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The process approach in the organization and management of mining enterprises

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Abstract

Within the context of reengineering, process structures are described with certain criteria and terms representing the organizational infrastructure of such forms. They include concepts such as suppliers, customers and process owners, as well as recommendations related to structure flattening, decision-making methods and other activities. In mining enterprises and/or plants, two areas are conventionally identified; "management" and "operations". As regards operations, production is inherently process-based, while management is dominated by task-functional aspects. Difficulties in introducing certain elements of process infrastructure, such as quasi-market principles, result from the character of the production process. The most possibly extensive implementation of process structures is advisable because it allows these to be improved also in other areas, and thus leads to increased management efficiency. Based on these premises, we propose a transformation of functional structures into process structures in mining enterprises and discuss their adjustment and improvement potential with respect to the character of activity carried out by the enterprise.

Key words: mining industry, mineral deposits, enterprises, reengineering, process approach, process structures

Introduction

As process structures derived from reengineering are experiencing a revival of interest, they are increasingly and effectively introduced into enterprises. This trend can be explained by two factors. The first factor relates to the fact that mining enterprises and, more specifically, mining plants are conventionally separated into two areas, i.e. "management" (understood broadly) and "operations." The management area is dominated by functional units (with a static structure) which perform specific tasks or functions, while the operations area is dominated by processes. The second factor refers to the fact that the process structures not only maintain their basic character (sequential implementation of activities and operations), but are also described by the infrastructure or by the environment of the process core, which includes certain criteria, as well as by new terminology describing the process. In this context, the process structure is conditioned by customers and suppliers, process owners, teams which replace cells, the flattening of the structure and other requirements assigned to the first factor.

Although many of these requirements cannot be satisfied for various reasons, such as occupational safety, some of them can be applied. A process approach is increasingly becoming a required standard, for example, in the use of management systems such as ISO 45001:2018, ISO 14040:2015. Nevertheless, the transformation of functional structures into process structures, even without satisfying all the formal requirements, may be a useful method to make the structures more economical and thus to increase management efficiency. Based on such premises, we propose a flexible structure-transformation project.

Rational Management of Mineral Deposit Resources

Mineral resources (mineral deposits) are physically limited, gradually depleting, unevenly distributed, and access to them determines the functioning of the economy and the ability to meet societal needs. These premises raise issues in public debate concerning the requirements for the rational management of mineral deposits. The general principles of rational mineral deposit management are set out in the Environmental Protection Law (Act, 2001) in a separate Article 125. This Act (2001) introduces general norms, for instance stating in Art. 125(1) that mineral deposits are subject to protection involving the rational management of their resources and the comprehensive use of minerals, including accompanying minerals; and in Art. 126(1) stating that the exploitation of a mineral deposit shall be conducted in an economically justified manner, applying measures that limit environmental damage and ensure the rational extraction and utilization of the mineral.

The Geological and Mining Law (Act 2011) explicitly states that a mineral deposit development plan must define the requirements for the rational management of the mineral deposit, in particular through the comprehensive and

rational use of the main mineral and accompanying minerals, as well as the application of extraction technologies that limit negative environmental impacts [Art. 26(3) of the Act 2011].

This issue is addressed by many mineral and economic geologists in scientific discussions (Nieć, 2010; Szamałek, 2011), who proposed a range of solutions necessary to be considered, both at the stage of mineral deposit documentation and during mineral extraction. In practice, mining plays the most important role in the rational utilization of mineral deposits. Therefore, the correct planning, design, and operation of a mining facility (mine) are of fundamental importance for effective management that complies with the principles of economics and management, as well as with the requirements of environmental protection, deposit geology, and mining engineering.

For this reason, the process of planning a mining project is of great significance in the protection of mineral deposits. Taking into account the information contained in geological documentation should enable the utilization of the main mineral and of accompanying minerals, the selective storage of mining waste, and its future recovery (Kudelko et al., 2013).

Characteristics of the process structure

The organization and management of modern mining companies are increasingly based on digitalization, which allows them to operate in conditions of growing volatility and uncertainty. The implementation of digital technologies is no longer limited to the automation of simple processes, but requires the development of a comprehensive strategy that includes the analysis needed, the selection of optimal tools and the proper definition of the technical and business requirements (Dyczko, 2023a). 3D modelling, advanced data analytics and software supporting the design and scheduling of mining operations are playing an increasingly important role in mining companies. An example of this is the selection and implementation of an IT solution enabling the creation of deposit models and exploitation planning, which, after expert evaluation, has become a basic design tool of a company (Dyczko, 2023a).

