

*exploitations process,
railway traffic control devices,
process management*

Jarosław MOCZARSKI¹

PROCESS MANAGEMENT IN RAILWAY TRAFFIC CONTROL DEVICES EXPLOITATION SYSTEM

The paper covers the issue of process management in railway traffic control devices exploitation system (RTC). Phases of devices life cycle and their exploitation system are presented. Processes conducted in exploitation phase of railway traffic control devices and issue of decision making in these processes management are described.

ZARZĄDZANIE PROCESAMI W SYSTEMIE EKSPLOATACJI URZĄDZEŃ STEROWANIA RUCHEM KOLEJOWYM

W artykule omówiono zagadnienie zarządzania procesami w systemie eksploatacji urządzeń sterowania ruchem kolejowym (srk). Przedstawiono fazy istnienia urządzeń i system ich eksploatacji. Opisano procesy realizowane w fazie eksploatacji urządzeń srk oraz zagadnienie podejmowania decyzji w zarządzaniu tymi procesami.

1. INTRODUCTION

Growing requirements concerning safety of railway traffic increase the importance of rational decision making in the RTC exploitation system. Decision problems occur in the field of objectives as well as in the field of system structure (organizational unit), its social (employees) and technical (RTC devices) subsystem. They result from surrounding's influence as well as from processes and events occurring inside the system. Decision making in the technical subsystem concerns first of all selection of means and methods of executing tasks resulting from the assumed objectives.

Efficient management of RTC devices exploitation process becomes a more and more difficult and complex task. Ability to observe events occurring in the exploitation process, to analyze them quickly and evaluate correctly is essential to make optimal exploitation decisions in given conditions.

¹Railway Scientific and Technical Centre, Chłopickiego 50, 04-275 Warsaw, Poland, jmoczarski@cntk.pl
Faculty of Transport, Warsaw University of Technology, Koszykowa 75, 00-662 Warsaw, Poland

2. PHASES OF RAILWAY TRAFFIC CONTROL DEVICES LIFE CYCLE

Life cycle of any technical object, also RTC devices, includes period from intention of construction till physical liquidation.

In this process at least four basic life cycle phases are determined [10]:

- Evaluation phase,
- Design and engineering phase,
- Construction phase,
- Exploitation phase.

The *evaluation phase* contains determining needs of a new device creation and objectives it is supposed to serve. Optional conceptions of the new device design appear, that are hierarchized and one solution is selected for implementation.

Design and engineering phase is a period of theoretical construction of the device. During engineering phase method of device operation is selected and physical phenomena that will be used are determined. Conceptions of energy transformation systems, structures of components and relations between elements are created. Range and methods of information processing are determined. Conception of a device is created, that will meet objectives determined in the evaluation phase, will assure sufficient efficiency of operation, as well as effectiveness and reliability. During engineering phase materials are selected to build components and elements of the device as well as its geometrical and dynamical features are determined.

In the *construction phase* substantial synthesis of the device takes place, according to objectives accepted in the previous phases. Constant control of the construction process is essential to avoid mistakes and deflections from the objectives. Departing from principles elaborated and determined in evaluation, design and construction phases may result in the device not achieving required characteristics. The construction purpose will not be achieved.

The *exploitation phase* is the last period of the device life cycle. In this phase the device is used to fulfill the assumed objectives, processes occur that change its characteristics and decrease exploitation value. Actions are taken aimed to restore the exploitation potential through servicing operations. In this phase mistakes made in the device construction process are revealed, while they are, next to the natural (corrosion, material aging) cause for the device break down, decreasing its durability and readiness. Object's exploitation phase contains set of events occurring from the moment of finishing its substantial synthesis till the moment of liquidation [12].

3. RAILWAY TRAFFIC CONTROL DEVICES EXPLOITATION SYSTEM

Each RTC device is an element of a certain exploitation system. So it belongs to a set of elements **E** ordained in the system by set of relations **R**. Generally, system in which the RTC device is exploited can be described by ordered triple $\langle \mathbf{E}, \mathbf{R}, \mathbf{C} \rangle$ where:

- E** – stands for the set of system elements,
- R** – set of relations describing interdependences occurring among the elements of the system,
- C** – set of objectives fulfilled by the exploitation system.

