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BLOCKCHAIN APPLICATION IN MINING MANAGEMENT

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Abstract. A new tool for achieving a sustainable business climate in mining is DLT communication and blockchain data recording. The introduction of DLT will help increase confidence among participants - mining executives, employees, regulators and suppliers. The factors that interdict the implementation of DLT are classified. Each of them has been analyzed and models for data exchange among roles have been proposed for illustration. The example is for measurement of the energy consumed and the material mined for an open pit. A scheme for the introduction of correction in case of measurement unaccuracy has been developed.

Intoduction. In order to achieve a sustainable business climate and increase economic performance, mining and processing companies are constantly introducing new safety techniques and technologies [1], are studying forces in mining machines for optimization purposes [2], are investigating the energy efficiency of electrical network [3] or error reduction models in optimization processes, and data analysis and control [4, 5]. In recent years, a new tool for sharing data between participants in a trusted process is DLT (distributed ledger technology). Distributed ledger communication provides security, resilience, chronology and the ability to overlay data without a centralized intermediary, making it a management tool across different sectors and industries.

Methodology. The purpose of the article is to show working communication schemes for the introduction of DLT in mining companies, as well as barriers to its implementation. Specific problems identical to those in the introduction of a distributed ledger in public utilities [6] – normative, infrastructural, technological, price – have been classified and analyzed.

It is naturally necessary to first define the DLT in order to analyze its applicability. This is a model for sharing data between trusted participants [7]. For the past year, regulations have been issued in the EU giving a precise definition of the term DLT – technology for replicating, synchronizing and decentralizing the shared and transmitted information in a specific network and in real time, consisting of a certain number of nodes with an exact copy of the information in each of them. The distributed ledger is made up of blocks, each containing information identical to the shared blocks. The three main qualities are: (traceability); (non-repudiation); (irreversibility) etc. They suggest that all participants in the system can change the data in the nodes, cannot deny the changes made, and the actions of the participants themselves are traceable.

There are many fields of applications for the mining industry – information on assets, inventory, money, quantities of fuel consumed, quality of electricity consumed, route control points, quantity and quality of imported and exported raw materials and products to and from the mining enterprise; the level of harmful emissions. The information flows listed are adequate according to the models of Morgen Peck and Lewis [8, 9]. Under the same models, a mine ventilation system is appropriate to operate a database.

Factors for the implementation of DLT. In order to determine the specifics of implementing DLTs for the recited information flows, analysis according to classified factors is required. Naturally, the complex influence of factors will lead to a new – subjective one.

Infrastructural factors. For communication via DLT, it is necessary to have digital measuring equipment that records the data in blockchain. For example, to track the amount of fuel consumed, vehicles must have a digital measuring device that transmits data each time the tank is charged. Digital sensors updating blockchain records can also monitor the quality of the extracted or processed product. The implementation of DLT for determining the quality of the consumed electricity after purchase and installation in the respective units of digital meters, as well as the appropriate software for communication and identification of the people certifying the entries in the block is seamless.

An example of inapplicability is the tracking of small-scale repair parts if they are not digital or have no identification numbers.

Technological factors. As expected, the inclusion of digital measuring devices for DLT implementation will cause technological problems. Firstly, the management of the mining company must determine the type of parameters monitored – quantity of fuel, quality of electricity (power factor, active and reactive energy, value of supply voltage, presence of harmonics), concentration and amount of concentrate processed, quantity extracted product, foam level in flotation and others. Secondly, it is the selection and purchase of measuring equipment, installation sites, compatible software and specialized hardware, the need for protection, and scheduling of people operating with it.

For the time being, it is technologically impossible to find a working solution to track spare parts or purchased (consumed) fuel because both types of consumables have no digital identities, i.e. there is no requirement for traceability.