At the level of integrated production management, particularly advanced solutions are used by the JSW Capital Group, which has implemented a Production Management System in its Demand and Quality System. This system serves to improve the quality of output, stabilize production parameters and maximize margins by taking into account both the quality parameters of the deposit and variable market demand (Dyczko, 2023b). It performs continuous quality forecasting, automatic variation of mining plans, and integration of data from mines, processing plants and coking plants, significantly accelerating the process of designing mining operations' (Dyczko, 2023b). This enables selective production control, optimization of the 'from deposit to sea' process and an increase in efficiency of up to 20%, accompanied by a change in the management's approach to the role of quality in the mining process (Dyczko, 2023b).

The organizational structure of the enterprise, being its integral element, determines the connection of all of its separate components into one entity. From this perspective, the enterprise is divided into organizational units, traditionally called management, operations, and auxiliary units. The company is managed by management units, commonly referred to as the management or, less frequently, as the headquarters, while the main operations are carried out by the so-called operations units. From an organizational perspective, the largest operations unit is the mining plant.

Mining companies are characterized by a dynamic and a static structure. The dynamic structure includes technological processes, which are determined by mining technology, organization of mining operations' and the work system. The static structure consists of the technological processes infrastructure and includes a group of organizational units connected by the specific standards and processes of their operation. The type of the structure, particularly in its static part, is defined considering the hierarchy and classification of organizational units. Taking into account the hierarchy, we distinguish linear, functional, linear-staff and matrix structures. Organizational units, on the other hand, are classified into functional, divisional, process and mixed structures. Each structure can be described by the following features: specialization, hierarchization, centralization and formalization (Butra et al., 2010; Kudelko and Wirth, 2015; Wirth, 2015; Kudelko, 2016).

In more recent literature, the issues of organisational structures and management processes in mining enterprises were also discussed by Kicki and Wanielista (2017), who emphasised the need to combine the process approach with the practical constraints of operating mining companies.

Process structures were developed and recommended for use in the 1990s (Hammer and Champy, 1996). According to these authors, reengineering is a strategy of radical change in an enterprise, consisting in redesigning structures towards processes and leading to a significant (radical) improvement of results in areas such as costs, quality, service and progress of activities, not all of which occur together.

Martyniak (1995) observed that reengineering is based on four general principles:

- starting with the needs of the customer,
- analysing processes in the enterprise,
- allowing for existing limitations,
- thinking differently.

The application of the reengineering method begins with the process flows (process charts). The detailed rules provided by Hammer (following Martyniak, 1995) can be summarized in the form of the following statements:

- activities should be organized around results, not tasks,
- those who use the result of the process should also be its organizers,
- scattered spatial resources should be treated as if located in one place,

- parallel processes should be coordinated during their execution,
- decisions should be made at the place where the process is performed, and spatially remote management has the exclusive right to control decisions,
- the information collected should flow into one open data bank.

Under the influence of reengineering:

- traditional functional units are replaced by teams responsible for a particular process,
- controlled workplaces are replaced by workplaces with responsibility and autonomy,
- remuneration criteria apply to the effects of an activity rather than to the activity,
- preparation for a professional career evolves from training towards education, career progression criteria change towards recognizing usefulness and not results, and values change from protectionism towards openness to the customer,
- company leaders transform from supervisors into animators,
- organizational structures become flattened,
- managers transform from arbiters into leaders.

Other authors define process structures similarly, emphasizing different dimensions. For example according to Gliszczyński (2013), the most important differences between the process management and the functional management of an enterprise include:

- viewing the enterprise as a set of processes rather than as hierarchically and functionally separated structural elements,
- streamlining processes in terms of quality, costs and deadlines,
- changing the supervisory functions of managers to the coordinating functions of process owners,
- increasing the importance of horizontal communication,
- allocating resources between processes and concentrating on process results,
- identifying external and internal customers,
- reducing the number of hierarchical levels and appointing interdisciplinary teams of contractors,
- developing employee multi-competence.

