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Circular business models as management innovations in subsoil use

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Abstract. In the last decade, there has been an active search for opportunities to implement the concept of sustainable development in practice. One of these areas is the formation of a circular economy, which provides for the development of closed-loop cycles of production and consumption based on circular business models. The article discusses the theoretical and practical aspects of using circular business models as managerial innovations in the field of subsoil use. Methodologically, the study rests on the conceptual foundations of business modeling and circular economy. The methods of analysis, synthesis, classification and observation are applied during the research. The work focuses on business model as a managerial innovation that provides a holistic view of entrepreneurial activity and shows its relationships with business processes in a company. The authors highlight the distinguishing features of circular business models, whether these are intra-firm models proposed in the reports of the Ellen MacArthur Foundation and Accenture, or inter-firm ones, which are circular industrial clusters or eco-industrial symbiosis. We develop a conceptual circular business model to be applied in the field of subsoil use, which specifies inter-firm business processes at a mining enterprise and substantiates the existence of direct and reverse symbiotic chains facilitating the exchange of products, services and waste within a circular industrial cluster. The research results demonstrate not only the possibility, but also the need to utilize circular business models in the context of subsoil use. This approach will help generate intra- and inter-firm benefits and thereby enhance the competitiveness of mining enterprises.

Keywords: managerial innovation; business model; business process; subsoil use; circular business model; mining enterprise; circular industrial cluster; eco-industrial symbiosis; symbiotic chain.

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Циркулярные бизнес-модели как управленческие инновации в недропользовании

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Аннотация. В последнее десятилетие происходит активный поиск практических направлений реализации концепции устойчивого развития. Одно из таких направлений – формирование циркулярной экономики, предусматривающей развитие замкнутых циклов производства и потребления на базе циркулярных бизнес-моделей. В статье рассматриваются теоретические аспекты и практические возможности применения данных моделей в сфере недропользования. Методологической базой исследования выступили концептуальные основы бизнес-моделирования и циркулярной экономики. Использованы методы анализа, синтеза, классификации, наблюдения. Бизнес-модель рассматривается как управленческая инновация, дающая целостное понимание предпринимательской деятельности. Представлена ее связь с бизнес-процессами организации. Выделены специфические характеристики циркулярных бизнес-моделей, как внутрифирменных, предложенных в докладах фонда Ellen MacArthur и консалтинговой компании Accenture, так и межфирменных, представляющих собой циркулярные промышленные кластеры или экопромышленные симбиозы. Разработана концептуальная циркулярная бизнес-модель для применения в сфере недропользования, в рамках которой выделены межфирменные бизнес-процессы горнодобывающего предприятия, обосновано наличие прямых и возвратных симбиотических цепочек, способствующих обмену продукцией, услугами и отходами, внутри циркулярного промышленного кластера. Результаты исследования свидетельствуют не только о возможности, но и о необходимости использования циркулярных бизнес-моделей в недропользовании. Такой подход будет способствовать получению выгод на внутрифирменном и межфирменном уровнях, а вследствие этого повышению конкурентоспособности горнодобывающих предприятий.

Ключевые слова: управленческая инновация; бизнес-модель; бизнес-процесс; недропользование; циркулярная бизнес-модель; горнодобывающее предприятие; циркулярный промышленный кластер; экопромышленный симбиоз; симбиотическая цепочка.

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INTRODUCTION

The transition from an outdated linear economy, which aims to meet increasing human needs, utilize primary natural resources and generate waste, to an innovative, environmentally sustainable model is accompanied by the use of circular business models [Suarez-Eiroaa et al., 2019; D'Amato et al., 2017; Dovgal et al., 2020; Prieto-Sandoval, Jaca, Ormazabal, 2018]. Companies' close interest in these models is due to the necessity to forge and uphold their formidable business reputation, as well as to obtain other competitive advantages [Rossi et al., 2020; Yadav et al., 2020; Potting, Hekkert, Worrell, 2017; Costa Fernandes et al., 2020].

The present research aims to investigate the possibility to apply circular business models as managerial innovations in the context of subsoil use. To attain the stated purpose, we accomplish the following objectives:

- to examine business models as managerial innovations;
- to identify the specific features of circular business models;
- to explore the possibility to apply intra- and inter-firm models in the context of subsoil use.

The novelty of the research lies in presenting circular business models proposed to be used at a mining enterprise through intra- and inter-firm business processes.