Despite the administrative, technological and technical inconvenience for management a large industrial firm, DLT is improving the quality of work. An example of monitoring the quality of a processed product is discussed as evidence. At the end of the shift, the responsible person transmits, certifies and sends to the responsible and regulatory authorities the measured values with their own identification key before the authorized person of the next shift. Thus, there will be no mistrust between the transmitting and receiving shift, and in addition, employees will have to demonstrate good faith and professionalism in the performance of their duties. At the same time, for the sake of clear accountability and compliance with the requirements of the regulatory body, an inspection by a third party independent of the mining company is required.

For the sake of clarity of algorithm of data transmission, is given an example. In this example on the structure of mining plant Maritza East EAD in Bulgaria is considered, which consists of three open pits and each of them has several excavators (fig. 1). A conceptual model for tracing the following measured data is proposed – ore amount and parameters of electricity consumed. The synchronized data from the smart metering devices is verified by the members of the respective shifts and forwarded to the blockchain and then to the relevant participants by a regulatory body, enterprise management or maintenance. According to the information received, it is possible to register a fault. Then Maintenance Responsible responds, which together with the Mining Supervisor certify the device's serviceability or repairs. When the system is working properly, the Mining Supervisor periodically checks and certifies the integrity of all devices and the correct transmission and recording of data.

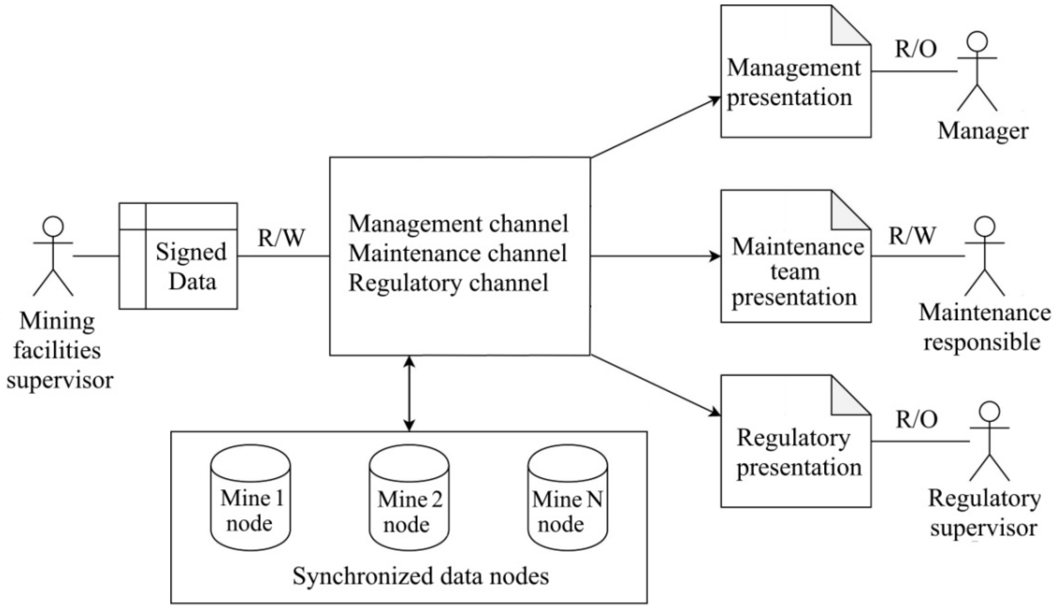

Figure 1– Model of data transmission in an open pit

If it is necessary to change the reported data due to a device failure or bad faith an employee, the correction is performed according to the model shown in Fig. 2. In case of irregularities detected by Manager 1, records are checked and wrong values of records are registered together with Supervisor 2 (for example, lower ore weight, reduced power factor). These records are adjusted to a calculated value which is 10 in the visualized case, approved by Supervisor 1. The result is a real value and all changes are logged and cannot be manipulated.