According to Stabryła (2006), the process-based approach emphasizes a dynamic and integrative concept of the organization (enterprise, institution) characterized by the following :

- 1) the organization understood as a dynamic system is a set of management processes and operational (executive) processes with corresponding multifunctional value chains,
- 2) the flow of processes is determined by:
 - a) scope of activity, e.g. related to the entire organization or individual areas,
 - b) configuration of management entities (hierarchical, network, sequential or mixed),
 - c) significant integration of management and operational functions,
 - d) separate modular processes and procedures (the latter are partial processes, also referred to as sectional processes or flows occurring within modules or between modules),
- 3) the organization has developed horizontal communication oriented towards comprehensive (multifunctional) customer service,
- 4) the organizational structure is transformed into input-output systems, and its configuration reflects its specialization according to the subject-process criterion,
- 5) input-output systems form a set of sequences which function as control-regulatory, information and operational (executive) links,
- 6) management instruments and operational techniques are inherent components of the processes.

According to Grajewski (2007), process organization can be defined as a system in which the relationships between the parties implementing the tasks is directed towards activities being part of the designed processes. The structure of such an organization is focused on the process-related character of its operation and thus configures the elements of the system by taking into consideration not only functions, but also processes. From this perspective, process organization should be built on the basis of the following assumptions:

1. All organizationally separated areas are in principle equivalent, being useful in the implementation of internal orders.
2. Each area of the organization is a customer and as such has the opportunity to choose to place an order both inside and outside the company. An area which does not find customers should be subject to self-structuring, including an option of liquidation. As a result, some modifications will occur under the influence of internal impulses, in a manner similar to the impact of the environment on the entire organization.
3. Each area of the organization is an internal service provider and can offer its services on both internal and external markets (except for the services reserved for internal use).
4. Processes in the organization are configured from the perspective of the customer. The design process thus starts by defining the expectations of the customer and then works backwards, configuring the processes within the organization so as to achieve the result (value) expected by the customer. This is the opposite of the traditional approach in which the product offer is limited by the capability of the unit and then action is taken to sell the product on the market.
5. The system is based on a permanent ability to negotiate terms of service delivery within the sequential value-creation chain. In practice, this means that separate areas of the organization must acquire the ability to evaluate both their own and other products from various perspectives, i.e. price, quality, delivery time.

6. The organizational system, including the structure, should be reconfigured from a functional to a process system.

Reengineering, in its radical and original form as a process structure, was defined in opposition to the functional-task structure (Figs. 1 and 2). However, the confrontation of process structures and functional structures is inappropriate. The following definitions (Krzyżanowski, 1995) are relevant in this context:

The goal of an enterprise is defined as its objectively and subjectively desired future state (the result of an action) to be achieved within a specified period of time.

A task is defined as a part of the goal, separate with respect to the object, time and procedures, and implemented using a specific technology or procedure.

A function is a set (scope) of potential (possible), usually repeatable, typical and procedurally formalized activities, distinguished by their type and relationship to a specific goal or task.

Management functions include planning, organizing, motivating and controlling. Executive functions include preparation and supply of production, as well as the formation and sales of products, respectively.

Processes can be described as follows:

- they pertain to a part of the activities of the enterprise,
- they are repetitive,
- they have an internal structure (operations and activities),
- process boundaries are determined by inputs (resources) and outputs (semi-finished products, services),
- the transformation of resources into results is determined by the technology and organization of the process and operational flows (mapping the movement of cargo and people in the transport system),
- the process has suppliers (resources) and customers (receivers of the process results),

the process has an owner.

As can be observed, the confrontation of process structures with functional structures is inappropriate, because processes basically correspond to functions. The differences are found in the terminology employed, in the introduction of market principles (suppliers, customers, transactions) and in the nature of the official and functional ties. This feature was probably noticed by supporters of radical process structures. As a result of extensive research, Hammer and Champy (1996) concluded: *"I have now come to realize that I was wrong, that the radical character of reengineering, however important, and exciting, is not its most significant aspect. The key word in the definition of reengineering is process – a complete end-to-end set of activities that together create value for the customer."*

Processes function in every organization, regardless of the awareness of their existence. The problem, however, is that the organizational system usually does not reflect the process-oriented character of the company. A process can also be viewed as the largest unit of work performed in the organization. Such a unit comprises subprocesses, which in turn consist of operations and then of activities. At each stage of the process, its transformation consumes resources and adds value to the product. Historically, reengineering can be approached from three perspectives (Table 1).

Radical reengineering The existing organizational reality is rejected under an assumption that it is not profitable, from the point of view of the expected effect, to waste time and effort on analysing the current state. The strategy is to eliminate all existing processes and replace them with completely new processes. The radical nature of this approach also lies in the fundamental simplification of processes in accordance with the principles of reengineering.