BUSINESS MODEL AS MANAGERIAL INNOVATION

In a strict sense, a business model is a managerial innovation that provides a meaningful and holistic view of entrepreneurial activity. Currently, a properly selected and workable business model is the key to a successful business. The concept of business models was first found in scholarly papers in the late 1940s – the early 1960s; however, the most in-depth studies in this area are relatively recent. To date, there is still no common understanding of the essence of business models [Klimanov, Tretyak, 2014; Orekhova, 2018; Ovans, 2015; Mustafa, Werthner, 2011; Johnson, Lafley, 2010; Weill et al., 2005].

The theoretical study of business models by Strekalova [2009] is of special interest. Based on the variety of approaches to defining this concept, the author categorizes business models into two groups: static (economic, operational, and strategic approaches) and dynamic (integrated, structural, and system-based approaches). According to the *economic approach*, the business model determines the way in which the company will deliver sustainable profits over an extended period of time. The *operational approach* describes the model as a way to create, propose and deliver value to the organization's customers, whereas the *strategic approach* deals with the model as a mechanism for implementing the company's strategy. The *integrated approach* combines the three attitudes mentioned above. The *structural approach* defines a business model as a structure of key interrelated systems that create and support competitive business. The *system-based approach* looks at the model as a system of elements, connections between them and dynamics, while each element contributes to the system, and all of them have system-related value. Strekalova offers a comprehensive definition of the term that summarizes the aforementioned approaches. A *business model* is a conceptual tool for studying a complex object that characterizes the fundamental elements of a business, their relationships and the system of the object's connections (mechanism) with the external environment, which allows creating a simplified holistic view of the business and reflecting its most significant characteristics: what value is created for the consumer and how it is created; to whom and how it is delivered; how resources and opportunities are used in order to create sustainable competitive advantage, generate income and yield profits [Strekalova, 2009].

Strekalova [2009] also proposes an additional constructive definition of a business model that contains seven fundamental components (the function and goals of the business; value proposition; market; a processor including the value chain, resources and infrastructure, a catalyst, and human resources; competitive strategy; business network; and economic model) and is mostly concentrated on the internal business processes in the organization. In turn, the synthesized definition of a business model given by Klimanov and Tretyak [2014] is based on a critical analysis and generalization of the works of Osterwalder [Osterwalder, Pigneur, Clark, 2010], Hamel [2000], Teece [2010] and other renowned researchers and is more focused on network structures and inter-firm relationships. As Klimanov and Tretyak [2014] put it, a business model deals with the process of defining, creating and proposing value for customers, and the appropriation

of income earned through its recognition in the market. The scholars also claim that, as an independent unit of analysis, a business model demonstrates a sustainable structure of market agents that interact with each other, co-create value and receive income. In the conceptual business model, they distinguish between four market agents (suppliers, manufacturers, distribution channels, and customers) and the flows connecting them (product, money, and information flows, as well as the flow of supervision, responsibility and power).

The experts from the Boston Consulting Group suggest considering a slightly different structure of business model [Lindgardt et al., 2009]. They argue that it is typically comprised of value proposition and the operating model, each of which embraces three components. *Value proposition* characterizes key segments (target audience and its needs), product or service, and the revenue model. The *operating model* encompasses the value chain, the costs model, and the organizational structure of business.

To get a comprehensive view of the substance of a business model as a managerial innovation, one should bear in mind that its content and structure are closely linked with other elements of the business management system, such as corporate strategy, business processes and the value chain. For instance, a prominent economist and management expert Michael Porter [2006] believes that an organization's business model is formed according to the chosen corporate strategy and includes business processes creating the value chain and establishing the ways to reach strategic goals. As stated by another researcher in the field of business management Oleg Kulagin [2016], each component of a business model can be viewed as a set of business processes characterized by ISO 9000 standards as a sustainable and purposeful combination of interrelated activities, which, following a specific method, transforms inputs into outputs of value to the consumer. At that, all business processes are grouped into three categories: *fundamental* business processes representing the stages of the product life cycle; *auxiliary* processes providing resources for the fundamental ones; and *management* business processes associated with the implementation of management functions (planning, organization, motivation, control, coordination) with respect to the fundamental and auxiliary business processes.

Business model is inextricably linked with the issues of inter-firm relationships, since the creation of value by an organization is only possible when it is interconnected with other companies [Klimanov, Tretyak, 2014]. If a business model is considered in the context of close sectoral, territorial or other cooperation of several organizations, then we talk about a cluster model.

