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**INNOVATION MANAGEMENT IN DIAMOND CUTTING IN THE**  
**NORTH**

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**Abstract**

Digitalization of the economy together with introduction of innovations is actively entering the industrial production, including diamond cutting. Being such a specific product, diamonds and diamond jewelry faced a significant challenge in reducing consumers demand and the threat of market replacement by diamonds grown in laboratory. The article revealed threats and risks faced by the industry in the global trend of decrease in consumers demand, including due to the spread of new infections (COVID-19). The types of innovations required to minimize risks and threats with the help of end-to-end technologies introduced into the diamond production are identified. The authors presented end-to-end technologies expected to be used in the diamond production. The authors conducted a technology audit of diamond-cutting enterprises engaged in processing in the North of Russia. The innovative development of the industry together with introduction of product and process innovations determines the need for the development of innovation management mechanisms. Furthermore, promising areas of innovative development that have a need for diamond production in the North are identified.

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*Keywords:* Technology audit, iamond cutting; innovative infrastructure, technological backlog, gem industry, database technology



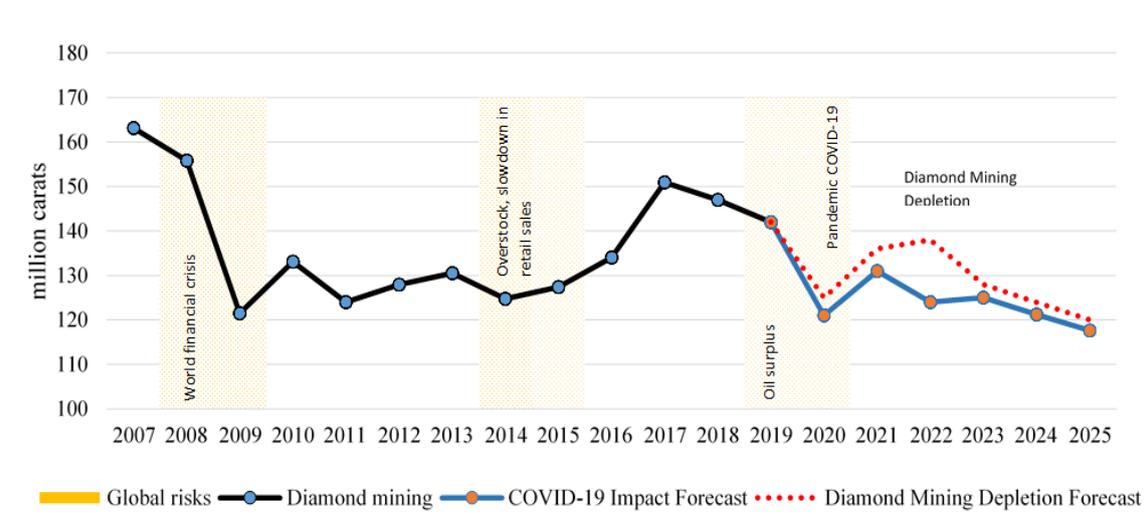
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## 1. Introduction

The diamond industry is currently experiencing difficulties in all segments of the diamond pipeline, from diamond mining to diamond production and marketing of finished products. In 2018, global natural diamond mining amounted to 147 million carats. In 2019, the planned global diamond mining is 142 million carats (The Global diamond report, 2019), but this forecast is more likely to be even lower due to the ongoing pandemic. Firstly, the drop in global diamond mining is associated with deterioration in raw material base, caused by decrease in the average diamond grade in ore and ore processing volumes. Secondly, the difficulties of financial and credit relations led to a cyclic economic problem of limited financial resources in the economic sectors, which provoked a prolonged decrease in consumers demand, especially for luxury goods. Thirdly, the restrictive measures introduced due to the spread of a new infection (COVID-19) reduced the retail sales of diamond jewellery and even forced many countries to close the jewelry stores. Wholesaling is stopped on diamond exchanges and sight holders temporarily suspended trading from February 2020. Despite the negative trends in the global diamond market, the business will undoubtedly recover from this crisis events (Figure 1). The questions are when to expect a revival of the market, how to survive difficult times for manufacturers and how to maintain the business liquidity? Thus, implementation of anti-crisis measures to preserve the business and use of tools enabling to reduce costs determine their need and relevance.

## 2. Important of the problem

According to expert survey conducted during Edahn Golan (The Golan Diamond Market Report..., 2020) seminar, most experts predict the diamond market recovery to be in the pre-holiday period of Christmas 2020 and New Year 2021. Revival of tourist trips as well as growth of postponed weddings and celebrations after the pandemic will give an impetus to increase consumers demand for diamonds.



