia ("a sequential change of phenomena, states in the development of something" or "an aggregate of sequential actions to achieve some result"): a ***process*** is an aggregate of sequential states of an object and functions ensuring transitions between these states.

Note that the functional part of a process is a hierarchical tree divided into functions and operations [11, 12].

A *function* is a set of operations grouped by a definite feature that ensure, in the aggregate, the transition of an object to a new state.

An *operation* is an elementary (indivisible) action performed on an object or its element (a structural unit of action; a way to perform an action in definite conditions).

An integral part of any process is its inputs, outputs, and resources.

Process *inputs* are the objects incoming to a process to be further changed and transformed. The nature of incoming objects is quite diverse. Inputs can be something tangible (raw materials, semi-finished products) or intangible (information (data), documents, messages, requests, and services).

Process *outputs* are the objects obtained by transforming the inputs of a process. In other words, they are process results. We emphasize that new objects or processes can be born within a process.

Process *resources* are tangible or intangible objects necessary to sustain a process. Like process inputs, these objects have a very diverse nature. Resources may include equipment and tools, personnel, information, finances, space (e.g., an office), infrastructure, information systems, algorithms, technology, and many more. Note that in different processes, the same objects can be both inputs and resources or outputs.

Nowadays, rich literature on the study of processes of various categories is available. However, most authors pay their attention to only two categories of processes, *computational* [13] and *organizational/management/business* processes [11]. Appropriate theories have been developed for these categories of processes, while there are only scattered models and methods of study (in particular cases) for other categories of processes. The existing approaches and the corresponding results provide no uniform description of the processes of creation and behavior of modern complex systems. Therefore, it is topical to develop appropriate theories for other categories of processes as well as to create a general theory of processes, integrating and generalizing the above partial theories.

Proceeding from the classification of activity by its goal orientation (namely, play – learning – labor), we can speak about:

- the methodology of play activity,
- methodology of learning (educational) activity,
- the methodology of labor (professional) activity, which can be further divided into:

○ practical activity, both in the sphere of material and spiritual production, and

○ specific forms of professional activity: philosophical, scientific (research), artistic, and religious [2].

Table 1 summarizes the types of activities in accordance with their goal object.

In view of the aforesaid, the object of research in the general theory of processes is the processes of (complex) activity, and the subject matter of research is the general regularities of the organization of activity processes and control of such processes.

Table 1

The types of activity: classification by the goal object

The type of activity	Goal object
Play	Play
Educational	Human (education)
Practical	Good, service
Scientific (research)	Scientific result
Artistic	Work of art
Philosophical	Scientific result
Religious	Human (faith)

Note that the general process theory being created should provide a systematized basis for solving several problems:

- process modeling,
- engineering (design) and re-engineering of processes, including alternative solutions of these problems,
- process analysis and verification;
- process automation.

Thus, the primary problem of process theory is to create a classification system for processes, determining the place of any process and establishing the presence of interrelations with other processes.

Many experts in the field of management and production organization of various economic sectors presented classifications of processes [13–22]. One of the most complete classifications of business processes was proposed in [14] with the following six attributes as classification bases: the presence of links with the environment (internal processes and external processes); the dependence on the subject area (technological, organizational, and business processes); the relation to the main product (main processes, auxiliary processes, management business processes, network business processes, production processes, and administrative processes); scale (organization-level processes and department-level processes); the production cycle stage of goods (goods movement processes, preproduction processes, and infrastructure processes); the type of activity (processes directly ensuring the release of products, planning and management processes, resource processes, transformation processes, meta processes, and product-oriented processes).

However, the proposed classifications have common shortcomings:

– no unification, narrow focus, orientation to particular industries, fields, etc.;

– orientation exclusively on economic categories, which complicates the use of such classifications when unifying the description and formalization of various types of human activities;

– no complex integration with the subject matter (object) and the subject of activity.