As with a business model, a cluster and a cluster model have numerous different interpretations. The concept of cluster was borrowed from mathematics and, in general sense, it refers to a combination of several homogenous elements, which can be regarded as an independent unit possessing certain properties. The origins of the modern cluster theory lie in the works of the British economist Alfred Marshall and the American economist Michael Porter [Bakhshyan, 2019]. In the 1940s, the Russian researcher in the field of economic geography Nikolay Kolosovsky coined a term "a territorial production complex" (TPC) similar to the concept of cluster. The principal difference between the two concepts is that a TPC lacks the competition component and can develop only amid a planned economy [Dondokov, 2015]. In the context of the market economy, clusters first emerged in the middle of the 20th century as a union of geographically adjacent and interrelated small and medium-sized enterprises. Since then, the system of the economic cluster functioning has become much more complicated, and it is now seen as a specific group of organizations (which are usually manufacturers, suppliers, research institutions, public and financial institutions, etc.) that complement each other and enhance the competitive advantages of each organization and the entire cluster.

Based on the results of the above generalizations[1], all the existing clusters can be grouped by the *nature of their emergence* (spontaneously formed, consciously created), *technological parameters* (intellectual, artisanal, industrial), the *method of formation* (with vertical ties, regional form, sectoral and industrial), and by other characteristics.

PECULIARITIES OF CIRCULAR BUSINESS MODELS

As noted above, in transitioning to a sustainable development economy, it is becoming increasingly relevant to develop and apply circular business models based on production and consumption cycles [Batova, Sachek, Tochitskaya, 2018; Guryeva, 2019; Pakhomova, Rikhter, Vetrova, 2017].

The authors' research has focused on providing answers to the following questions: How are circular business models formed? How do they operate? What competitive advantages do they offer to enterprises? How cost-effective are they?

The most popular and inclusive circular business model allowing for a variety of closed-loop biological and technical cycles takes the form of a diagram and is put into words in the reports of the Ellen MacArthur Foundation[2]. The experts from the Accenture Consulting presented a similarly complex circular business model and broke it down into several simplified and complementary

[1] What is cluster in economics? https://spravochnick.ru/ekonomika/chto_takoe_klaster_v_ekonomike/.

[2] Towards the cyclical economy. Economic and business rationale for an accelerated transition to sustainable development. Ellen MacArthur Foundation, 2013. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf.

circular business models[1], which are currently being studied by the scientific community and used by enterprises in real-case scenarios. These models weakly correlate with classical business models examined within control theory and largely centered around business innovations in the field of limited and efficient exploitation of resources for producing goods / services, as well as around extending the lifetime of the existing products / services through repair and reconstruction and completing the life cycle of products through their processing.

There are several types of circular business models:

1. *Circular Value Chains, or Circular Supplies*. Such models are oriented towards the transition from non-renewable resources utilized as a source of raw materials and energy to renewable and inexhaustible resources as their effective substitutes;

2. *Resources Recovery*. These models are associated with various methods of waste disposal, such as reuse of waste so that the material reacquires the properties it had in its original state (waste reuse), putting waste back to the production cycle after appropriate preparation (waste recycling), extraction of useful components for their reuse (waste recovery), as well as the use of municipal solid waste as a source of renewable energy (secondary energy resources) after extracting useful components from them (waste-to-energy processes);

3. *Product Life Extension*. The business model aims at keeping a product life cycle extended for a prolonged period through its repair, modernization, reconstruction and restoration;

4. *Sharing Platforms*. The model implies creating platforms for interaction between product users (households, enterprises) in terms of the exchange and sharing of a durable product, which can only be used by the same user for a short time;

5. *Product as a Service*. According to this model, instead of purchasing the product, a lease deal is concluded which establishes that ownership is kept by the manufacturer and the product is borrowed by the lessee with an added service package including technical maintenance [Mochalova, Sokolova, 2021].