Soft reengineering (Business Process Improvement) It was developed as an alternative to classic reengineering. While maintaining all the principles of the latter, it rejects the method of radically eliminating the organizational reality as a starting point for designing the process-based organization. The design procedure involves making a record of the existing processes and then improving them by following the principle of gradually eliminating operations which do not add value in the processes.

X-engineering The next level in the evolution of reengineering is so-called X-engineering. This involves achieving radical improvements in performance by using information technology to redesign processes beyond a single organization. As a tool for mitigating inefficiency and duplication of processes between companies, it offers savings and completely new opportunities for cooperation. In its principle, X-engineering emphasizes the harmonization of processes at a supra-organizational scale. This harmonization involves developing rules and systems that are similar to or mutually compatible with the systems used in various cooperating entities, i.e. between the enterprise and its suppliers, partners and customers.

Transformation of the functional structure into the process structure in a mining enterprise

Difficulties with introducing process structures are known in coal mining and copper mining. Their reasons are more complex than the typical resistance to change and are attributed, for instance, to:

- the method of introducing modifications,
- the benefits from the modifications introduced,
- awareness of the limitations in the modifications introduced,
- awareness of the pitfalls related to the modifications.

Modifications can be introduced following three methods: diagnostic, prognostic and directive. In the diagnostic method, the target project is developed by analysing the current state, with the advantages and disadvantages being identified and assessed at the beginning (Fig. 3). In the prognostic method, the accumulated information serves as a basis for presenting a model state, and the elements of its future structure are adapted to it (Fig. 4). Of course, an approach combining both methods is also possible (bottom up). The directive method simply involves the decision of the executive officer (or president) of an enterprise or group of enterprises to transform the functional structure into a process structure. Such a decision may reflect the extensive knowledge or intuition of the executive officer.

The classical model of organisational design methods proposed by Trzcienski (1970) is used in this paper as a historical and methodological reference point. More recent studies (e.g., Grajewski, 2007; Kudelko, 2016; Kicki and Wanielista, 2017) have further developed these ideas and adapted them to the conditions of contemporary industrial (including mining) enterprises.

In practice, elements of each of these methods can be used. However, several benefits of the modifications introduced deserve to be indicated. Such benefits may occur both on the revenue side (for example, an increase in production) and on the costs side (reducing the costs of labour, materials, energy, as well as fixed costs). From a different perspective, technological, organizational or informational benefits are available.

The modification of an organizational structure also requires allowance for various legal, technological and logistical restrictions. For example, the principles of process structures emphasize the delegation of decision-making powers as low as possible, while in mining operations, managers (supervisors) must have appropriate approvals from the Mining Offices, and the scope of their powers is strictly defined. Various types of trap are also mentioned, including market rules (suppliers, customers) and measures of process results. Although more such difficulties can be listed, they should not be the reason to abandon the idea of process structures, which should be sensibly introduced or improved. A process approach, as an important element of planning, implementation, monitoring and implementing corrective or remedial actions, is essential for a continuous improvement process (PDCA). Managing mineral resources, which are the core assets of a mining company, requires a holistic approach: properly defining the quantity and quality of these resources (both primary and secondary minerals), and optimal methods of their exploitation and processing, while avoiding or minimizing losses, deletion and waste.

Proposal for a flexible transformation of functional structures into process structures

With the view to the above, the authors have developed a proposal form for transforming functional structures into process structures and adjusting them to a particular enterprise. In mining enterprises, such modifications should be developed and implemented carefully, with the primary focus on work safety.

In this proposal, the process structures project is carried out in the following procedure (Table 2):

Phase 1: Pre-implementation (design) studies

Stage one: Opportunity study
Stage two: Feasibility study

Phase 2: Implementation of the project

Stage one: Implementation of partial solutions
Stage two: Implementation of the target project

In the first stage of phase 1 (opportunity study), it is proposed to:

- initially describe the activities of the enterprise as a set of technological, administrative and management processes, covering the entire mining project cycle, i.e. prospecting and exploration, development, extraction, liquidation/closure of the project, including an assessment of the possibility of using this infrastructure for other purposes (e.g., geoenergy: heat mining)
- analyse the scope of activities of the organizational units in the enterprise from a process-based perspective, and form conclusions.