One of the structures that can be determined in the exploitation system is its organizational structure. It applies to [3] mutual subordination of various elements of the system (organizational cells) and flow of information, substance and energy among them. In the current organizational structure of Polish National Railways (PKP) the biggest organizational unit is Railways Department (Zakład Linii Kolejowych), whose basic tasks include among others:

- Conducting railway traffic according to schedule,
- Preserving railways and other infrastructural elements in technical condition, assuring required safety and quality of railway traffic,
- Diagnosing condition of elements of the infrastructure.

Exploitation tasks in the Railways Department are executed by exploitation sections supported by diagnostics sections. Each exploitation section consists of adequate to its size number of units.

The organizational structure applies to method of work organization, meaning organization in the functional sense. Railway Department is also an organization in the material sense, meaning “isolated from the surrounding and aimed at reaching its objectives, internally arranged body” [5]. Executors of assumed objectives, tasks and functions are people (employees) using various technical devices and techniques (technologies, procedures) of actions. Almost all contemporary organizations, among them also Railway Department, are complex social and technical systems. They are open systems, closely bound to their surroundings from where they draw various resources (people, materials, devices, information, energy, financial resources) delivering in return its products (services) essential for other organizations or individual people.

Exploitation system of technical objects is created from exploitation resources available to the organization. These resources include [3,6]:

- Technical objects, as exploitation objects,
- Exploiters of these objects, their managers and supporting personnel,
- Energy (energy carriers) and exploitation materials,
- Management base (equipment necessary for exploitation management),
- Exploitation base (equipment necessary for using the exploitation devices),
- Servicing base (equipment necessary for servicing the exploitation devices),
- Financial means and values,
- Exploitation, operational and logistical information,
- Organization (both in functional and material sense),
- Natural environment,
- Time conditions.

In the following part of the paper exploitation system will include set of RTC devices and other exploitation resources available in the area of the Railways Department.

Borders of the RTC devices exploitation system – as in case of any system – are determined by its surrounding, and more precisely by a set of elements which the exploitation system is bound with by relations and that are considered to be its surroundings. Exploitation system as an open system is bound by relations with generally understood surrounding, characteristic for any organization active in the area as well as with purpose surrounding, specific for the given system.

Usually as surrounding we understand so called external surrounding, containing [3]:

- Market of energy, operational and exploitation materials, devices, employees,
- Market of customers for products obtained by exploiting technical objects (material products, services, information),
- Market of waste collectors,
- Natural environment.

Also internal environment can be determined, containing elements of the organization, in which the discussed exploitation system is included, that do not belong to the system. In the discussed exploitation system the elements of the internal surrounding are i.e. general management and operational management of Railways Department or Polish Railways (PLK SA)

Diagram of the organization as a social and technical system is presented on the Fig. 1.

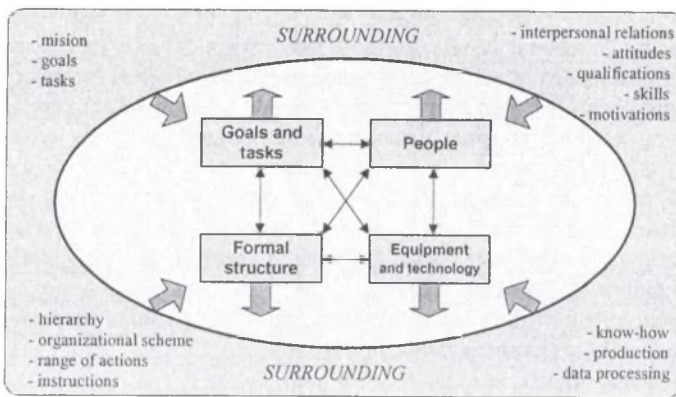


Fig. 1. Organization (Railways Department) as social and technical system [5]

Independent of the aspect of life, used resources and surrounding, where it occurs, as exploitation we understand certain long-term activity, whose aim is to achieve long-lasting benefits [9]. Usually exploited object (system) is the property of the explorer – the host, who is interested in the system generating benefits for possibly longest period of time.

Exploitation of an object is never the aim of man's activities. As a process, set of events and actions, exploitation is supposed to enable achieving the main goal – certain benefits resulting from the object's purpose. At the same time in the exploitation process other exploitation goals are formed, concerning resources, surrounding and conducted processes.