2. PROCESS CLASSIFICATION BASES

As shown in Fig. 1, the artificial processes of activity are divided into two categories, namely, the processes of an actor and the processes of the subject matter of activity.

The **processes of an actor** (elementary or complex activity), common to all types of activity, are summarized in Table 2; also, see Table 1 in the monograph [1]. In fact, Table 2 describes the life cycle of an activity as a complex system evolving over time.

Further detailing is carried out for a particular activity. The process models of complex activity were discussed at length in [Chapter 5, 1] and are not studied here.

The correlation between the processes of an actor and the processes of the subject matter of activity was considered in [Chapter 2, 1].

We propose a classification for **the processes of the subject matter of activity** based on their division into the following four groups (Fig. 2).

1. **The life cycle** (LC) of a process, which includes:

- concept and design;
- production (creation and organization);
- testing;
- application;
- support, maintenance, and modernization;
- utilization.

Further detailing of the processes of this group is carried out for a particular practical activity and includes at least two additional levels.

Table 2

Phases, stages, and steps of complex activity

Phase	Stage	Step
Design	I. Fixing demand and understanding needs	1. Fixing demand and understanding needs
	II. Setting goals, structuring goals and tasks	2. Creating a logical model
	III. Selecting and developing technology	3 Checking the readiness of technology and the sufficiency of resources
		4. Creating a cause-effect model
		5. Creating technology of lower-level elements
		6. Forming/modernizing resources
		7. Calendar-network scheduling and resource planning
		8. Performing optimization
		9. Assigning actors and defining responsibilities
		10. Allocating resources
Implementation	IV. Performing actions and obtaining results	11. Performing actions and obtaining results
Reflection	V. Assessing results and reflecting	12. Assessing results and reflecting