When preparing the opportunity study, contrasting processes and functions is apparently pointless, as functions correspond to processes and the differences lie in the boundaries of functions and their autonomy. Also, mining enterprises consist of the "management", which is dominated by functions, and "operations", which are actually sets of processes. Therefore, the process structure is inherently used in such enterprises. The mining "operation" comprises:

- the main processes (initial work, development and extraction, horizontal transport of excavated material, vertical transport through shafts, transport of excavated material at the surface),
- accompanying processes (ventilation, drainage, backfilling of excavations, transport of workers and materials, energy transmission, deposit exploration),
- service processes (machine- and energy-related services, etc.).

The main processes, as those that create added value for the mining company, are the essence of mining activity, but the accompanying processes are necessary in the implementation of the main processes and have a particular role in the arrangement of the work environment. The service processes support the main and accompanying processes, but their position in the organizational structure may be different and they may be subject to market relations. The main processes are sequential, while the remaining processes are carried out in parallel.

As the functional system dominates in the mine management, its activities can be classified into groups of processes related to:

- planning (exploration of the deposit, development of the project, operations plans, including concept-plan of mining work and others),
- preparing production (sources of supply, resources, etc.),
- maintaining operations (supply of production-related resources),
- administration (HR activities, reporting, etc.),
- management (executive officer, mining plant operation manager, other managers – process owners and staff units).

The opportunity study should include conclusions regarding:

- outsourcing certain activities,
- liquidation, establishment, merging and/or division of organizational units,
- a decision to finish the study (no justification for modifications) or to move to the feasibility study.

In the second stage of phase 1 (feasibility study), it is proposed that there should be:

- strict definition of processes and their position in the company structure,
- development of a process management project along with the organizational infrastructure adopted.

In defining processes, three basic dimensions should be included: input, transformation and output. Inputs and outputs define the boundaries and scope of the processes as well as the states of the enterprise in the areas of implemented processes. The input to the process requires resources, as well as the main production factors and natural resources. The process output can be characterized by a change in the state of the enterprise within the area covered by the process, by the received semi-finished products, or by the services provided.

Process transformation can be characterized by the technologies or procedures employed, the organization of work and the work system. Processes are graphically illustrated using technological stages, work schedules and work systems, as well as transport flows (mapping the movement of loads and people in the transport system).

The project management part should include the development of the project infrastructure, i.e.:

- defining suppliers and customers of processes – although such relationships may occur between project managers, they are more frequent between the president and the executive board,
- defining, where possible, measures of process results in quantitative form,
- developing a process-based cost system,
- defining functional, service and information ties within processes, between processes, as well as with external processes (X-reengineering),
- developing a uniform quality management system (quality manual, procedures, regulations),
- developing an IT process-support system,
- developing process documentation.

The implementation phase comprises two stages; the first is the implementation of partial solutions, and the second is the implementation of target solutions.

The scope of the first stage should include:

- a) implementation of the process structure within the areas of management, as well as production planning, preparation and service, because the process system is implemented in the operation area,
- b) implementation of inter-process links within the areas of management and operations,
- c) implementation of partial solutions related to process infrastructure, such as an integrated quality management system, mining allocation schedules, etc.,
- d) potential change of terminology, for example from process owner to process manager.

In the second stage, the process structure is implemented in its complete scope at the enterprise level, and these modifications should be gradual due to, among other considerations, acceptance by the company's stakeholders.

Conclusions

The organizational structure of an enterprise is defined as the combination of organizational units and processes, which, as an entity, contribute to the success of the enterprise. This combination is manifested in service, functional and information ties. Structure is a management tool. A significant number of structures are known and constantly improved in the field of organizational solutions, and their selection should be informed by the character of the enterprise and encompass the entire mining project cycle in accordance with LCA principles.

In mining enterprises, the basic principle behind structure development is work safety and all other assumptions must be subordinated to this principle. Therefore, linear working relationships will dominate in mining

structures and the technological procedures must be strictly observed. At present, operations in mining enterprises have a clearly process-based character, while the management has a functional character in terms of the organizational units.

In process structures derived from reengineering, a set of defined criteria allow the structure to be classified as process-based. Such criteria include quasi-market concepts, e.g. suppliers, customers and process owners. In process management, decisions should be made in the location of process implementation, remuneration should refer to results and not tasks, and training should be replaced by education.