There are four principles of efficiency underlying the aforementioned business models:

- using durable (inexhaustible and renewable exhaustible) resources, such as alternative energy sources. According to experts' estimates, this can help resolve the problem of limited resources in the context of ever-growing customer needs and produce 40 % of the expected effect from the introduction of a general scheme of a circular economy;
- forming connected value chains by using outflows (waste) of some processes as inflows (secondary resources) for other processes. This principle implemented is capable of producing 20 % of the total effect;
- extending the product life cycle through maintenance, modernization and restoration, thereby reducing extra demand for resources when producing goods to fill shortages. This approach can stimulate 30 % of the total effect;
- organizing liquid markets, where supply meets demand for products that might be previously illiquid due to their rarity, high price, etc. and where their optimal use is ensured throughout the entire life cycle. This principle gives 10 % of the total effect.

According to experts from Accenture, in order to implement the above circular business models at specific enterprises (focal areas), the management team should figure out which of these business models are suitable to be adopted in the existing or newly organized business. Then, they should think over the possibilities of deriving a synergistic effect from creating a circular alliance (cluster, symbiosis) jointly with their partners and customers, and finally, work out a scheme to organize a simple or complex intra- and / or inter-firm circular business model[2].

To analyze various circular business models as managerial innovations, their generalized structure was explored from the perspective of inter-firm cooperation and value co-creation. To do so, the aforementioned approach by Klimanov and Tretyak was applied. The approach made it possible to form a conceptual circular business model (Fig. 1) that embraces four inter-firm business processes co-creating value and earning income (supply, production, distribution, and consumption) and connecting their flows (material, information, and money). Within the framework of the material (material-energy) flow, which is directed from supply to consumption, one considers renewable resources, secondary and non-toxic raw materials, and the value created (goods, services). The information flow implying the conclusion of contracts for the supply of a product or a service is directed both ways. The money flow is associated with payment for resources and raw materials, as well as for the value created.

As a managerial innovation, the presented circular business model can be put into practice only if the following conditions are met:

- awareness of all market agents of the importance of its application supported by economic, environmental and social benefits;
- skills in the use of circular technologies in the spheres of production, distribution, exchange and consumption;

[1] Circular advantage: Innovative business models and technologies to create value in a world without limits to growth. Accenture, 2014. https://www.accenture.com/t20150523T053139__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Strategy_6/Accenture-Circular-Advantage-Innovative-Business-Models-Technologies-Value-Growth.pdf.

[2] Circular advantage: Innovative business models and technologies to create value in a world without limits to growth. Accenture, 2014.

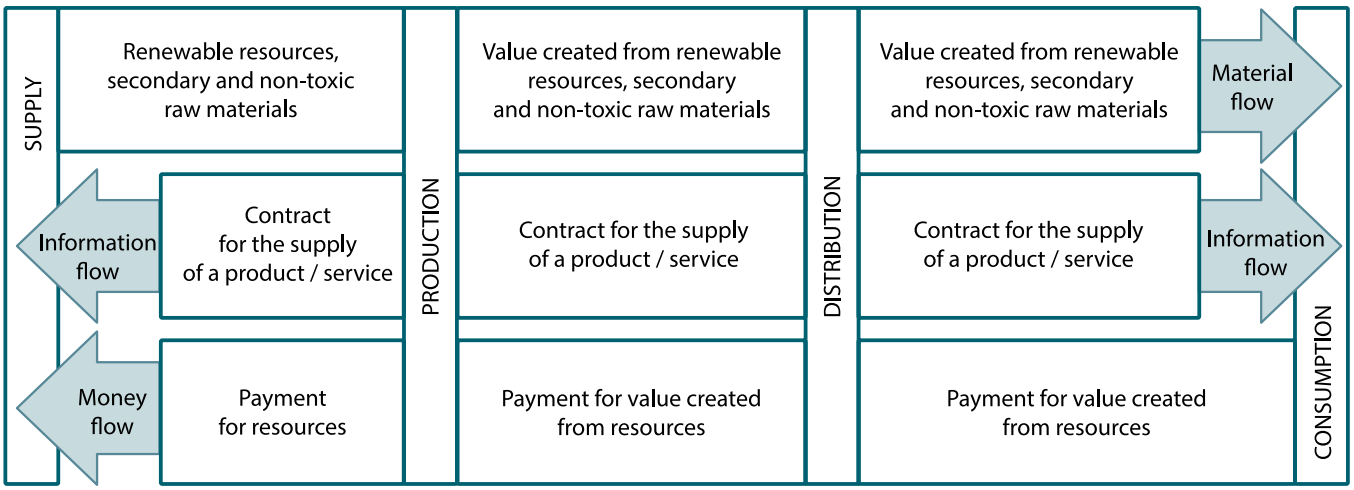

Fig. 1. Conceptual diagram of circular business model highlighting inter-firm business processes

Рис. 1. Концептуальная схема циркулярной бизнес-модели с выделением межфирменных бизнес-процессов

• formation of mutually beneficial relationships between market agents producing a synergistic effect.