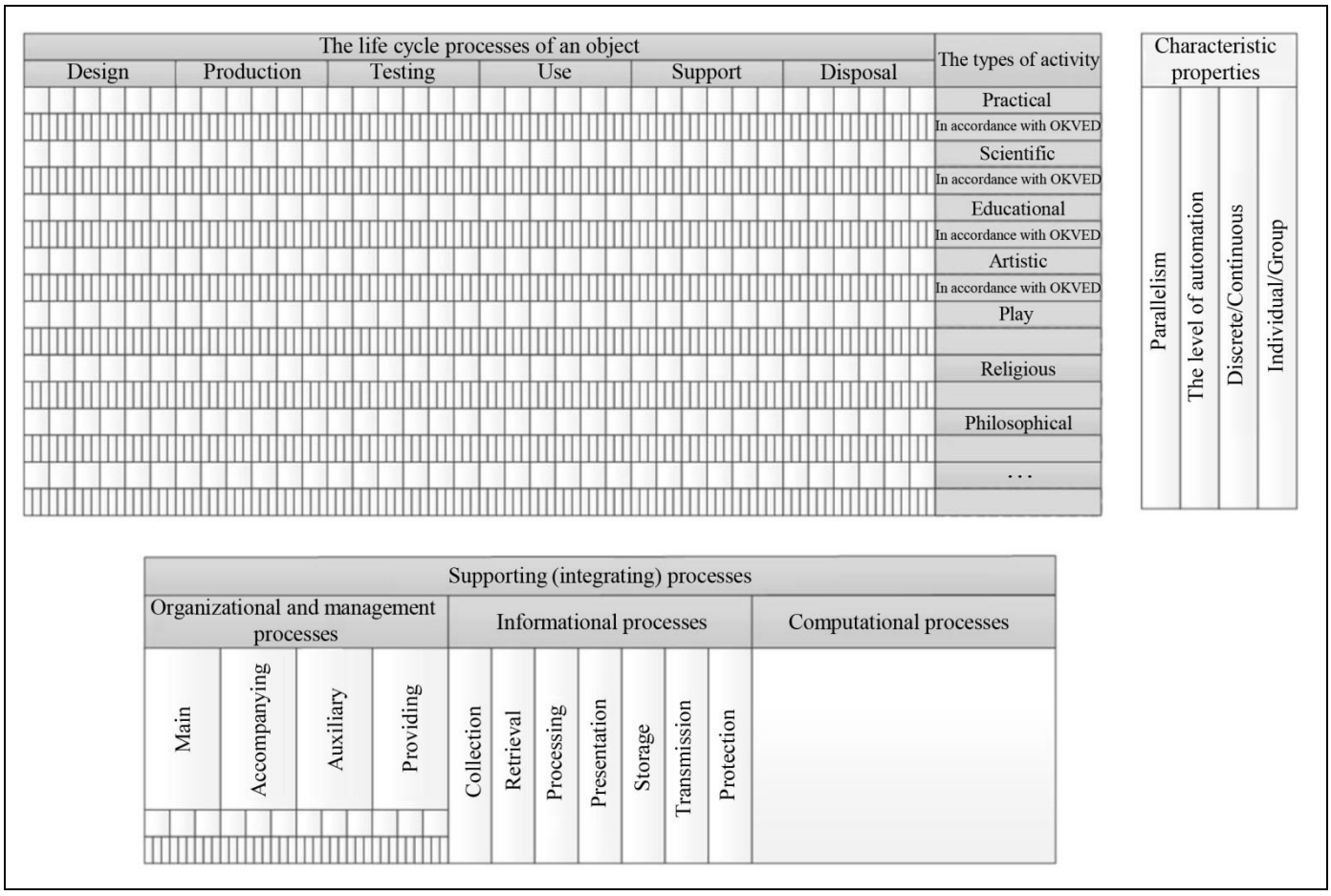

Fig. 2. The classification scheme for processes.

2. **The type of activity**, in accordance with the partial methodologies of activity reflecting the specifics of each activity within the life cycle stages of its goal object, namely:

- play activity,
- educational activity,
- practical activity,
- scientific (research) activity,
- artistic activity,
- philosophical activity,
- religious activity.

For practical, educational, scientific (research), and artistic activities, further detailing can be carried out, e.g., using the Russian Classification of Economic Activities (OKVED) [23] with at least four additional levels.

3. **Supporting** processes (integrating processes), which penetrate the processes of groups 1 and 2 above and link their functional components:

- organizational and management processes (business processes),
- informational processes, and
- computational processes.

Further detailing of such processes is also multilevel. In particular, organizational and management processes can be divided into main, accompanying, auxiliary, and providing processes; in turn, they can be further detailed in accordance with the functional hierarchy of an enterprise or organization (for example, see [6, 12]).

Main business processes are those oriented towards producing goods or rendering services that are the goal objects of enterprise formation and generate income. For example, for a fat-processing integrated works, such processes are butter production and margarine production; for a road transport enterprise, the main process is rendering transportation services.

Accompanying business processes are those oriented towards producing goods or rendering services that are the results of the enterprise's concomitant production activities and also generate income. For a fat-processing integrated works, such processes are soap production and glycerin production.

Auxiliary business processes are those intended to maintain the main and accompanying processes and oriented to support their specific features. For a road transport company, such processes are vehicle repair and maintenance and transportation safety assurance; for a fat-processing integrated works, the process of repair of oil refining equipment.

Providing business processes are those intended to ensure the main and accompanying processes and oriented to keep their universal features. For any enterprise, such processes are the financial provision of its activity, the provision of personnel, legal provision, etc.

Similarly, *informational processes* (processes related to changes in information or actions using information) can be divided into the processes of information collection, retrieval, processing, presentation, storage, transmission, and protection.

Information *collection* is a process that involves finding, gathering, and extracting primary data, which precedes the solution of any problem.

Information *retrieval* is a process of extracting stored data necessary to achieve a particular goal.