Functional structures are transformed into process structures by introducing process terminology, e.g. by replacing managers with process owners, units with processes, and by establishing virtual suppliers and customers. Unfortunately, such artificial solutions lead to confusion in the enterprise, and in the mining industry such transformation is unacceptable. However, the transformation into process structures offers an excellent climate for improving structures, particularly in the organization of processes and organizational infrastructure. This applies, for example, to the allocation of resources, concentration of mining activity, synchronization of production capacity and numerous other organizational aspects. As pertains to organizational infrastructure, quality systems and IT support are of significance.

The proposed project-based, pragmatic method of introducing or improving process structures in mining enterprises is expected to contribute to improving the efficiency of their management, and to making optimal use of resources, especially in their key business areas.

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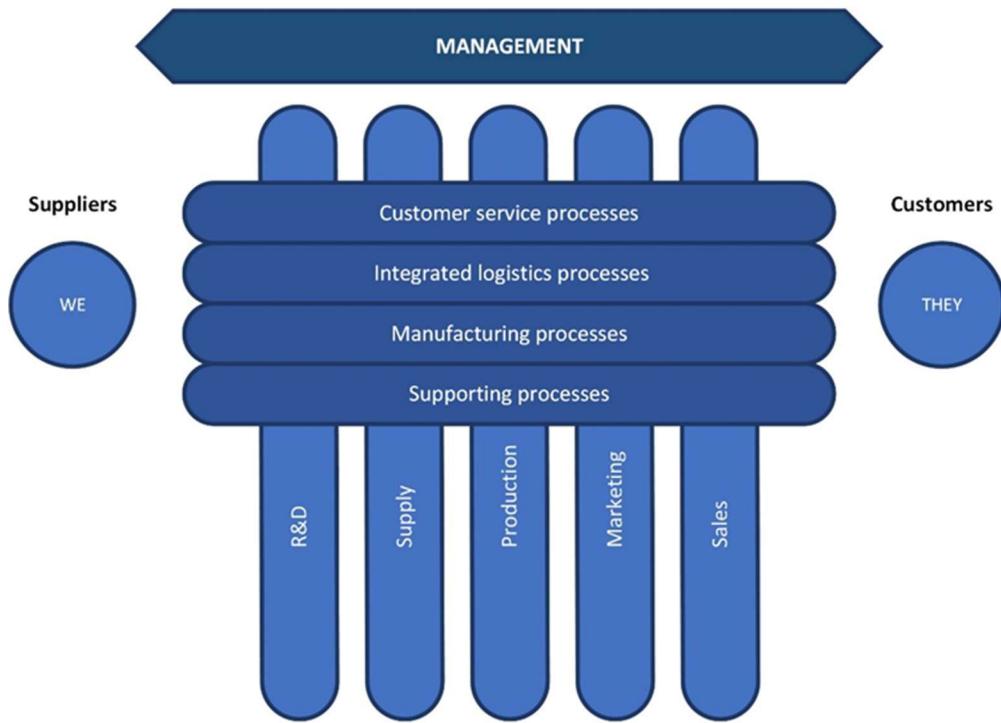


Fig. 1. Reengineering – processes and functions in an organization (Grajewski, 2007)