APPLYING CIRCULAR BUSINESS MODELS IN SUBSOIL USE

When analyzing the possibilities of using the listed circular business models in subsoil use – an area, in which a mining enterprise acts as a manufacturer of goods and services, but not a supplier that is traditional for business models utilized in other focal areas – the following conclusions were drawn.

The Circular Supplies business model in essence centers around replacing mineral resources as a source of raw materials with renewable resources serving as their economically and environmentally efficient substitutes, which, if involved in production, will save expensive and scarce types of mineral resources and reduce the adverse effect on the environment. Thus, it is possible to apply circular value chains at mining enterprises only in terms of auxiliary materials and energy obtained from renewable resources in the process of extracting and processing minerals.

The Resources Recovery business model is most in demand due to a massive amount of waste generated while mining and processing minerals. Mineral resources are possible to restore mainly through the utilization of mining waste, which implies their reuse or recycling, e.g., the use of overburden for quarry reclamation; development of man-made mineral deposits (dumps, spoil tips, tailings dams); use of tailings as a secondary raw material to produce building materials, etc. [Petukhov, 2016; Kinnunen, Kaksonen, 2019].

The Product Life Extension business model is not applicable to a mining enterprise's core activity associated with the extraction of minerals due to the nature of the final product, which is not a finished product, but raw materials for further processing. However, it might be applied to the non-core (secondary) activity of a mining enterprise, such as mechanical engineering, when restoring and re-profiling mining machines, drilling rigs and machinery, and improving the wear resistance of their parts.

The Sharing Platforms business model can be implemented through joint development of mineral deposits, as well as the exchange of specialized mining and exploration machinery and equipment.

The Product as a Service business model is realized through the rental of specialized equipment used at certain stages of mining, processing and exploration works [Mochalova, Sokolova, 2021].

At the next stage of the research, we aim to investigate intra-firm business processes of a mining enterprise contributing to the formation and evolution of circular business models. To accomplish that, the decomposition principle was applied using the Business Studio software. In the course of the decomposition, the block A0 (Fig. 2) displaying the organization as a whole were detailed in the subsequent block A1 (Fig. 2). The complex process of the upper level was gradually broken down into its components (sub-processes of the lower level) (Fig. 2, A2).

The following elements were established in each business process: process owner; process control; process technology; process limits; input; output; system of process indicators; process resources; etc. (Fig. 3). For example, it is possible to distinguish between the following elements of the Mineral Extraction business process. The process owner is the head of the mining workshop. Process control is implemented in accordance with the annual Mining Plan. The process technology consists in the extraction of minerals by the open-cut mining method, including drilling and blasting, excavation, transportation, etc.). The process limits are determined by the mining allotment specified in the mining allotment act. The inputs include the material flow (fuel and lubricants, gas, electricity, oxygen, overalls, cables, tires, batteries, etc.) and the information flow (consumer requirements for the quantity and quality of products). The outputs are the