Information *processing* is a goal-oriented process of changing the content or form of information presentation. Two types of information processing can be distinguished: processing related to obtaining new content or new information (transformation by rules, including formulaic calculations), research of cognition objects by their models, logical reasoning, generalization, etc.); processing related to changing the form of information presentation without changing its content (structuring, coding, etc.).

Information *presentation* is a process of bringing information material into a more convenient form depending on the situation and addressee.

Information *storage* is a process of fixating information on some carrier, in one way or another.

Information *transmission* is a process executed according to the following scheme: information source – encoding device – communication channel – decoding device – information receiver.

Information *protection* is a process of restricting the access of unauthorized actors to information to ensure security.

4. **The characteristic properties of processes**, which any process from groups 1–3 may have, in particular:

- the level of automation (manual, automated, and automatic);
- parallelism (synchronous, asynchronous, conveyor, and sequential);
- the composition of executors (individual, group, and multi-role);
- character (discrete, continuous), etc.

The characteristic properties of processes are not a classification basis, as they merely introduce additional requirements for process description languages. For example, to describe parallel processes, one needs branch synchronization tools in the language, etc.

Within systems engineering and software engineering as the most developed disciplines for LC, the LC processes of systems fit into this scheme. For instance, the technical processes presented in the book [8] detail all the processes of elementary activities for a particu-

lar practical activity (e.g., software systems development). Agreement processes, organizational project provision processes, and project processes (except for the information management process) are organizational and management processes, and the information management process is an aggregate of information processes.

The processes included in the above classification are, in essence, elementary processes. In real life, the following *complex processes* (also called integrating processes) dominate:

- one of the processes of a particular elementary activity, represented by an element of the matrix in Fig. 2 for any level of its detail;
- one of the organizational and management processes, whose type corresponds to the selected process of a particular elementary activity;
- a set of information processes linking the functions of the selected process of a particular elementary activity;
- a set of computational processes detailing some functions of the selected process of a particular elementary activity.

Note that a computational process is a special case of a lower-level control process. The former process has the highest level of formalization and, as a rule, is modeled by a system of finite-state automata or a special state transition diagram. Therefore, one can build a set of methods to study a computational process, predict its behavior, and control the process [24].

3. AN ILLUSTRATIVE EXAMPLE OF A COMPLEX PROCESS

Figures 3 and 4 show an example of a complex process, i.e., the repair process of a motor vehicle. Consider its fragment indicated by solid lines in Fig. 3; this is a supporting process according to LC processes and a process of practical activity according to the types of activities. Further functional detailing allows attributing this process to OKVED's section 45 "Wholesale and Retail Trade in Motor Vehicles and Motorcycles and Their Repair" and, further, to OKVED's subsection 45.2 ("Maintenance and Repair of Motor Vehicles"), including (in accordance with items 45.20.0–45.20.5) the following types of works:

- repair of motor vehicles, including: mechanical repair, repair of electrical systems, injection system repair, routine maintenance of motor vehicles, body repair, chassis repair, washing and polishing, painting and drawing, windshield and window repair, car seat repair;