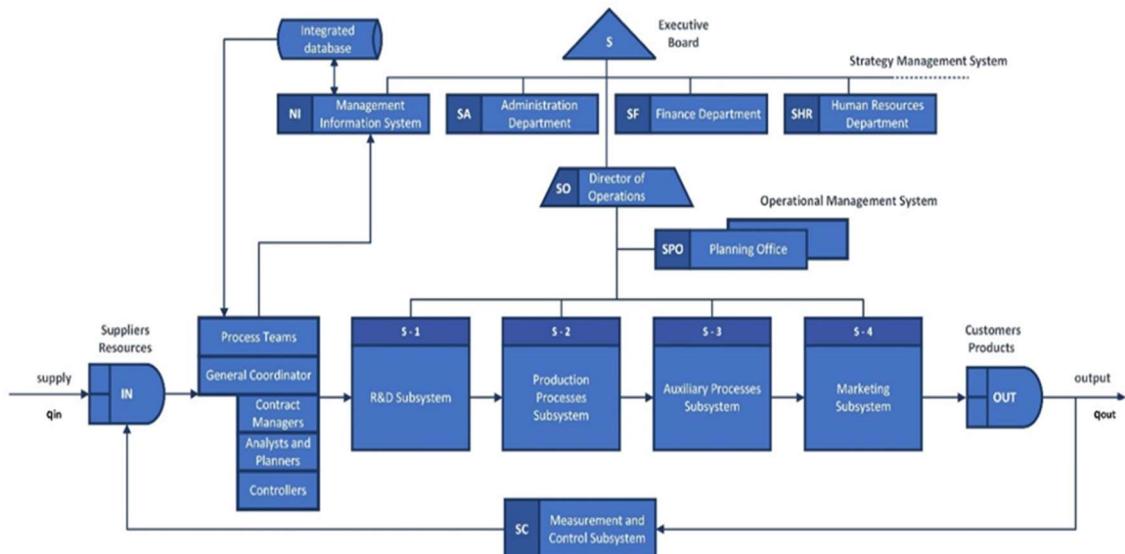


Fig. 2. Model of the process-based organizational structure in an enterprise (Grajewski, 2007)

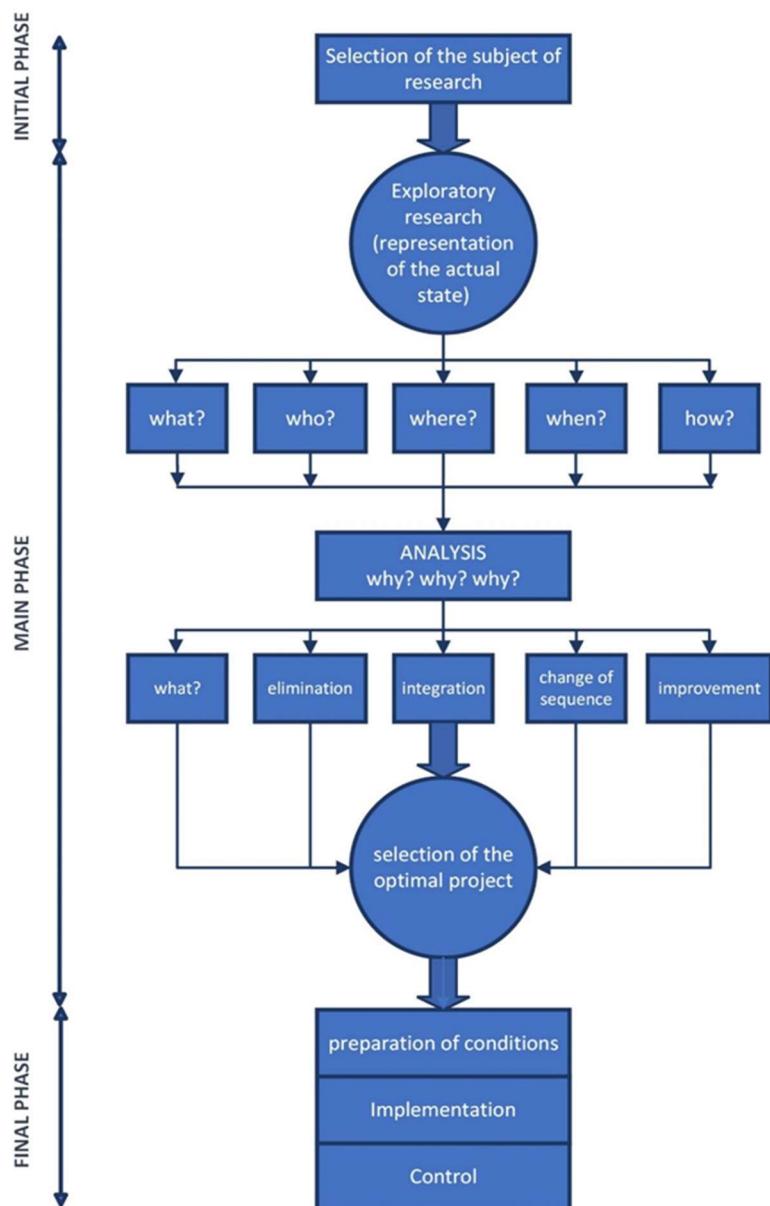


Fig. 3. Diagnostic method for designing an organizational structure according to a classical model (Trzcieniecki, 1970); for contemporary extensions see, for example, Grajewski (2007) and Kicki and Wanielista (2017).