Organizational cells of Railways Department, that directly or indirectly participate in fulfilling tasks enabling achieving exploitation goals belong to the RTC devices exploitation system. Organizational structure of the system should be the result of decomposing goals into tasks and assigning their realization to isolated cells. Cells participation in fulfilling exploitation goals determines their belonging to the system.

4. RAILWAY TRAFFIC CONTROL DEVICES EXPLOITATION SYSTEM

Purposeful man's activity is executed within frames of an operation system. The discussed RTC devices exploitation system is such an operation system. Conducting operations requires determining goals (tasks), processes (sequences of actions and methods of their conducting) as well as proper use of the above mentioned exploitation resources.

Exploitation of the railway traffic control devices may be described in a static approach – systematic (structural) or dynamic – as a process. Exploitation process may be described [6] as a set of causally bound events occurring between exploitation phases, its exploitation states, events occurring within any of the states and also physical and chemical events, occurring within the device itself. Processes realized in the exploitation system enable achieving the basic goal (benefits resulting from the object purpose) and other essential exploitation goals. All these processes are component elements of the exploitation process of set of the RTC devices that take place in the exploitation system.

According to description of devices' life-cycle phases presented in chapter 2, exploitation process includes period from the end of the substantial manufacturing till the physical liquidation (or sale). In this process a set of subprocesses and fragmentary activities can be determined. The basic ones are [10]:

- Prior to usage processes, including: storing, transport, installation, breaking-in, technological tests, etc.,
- exploitation processes,
- servicing processes, including inspections (periodical, guarantee required), conservations, regulations, repairs (maintenance, medium, main, post breakage), replacements, modernizations, etc.,
- logistics processes, including: power supply, material supply, information, employees – operators supply, etc.,
- Devices and their elements liquidation processes (sale, recirculation, utilization and storage of waste),
- Processes supporting exploitation process managements (diagnostics, research).

Presented processes are called steered processes. In the devices exploitation phase we encounter also non-steered processes – destructive processes, where we can include tribological wear-off, corrosion, erosion, chemical wear-off.

On the Fig. 2 process structure of the exploitation system is presented.

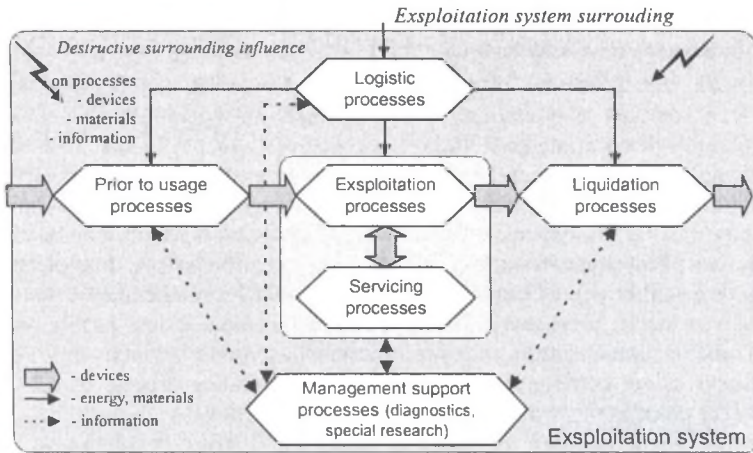


Fig.2. Process structure of exploitation system

Prior to usage processes include the initial phase of exploitation after the phase of manufacturing the devices has been finished, when the devices are in the state of waiting and preparation for usage. In this phase devices are being transported to warehouses or other storage locations, stored, transported to location appointed by the buyer and installed.

In the *exploitation* phase the purposeful process is being conducted – actions are conducted that are supposed to bring the owner the determined benefits. Exploitation of the devices is the main process during their existence, because only in this phase it is possible to answer needs, for which they have been designed, engineered and constructed.

The exploitation process is a sequence of events concerning tasks fulfillment in the subsystem man – device (or device only) in given surrounding, where the subsystem is in the condition of capability.

The purpose of the *servicing* process is to maintain the devices in condition of capability enabling realization of exploitation phase activities. For correct selection of servicing system as well as for rational planning of servicing procedures and for correct evaluation of required work input as well as their range, following information is required:

- Condition of RTC devices,
- Quality of their elements,
- Accuracy of exploitation processes realization,
- Intensity of surrounding influence (destructive processes),
- Costs of maintenance works, etc.