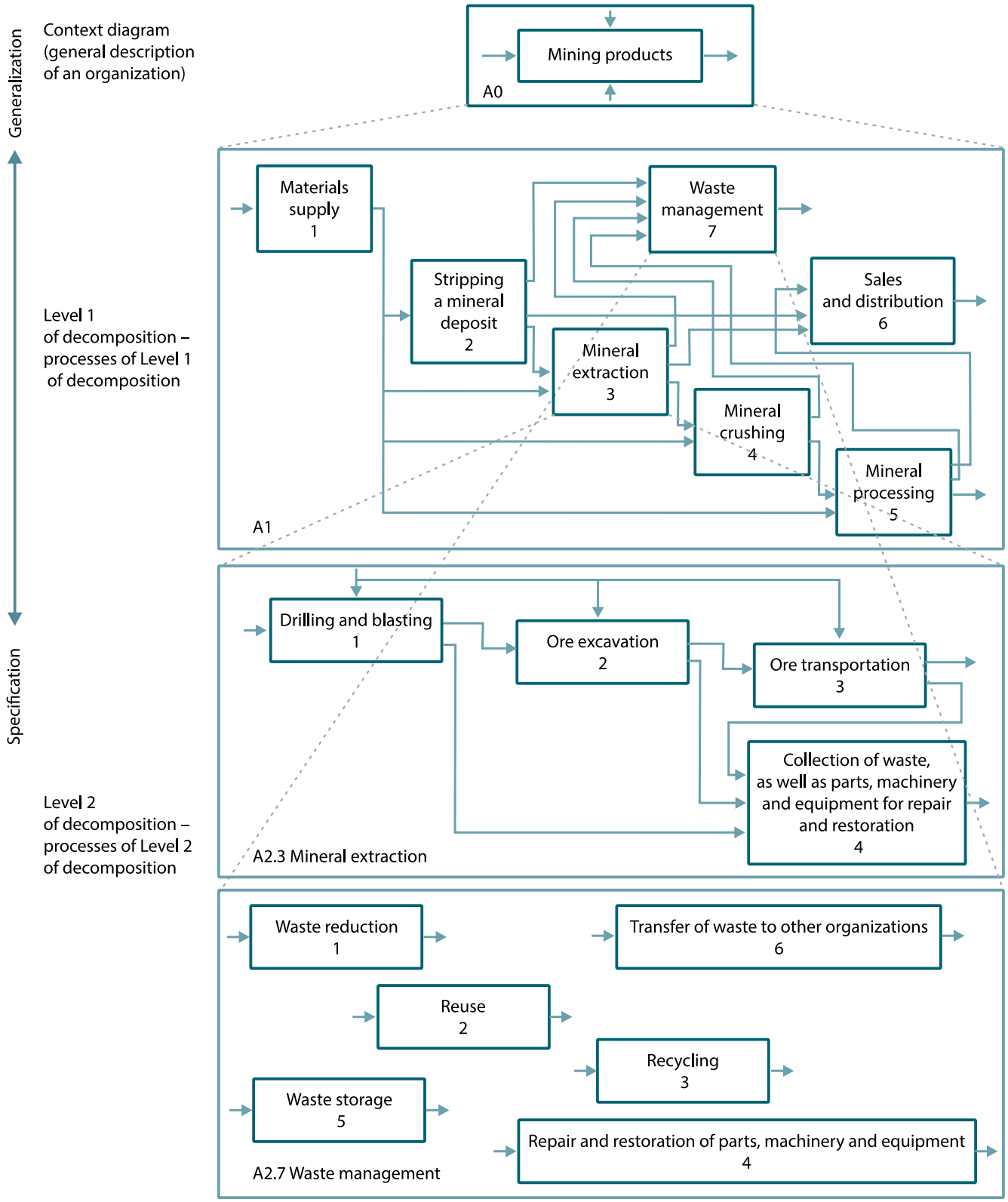

Fig. 2. Levels of business processes at a mining enterprise within the circular business model
Рис. 2. Уровни бизнес-процессов горнодобывающего предприятия в рамках циркулярной бизнес-модели

material flow (mined minerals, associated products, waste fuels and lubricants, unused heat, worn-out overalls, etc.) and the information flow (data on the volume and quality of mined minerals, mining surveyor's report). The system of process indicators characterizes the volume of minerals extraction and stripping, as well as the concentration of the useful component in ore. The process resources encompass the mining workshop personnel, mining machinery and equipment, a mineral deposit, etc.

The research results demonstrate that each business process considered is embedded in a certain system of processes that are performed both in the mining enterprise and external organizations. Thus, a mining enterprise as a "manufacturer" of mineral raw materials should