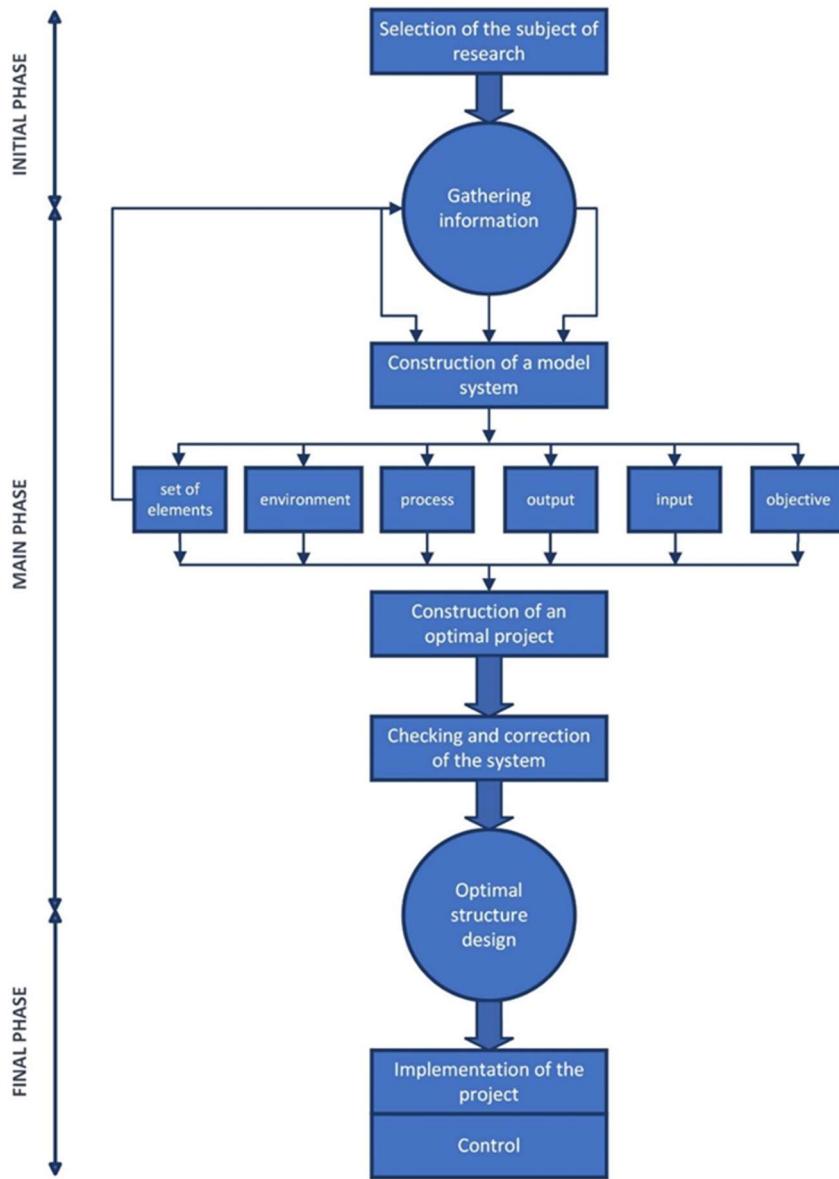


Fig. 4. Prognostic method for designing an organizational structure (Trzciensiecki, 1970*).

*Classical model of Trzciensiecki (1970), whose methodological assumptions remain valid, while detailed organisational solutions have been further elaborated in later research on modern enterprises.

Table 1. Radical reengineering and soft reengineering

Features analysed	Radical reengineering	Soft reengineering
Scope of modifications	Radical modification – quantitative leap	Gradual modification
Object of modifications	All processes	All processes
Design area	Process as a starting point for both the flow and modification of structures	Existing functions and/or procedures
Modification and implementation duration	Modification horizon – from short to medium term	Improvement horizon – long term
Level of risk associated with implementation	The aim of the design works is to achieve maximum efficiency; risk – high	Individual, continuous learning results in the improvement of existing function processes; risk – low and moderate
Employee involvement	Limited employee involvement – significant involvement of external experts	All employees are involved in the process of the development and evolutionary improvement of new solutions
Modification initiators	Modification is initiated by the management	Modification is initiated by all employees

Source: Grajewski (2007)

Table 2. Project of developing and implementing a process structure in mining enterprises

Phase	Stage	Action(s)
Design studies	Opportunity study	Description of the enterprise structure as a set of processes Analysis of the current structure according to process criteria
	Feasibility study	Defining processes according to the input-transformation-output scheme Process management project
Project implementation	Partial implementation	In the area of management In the area of organizational and economic processes infrastructure
	Comprehensive implementation	At the organizational and process level in a gradable form

Source: the authors