Logistics, further called „provision” [6] consist of all elements and relations enabling correct flow energy, materials and information between the surrounding and the system.

The aim of logistical [10] activities is to:

- To forecast quantity and quality of required services, materials, spare parts, energy, media and information,
- To provide RTC devices and the system of their exploitation with above elements,

- To store, preserve and manage stock,
- To manage the exploitation waste usage,
- To gather, process and transfer information necessary for correct execution of processes in the exploitation system and system's cooperation with the surrounding.

Withdrawing equipment from exploitation is conditioned by technical and economical criteria. *Liquidation* process of RTC device may lead to their sale or change of purpose. Certain elements and components may be recirculated, scrapped, stored or utilized. Liquidation of devices may often result in threat to people and natural environment and generates significant costs for the owner.

Management supporting processes (diagnostics and research) are essential for rational exploitation of RTC equipment. They enable identification and evaluation of their technical condition, evaluation of the exploitation process parameters, as well as judgment of construction and technical solution accuracy. They allow to recognize and evaluate factors causing wear-off and damage of equipment, identify statistical regularities concerning damage occurrence, find causes for observed phenomena as well as forecast their results.

For efficient use of research, observation and monitoring results, it is essential to gather and preserve for sufficient amount of time gathered information and data. This issue is particularly important in case of complex and responsible exploitation systems, where both railway transportation system and its part – traffic control system can be included.

Destructive processes occur in every device independent of human's will. They are result of external influences as well as of influence of working factors and mistakes of operators. They cause devices' elements wear-off leading to unbeneficial changes of their technical condition. Awareness of these processes allows to decrease their intensity as well as forecast and anticipate negative results.

5. PROCESSES MANAGEMENT

Exploitation of a single RTC device consists of processes occurring sequentially and often parallelly in a mixed way. Exploitation of set of RTC devices creates a complex matrix of processes conducted in the exploitation system. Considering complexity of tasks and constructional complexity of contemporary RTC devices many disturbances occur during execution of these processes – external as well as internal.

Solving complex organizational issues, to which exploitation tasks certainly belong, requires methods elaborated by scientific organization of work. The rule of organized activities cycle, according to which each activity should be conducted in five stages [5,11] may be the basis for determining the basic functions of management [3,5]:

- Planning (assigning tasks to employees as well as resource necessary for their completing and delegating responsibility for completing those tasks),
- Managing (understood as coordinating activities and motivating employees to achieve determined objectives),
- Controlling (monitoring of plan execution).

According to [2] planning is „a process of assigning what should be done in the given time”, it is [1] „something we do before we start acting”. Management however is “a process

of execution, evaluation and plan adaptation” [2] in case when circumstance occur that make achieving the goal of actions more difficult.

The above presented controlling function should be understood as monitoring, evaluation, elaboration diagnosis and correcting the plan as well as its realization.

From the organizational point of view in RTC devices exploitation system two subsystems can be determined: exploitation management system (EMS) and exploitation execution system (EES). For every management function (set of management functions) realized in exploitation management system EMS the common feature of all managers on all levels is decision making. Decision making is defined as selection of one from the possible in given situation optional courses of action [5].

Decision problems in RTC devices exploitation system apply to realized goals as well as to the structure of Railways Department and its organizational cells. They are the result of surrounding’s influence, processes and events occurring inside the organization. In case of the exploitation system such as Railways Department, decision making in its technical subsystem is correlated with management of all processes occurring in exploitation phase of RTC device [8]. Decision making scheme of RTC devices exploitation process management is presented on Fig.3.