**Figure 1.** Global diamond mining with a forecast estimate up to 2025 (Source: compiled on the basis of forecast estimates of world experts in the diamond industry (Even-Zohar, 2020; The Global diamond report, 2019; The Golan Diamond Market Report..., 2020)

The forecast estimate of global diamond mining until 2025 is based on the informational background prepared on the basis of annual reports of diamond mining companies (Annual reports of ALROSA, PJSC, 2020; The diamond insight report, 2019) and analytical reports on diamond industry research, including large consulting companies as AWDC, Edahn Golan Diamond Research & Data, Diamond Pipeline, etc. (The Global diamond report, 2019; The Golan Diamond Market Report..., 2020; Even-Zohar, 2020). Scientific approaches and research methodology are developed based on the scientific results of researchers, expert opinions and specialists interviews (Aletdinova, 2013; Koki Costa da Nogami et al., 2018; Mohtasham et al., 2017). Methodological foundations of the study on the management of innovation and digital development of the economic sectors were based on scientific papers prepared by the following scientists (Bhat & Bowonder, 2017; Nikolaev et al., 2016; Salimova & Khakhaleva, 2017; Samsonov et al., 2017).

The key factor of business liquidity for diamond manufacturers is the value of processed rough, namely diamonds. In the majority of cases, diamond manufacturer's use for processing natural diamonds mined in South Africa, Russia, Botswana and other countries (Pototskaya, 2013). The price of natural diamonds is formed according to the law of supply and demand, but the price dynamics depends on the following quality characteristics of diamonds: mass, purity and color (more than 6,000 items). The price changes in different ways depending upon the demand for diamonds of a certain quality category of raw materials. Diamond manufacturers have a small added value of 1-3% (The Global diamond report, 2019), which determines the need to pay special attention also to control of production costs reduction. During the crisis period, diamond manufacturers try to maintain at least 1% of added value, and sometimes even 0% added value is considered a good result for business as compared to incurring losses. Thus, the problem of reducing the diamond production costs is considered relevant and desired during the crisis of the industry. The liquidity issue is particularly acute for diamond manufacturers operating in the North. Difficulties lie in bearing additional expenses for utility bills and transportation costs associated with servicing production facilities (heating, water supply, electricity and other expenses) under the conditions of uncongenial climate of the Extreme North, where the temperature in severe winter periods drops to 45-50°C below zero. Therefore, the introduction of innovations and their management in order to achieve the goal of reducing the finished products costs is relevant and important in difficult socio-economic conditions of the region.

The study object of this article is the diamond-cutting enterprises of Russia located in harsh environment of the Republic of Sakha (Yakutia). Yakutia is world famous for its reserves and volumes of extraction of natural diamonds. Over 90% of mined diamonds are exported to world diamond exchanges in China, Belgium, India, the USA and other countries (Mbayi, 2015; Radhakrishna, 2007). In 1992, the regional government of Yakutia made a political decision to organize the processing of mined diamonds at local production in order to create employment opportunities and gain added value. As a result, large-scale state programs to organize diamond-cutting shops in rural settlements of Yakutia were launched, the educational system for training personnel was created, and the work of financial institutions (banks, holdings, leasing, etc.) was organized (Grigoryeva, 2020). As a consequence of this, high commercial and managerial costs with low gross profit did not allow many diamond-cutting enterprises to remain liquid, and the number of enterprises decreased from 55 to 6.

Maintaining the industrial production of diamonds in the North remains the state decision of the regional executive bodies. Changed conditions of socio-economic development of the region together with emergence of process, product and marketing innovations with change in technological mode make it possible to bring market participants to a new managerial level of development of the diamond-cutting industry in Yakutia using new techniques and mechanisms for managing innovations.

### 3. Results

Technology audit conducted in diamond-cutting enterprises of Yakutia shows that fixed assets of the enterprises were acquired and imported into the region in the 90s. High technical level of operating equipment, machines and mechanisms can be maintained by enterprises with a sufficient level of profitability. Insufficient production capacity of high-tech equipment or absence of it as well as high degree of depreciation of fixed assets leads to increase in production cost along with higher prices for diamonds against poor cutting and larger share of production fault (Table 1).