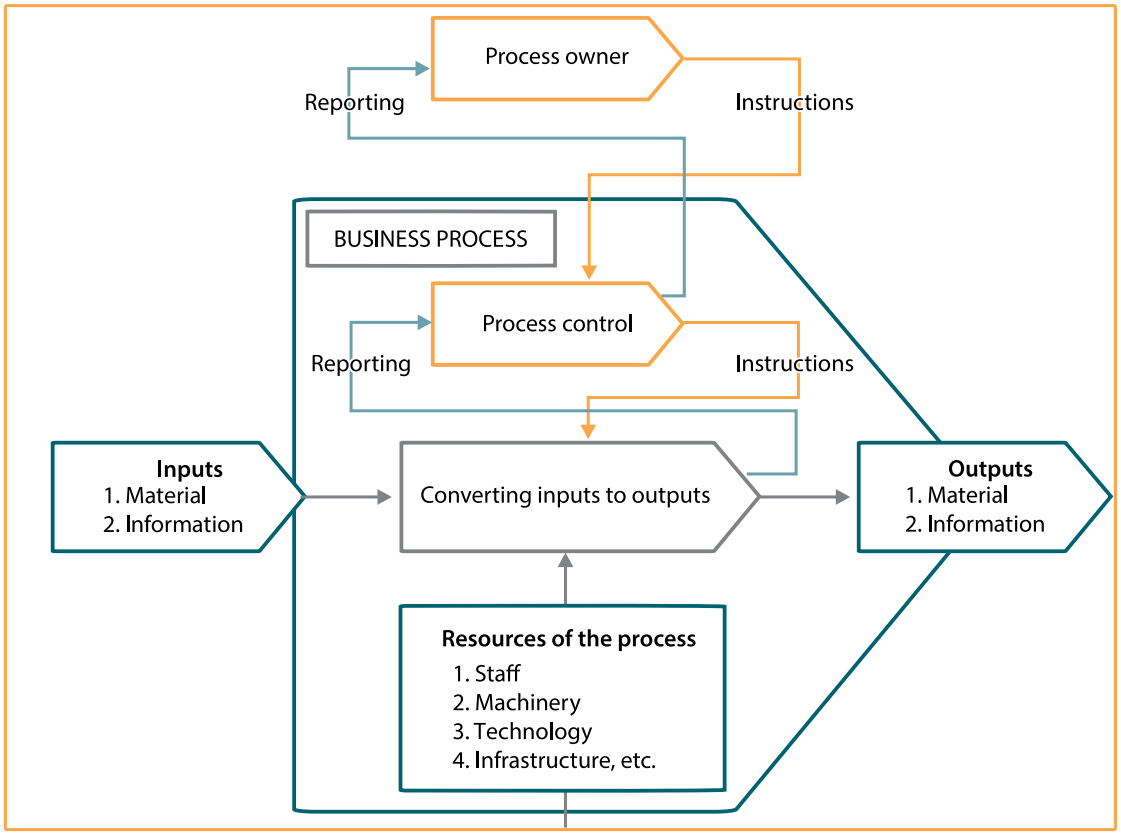

Fig. 3. Block diagram of the business process[1]
Рис. 3. Структурная схема бизнес-процесса

be part of a circular cluster model in order to, in cooperation with other companies, organize the cascade use of mineral raw materials and thereby form a closed-loop cycle of production and consumption "extraction – production – processing and reuse". Fig. 4 presents direct (starting with a mining enterprise) and reverse (ending at a mining enterprise) symbiotic chains included in this model.

The circular business model in subsoil use can be formed in accordance with the characteristics of the territorial cluster provided in the Guidelines on the Implementation of Cluster Policy in the Constituent Territories of the Russian Federation released by the RF Ministry of Economic Development in 2008, as well as the Procedure for Compiling a List of Pilot Programs for the Innovative Territorial Clusters Development adopted following the meeting of the Presidium of the State Council of the Russian Federation of November 11, 2011. However, taking into account the particularities of a mining enterprise, one should focus on the definition of an industrial cluster presented in the Federal Law of December 31, 2014 No. 488-FZ "On industrial policy in the Russian Federation" and the Decree of the Government of the Russian Federation of July 31, 2015 No. 779 "On industrial clusters and specialized organizations of industrial clusters": this is a set of entities operating in the industrial sector, connected by business ties due to territorial proximity and functional dependence, located on the territory of the same constituent entity of the Russian Federation or on the territories of several constituent entities of the

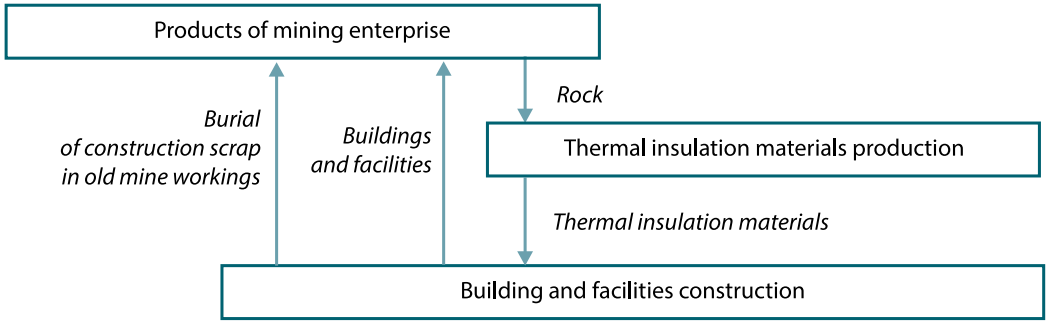

Fig. 4. Direct and reverse symbiotic chains with the inclusion of a mining enterprise
Рис. 4. Прямая и возвратная симбиотические цепочки с включением горнодобывающего предприятия

[1] What is business process? https://rich-c.ru/biznes-prozess1.