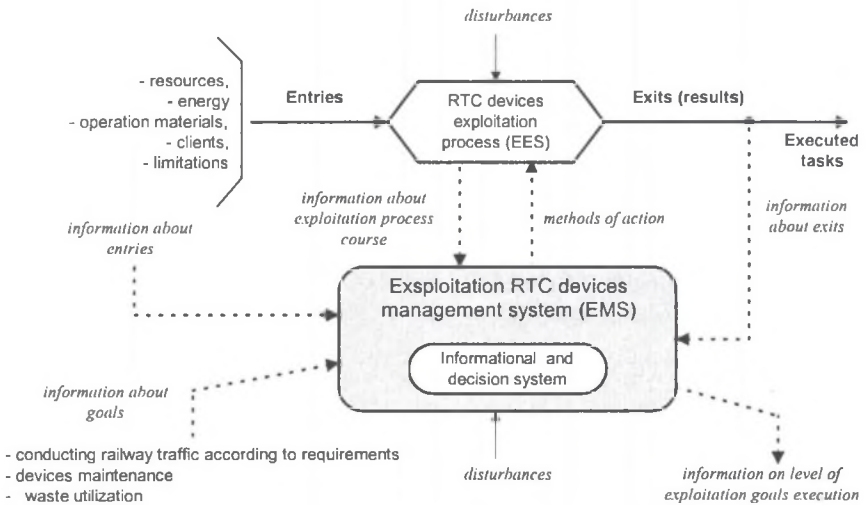


Fig.3. General decision scheme of exploitation process management

Process management in exploitation system is presented in a four-element model of making changes [3] which applies to all of the above presented management functions.

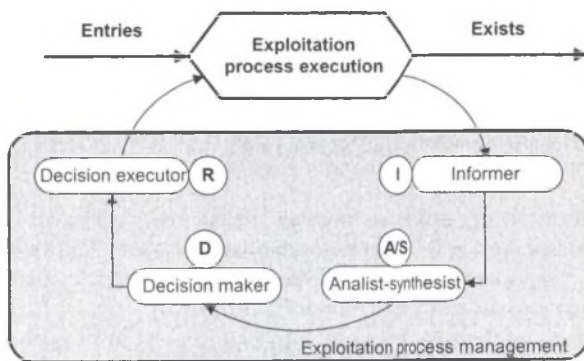


Fig.4. Elements of the exploitation process management system model

The task of the *informer* (I) is to monitor processes execution flow and gathering and preserving significant data (exploitation information). *Analyst / synthesist* (A/S) is an expert who evaluates the gathered data and passes the results of analysis/synthesis to the *decision maker* (D), based on appropriate criteria, selects the course of action, and *decision executor* (R) undertakes actions enabling its implementing in the exploitation execution system. (EES)

In the RTC devices exploitation system the role of the *informer* and *decision executor*, and often the *analyst* as well is usually played by the maintenance staff. Only in case of technical condition evaluation the *informer* as well as the *analyst* is a diagnoser from the diagnostics section. Exploitation decisions, depending on the management level, are made by maintenance staff, section manager (exploitation or diagnostics) or director of Railways Department.

Management in any organization is considered to be a informational and decision process. Decisions are made as a result of information processing, therefore the information subsystem and especially the management information subsystem of various levels is so important for operation of any organizational system.

The aim of information subsystem existence is supporting existing activities: decision making, their execution, control and evaluation as well as modification.

Information systems used to solve decision problems are also called information and decision systems. Such systems are described with a set of exploitational and constructional parameters. Among the most important parameters are [5]:

- Costs of system construction and exploitation ,
- Its selectivity (users' access to necessary and valuable information),
- Time of reaction (from the moment of event occurrence till delivery of appropriately processed information to the decision maker),
- Accuracy and reliability understood as system's ability to accurately present occurring events,
- Disturbances created by the system and deformation of processed information,
- Ability of the system to process information from all processes occurring in the organizational system.

Giving the system the required exploitation parameters requires prior determining of constructional parameters and selection of appropriate technical solutions.

6. SUMMARY

Efficient execution of tasks in railway transportation system requires efficient management of processes in the RTC devices exploitation system. Ability of rational decision making is especially important in situation of financial limitations and significant wear-off on infrastructural elements of railways, including RTC devices.

It is characteristic of the system approach in management to be open to communication with surrounding. It results in complex research of many factors influence on system functioning, creates need of modeling and simulating occurring (executed) processes – including the management and optimalization process of single actions and processes as well as functioning of the whole system. To improve efficiency of decision making it becomes necessary to elaborate a model of RTC device exploitation management system as well as to manage execution of each process described above. Efficient planning, managing and controlling of planned tasks execution requires constructing and implementing appropriate information system [7] in Railways Department. The background for elaborating such a system, enabling gathering, preserving and processing data about RTC devices exploitation process should be a model of exploitation management model.

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