**Table 1.** Equipment used in diamond processing

Process	Technically obsolete equipment	High-tech equipment	Primary features of equipment
Planning	Magnifier, microscope, micro calculator	OGI Systems, Sarin and Helium scanners. Automatic unit for determining color and shape of crystals	Automatic high-precision scanning of diamond crystal, building realistic 3D model and determining optimal position of diamonds in the crystal
Marking	Rapidograph, marker	OGI Systems, Sarin and Helium diamond laser marking units	Drawing a marking line on diamond surface with laser
Sawing	Mechanical sawing unit with diamond-coated copper blade	Sarin and Helium laser sawing units	Allows reducing time and accuracy of diamond sawing, regardless of the nature of internal inclusions of diamond
Peeling	Peeling machine for mechanical processing with grinding disc (diamond on diamond)	Maksikat, etc. automatic peeling machines, crystal-crystal grinding technology	Automatic workpiece feeding and processing zone video control system, automated workpiece centering
Cutting	Two spindle cutting machines with cast iron cutting disc	Semi-automatic grinding devices and cutting machines with Coborn engine	Reducing disk runout and control over disk rotation speed
Quality control	Magnifier, microscope	OGI Systems, Sarin and Helium scanners with software for determining diamond proportion	Accuracy of measuring plane inclination angles with an error of up to 0.2° and error of linear dimensions up to 0.02 mm
Accounting of the raw materials movement in production	Record books filled in manually	Automated systems for managing stocks, material flows, systems for managing stocks, etc.	Improving the quality of accounting and control over raw materials movement. Automation of reporting documentation

Diamond-cutting companies have an average technological position relative to leading foreign mining companies. Possible areas of modernization and technological re-equipment are as follows:

- updating of cutting and peeling technologies;
- modernization of diamond sawing technology;
- use of systems with the ability to localize diamond crystal inclusions to take them into account when calculating the optimal position of diamonds;
- use of control systems for diameter of the workpiece and intensity of crystal during the turning process; and
- equipping cutting machines with systems exhausting air from the processing zone.

Development and creation of new types of technological support innovations as well as conducting research and development of the innovation infrastructure segment are irrational in the North due to a number of insurmountable difficulties.

#### 4. Discussion

Consequently, the introduction of process innovations is possible only by borrowing and acquiring ready innovative products (technologies, equipment, tools, etc.) from a number of companies specializing in the development of advanced diamond processing technologies. The leader is Sarine Technologies Ltd, which is a publicly traded company on the Singapore Exchange headquartered in Hod HaSharon (Israel) with an extensive network of affiliates, distributors, service centers and technology laboratories all over the world. Therefore, process innovation management is possible solely through modernization and technological re-equipment by directing investments in purchase of advanced technologies.

Promising scientific direction for the development of diamond laboratory tooling is associated with introduction of artificial intelligence for the diagnosis, evaluation and automation of industrial production (Figure 2). The elements of production digitalization are desirable in each area, including using end-to-end technology (Grigoryeva & Sentizova, 2019).

<b>Diamond movement accounting system:</b> digital footprint from the place of extraction, planning, cutting, polishing and sales (Big Data). For example, Tracr (DeBeers) and Sarine Diamond Journey software.
<b>Diamond sorting, marketing and tracing:</b> using machine vision technology for streaming determination of diamond characteristics (shape, color and quality)
<b>3D diamond measurement and modeling:</b> detection of tiniest diamond defects and facet joints accuracy
<b>Planning process:</b> viewing the inner of diamond for inspection, mapping software and monitoring IT solution
<b>Diamond laser cutting:</b> cutting method including bizarre shapes
<b>Cutting and peeling machines:</b> automatic polishing, equipping with systems exhausting air from the processing zone and robotization
<b>Energetics:</b> digital transformation substations and smart grids

Figure 2. End-to-end technology in diamond production

At the stage of entering the digital economy, the Russian diamond mining and processing business will undergo transformation in the following components: production relations, economic system structure and the need for new competencies of specialists. Also, the transformation of the personnel training system, the need for new requirements for communication, computing and information systems, and transformation of the production process are expected (Grigoryeva & Sentizova, 2019).

The complexity of implementing measures for the innovative development of diamond manufacturers in the North lies in attracting investments and other financial resources to update the material and technical basis of industrial production. The introduction of process innovations will help reducing production costs, increasing labor productivity and, therefore, achieving positive added value.

## 5. Conclusion

Transition to a new technological mode of industry provides additional opportunities for organizing and managing diamond production with less dependence on the location of production and entrance to global markets. The introduction of marketing innovations in management of diamond and jewelry sales will help expanding the scale of sales. The introduction and development of online sales mechanisms can attract consumers from all over the world.

Sales activity of regional diamond manufacturers in the North is distinguished by the problems of selling finished products of retail sales abroad; therefore, wholesaling that do not allow them to reach a competitive level is peculiar to them. The introduction of process and product innovations by industry competitors determines the need to develop mechanisms for managing innovations and their active implementation in diamond production. Distinctive aspects of the organization and management of diamond production in the North leads to the development of special individual mechanisms for managing innovations adapted to the conditions of the Extreme North, which is the main task of the further research.

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