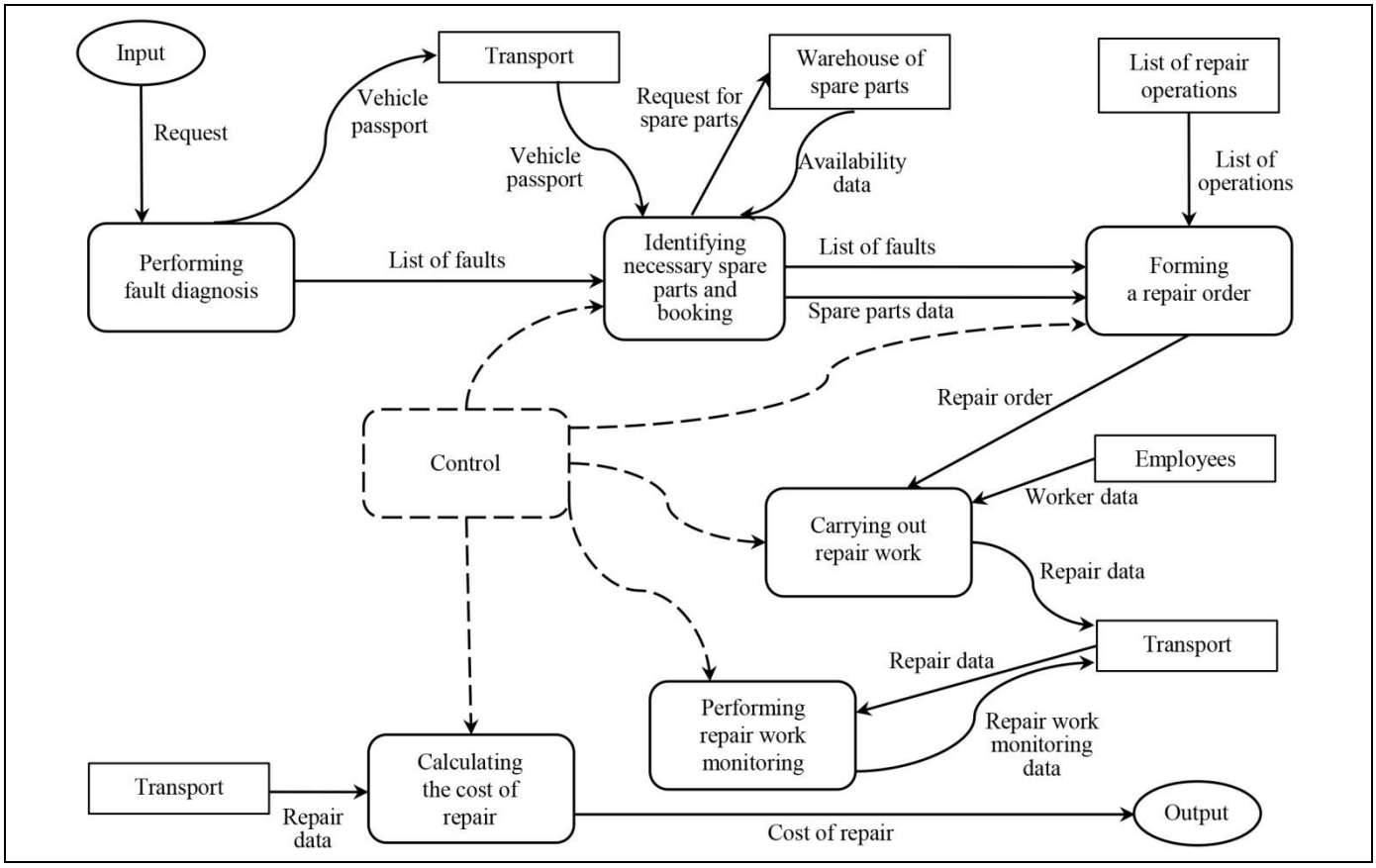

Fig. 3. The functional diagram of the motor vehicle repair process.