Russian Federation, and producing industrial products. A distinctive feature of the industrial cluster built according to the principles of a circular economy is the connection of industrial companies on the basis of closed-loop cycles of production and consumption.

The cluster "Integrated processing of coal and industrial waste" (Kemerovo region), as an illustration of a circular cluster, stands out among the existing industrial clusters of Russia[1]. It is named among the pilot innovative territorial clusters and supported by the Cluster Development Center of OAO "Kuzbass Technopark" as part of the program of the RF Ministry of Economic Development to support small and medium-sized businesses. The production chain of the Cluster's enterprises is three-directional: extraction and processing of gas (methane) from coal seams, processing of coal and its enrichment rejects, and processing of ash and slag and other industrial waste. Among 46 members of the Cluster are small and large industrial enterprises, marketing, research and educational organizations. "The mining and metallurgical cluster" (Republic of Khakassia) is of special interest among the clusters being created; it implies building two metallurgical plants and introduction of independent ore processing[2].

The concept of industrial symbiosis is an alternative to the term "industrial cluster" applied to industrial enterprises associations [Preobrazhenskiy, Tolstykh, Shmeleva, 2020; Branson, 2016]. As evidenced in practice, geographic proximity, common industry and even physical exchange of resources are neither necessary nor sufficient in the formation of both an industrial cluster and industrial symbiosis. What is important here is the interaction between their participants through transactions. In terms of circular industrial clusters and eco-industrial symbiosis, these transactions should be associated with organization of an industrial system with closed-loop technological and biological cycles.

The Baltic Industrial Symbiosis (BIS) initiated as part of the Interreg Baltic Sea Region Programme 2014–2020 is an illustration of the eco-industrial symbiosis aimed at promoting cooperation between Denmark, Sweden, Norway, Finland, Poland and Russia in developing the innovative, transport and environmental potential of the Baltic region. Enterprises interested in joining the cluster undergo a free screening test using the Symbiosis Center Denmark methodology. Once the test is done, the data is uploaded to a database, which juxtaposes the waste and needs of various organizations and allows forming symbiotic chains that help enterprises get rid of unnecessary waste and reduce raw materials costs [Afonina, 2020].

To ensure the long-term and effective functioning of circular industrial clusters / eco-industrial symbiosis, the following conditions should be met:

- the presence of the cluster center / process owner capable of coordinating the interaction between organizations within the cluster / symbiosis;
- the development of a database containing the information about the opportunities to include enterprises in different circular schemes, as well as about their inputs (received waste and recyclables) and outputs (generated waste and recyclables);
- a balance between the circular needs of some members of the association with the capabilities of others;
- observance of mutual obligations by the members of the cluster / symbiosis for the reception and delivery of waste; and etc.

CONCLUSION

The research findings allowed us to conclude that it is both possible and necessary to develop circular business models in subsoil use. These managerial innovations contributing to the increase in enterprises' competitiveness in the context of the sustainable development concept can be applied both at the intra- and inter-firm levels. When forming intra-firm circular business models, it is expedient to concentrate on those proposed in the reports of the Ellen MacArthur Foundation and Accenture Consulting. Inter-firm business models can be presented by circular industrial clusters or eco-industrial symbiosis that unite different enterprises in order to construct direct and reverse symbiotic chains, which stimulate the exchange of products, services and waste. The use of circular business models in subsoil use should contribute to the formation of closed-loop cycles of production and consumption, which help reduce the amount of waste disposed in a particular territory, limit the use of primary raw materials and thereby increase the environmental and economic efficiency of mining enterprises and promote the well-being of the local population. ■

[1] The list of industrial clusters of the Russian Federation - 2020. https://russiaindustrialpark.ru/article/perechen-spisok-promyshlennyh-klasterov-rossii-2020-god.

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