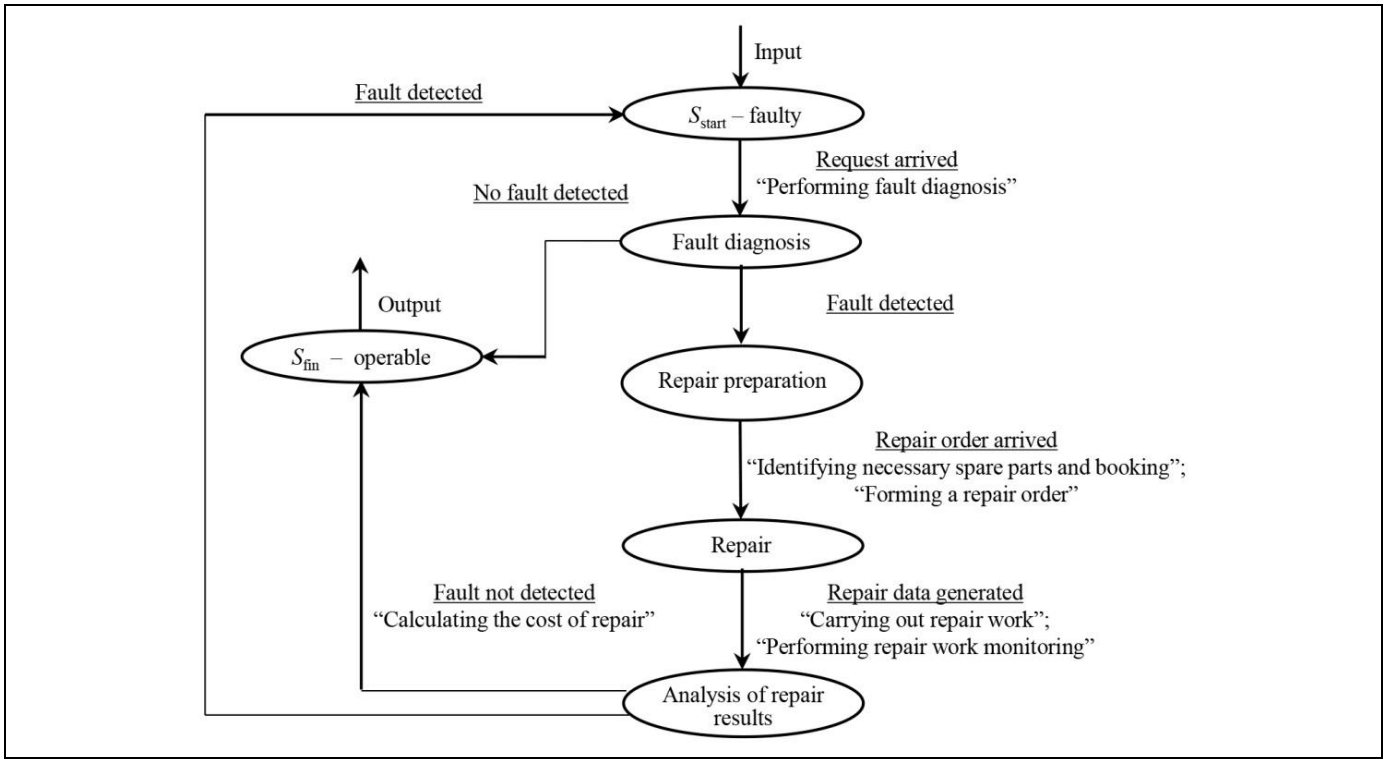

Fig. 4. The behavior diagram of the motor vehicle repair process.

- tire fitting and all kinds of related works;
- anti-corrosion treatment;
- installation of additional equipment (alarms, radio equipment, additional headlights, etc.), spare parts and accessories not directly related to the production process;
- pre-sale preparation;
- roadside assistance;
- transportation of disabled (non-runner) vehicles to the place of repair or parking.

The fragment indicated by dashed lines in Fig. 3 (and its detailing process with the state transition diagram, see Fig. 4) is an organizational and management process, and its type may vary depending on the enterprise type. For example, it is the main process for a service center and an auxiliary one for a motor depot rendering transportation services.

The fragments depicting the functions related to data storage are informational processes, and their types depend on the way the information is changed or used. Finally, the "Repair bill" fragment can be a computational process if represented by a formula for calculating the required result.

CONCLUSIONS

This paper has proposed a classification system for processes, providing a foundation for solving the relevant problems (see Section 2) within process theory and a systematized approach to study the processes of activity. In this research direction, further priority challenges include:

- development of a unified process model to integrate its functional, informational, and behavioral aspects. Such a model can be based on the corresponding models from algorithmic theories of processes (first of all, the theory of computational processes and the theory of business processes);
- development of a set of research methods for processes based on the stages and steps of its life cycle.

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