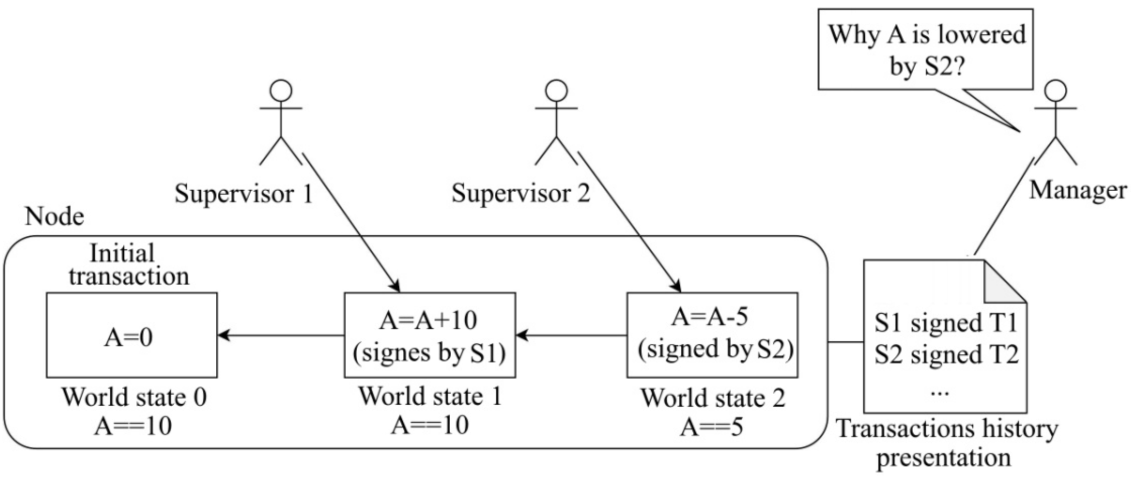

Figure 2 – Blockchain write error correction

For the proposed scheme, a consensual Practical Byzantine Fault Tolerant mechanism is appropriate because management is central, with predefined and clear participants, lacks node initiatives, is relieved of hash power requirements, and continues to work with software issues. It is suitable in the scheme described because it works with a large amount of data, albeit with a slight delay, which is not relevant in this case.

Regulatory factors. There is already a legal framework on energy efficiency. By the end of 2020, it is necessary to introduce "objective and non-discriminatory criteria" for the sale, purchase and consumption of energy, including means of transport. According to the directives, consumers need to prove and certify energy savings, and according to the current regulatory framework, electricity and fuel measurements will only be carried out with digital measuring devices in security studies [10] and IoT confidentiality [11, 12, 13]. Of course, this is feasible through digital meters and data storage via DLT.

Supporting the urgent need to introduce DLT is to achieve the goal of reducing global warming. Under the Paris Agreement and regulatory requirements for the measurement of greenhouse gas emissions, will make it mandatory for all industrial users to submit reports on "carbon capture (CO_2) from industrial installations, their transfer to a storage site and injection into a suitable underground geological formation permanent storage" [14]. Therefore, legally binding and safeguarding consumer, employee and regulatory confidence, the creation of secure and confidential use and recording of information from harmful emissions and energy information systems will be mandatory for all industrial sectors [15].

Prices. The cost of implementing DLT is high, but given the sustainability criteria and, in particular, cost savings, the investment will be quickly restored. In addition, mining companies will establish unambiguous confidential communication and accountability with their employees, suppliers and regulatory authorities in accordance with Directive 2006/32/EU and Procedure 2018/2085(INI) [16, 17].

Subjective factors. The synergistic impact of these factors precludes unilateral consideration of price, regulation or infrastructure. This is a challenge for mining executives to implement the DLT. Support for digitalization is Directive 2012/27/EU [14], which states that "energy efficiency is identified as a key element in ensuring sustainability in the use of energy resources". This, of course, is not an unequivocal and complete answer to the problem posed.

Conclusion. The presented conceptual model shows the benefits of introducing DLT for the mining sector and all retail outlets are undeniable – fairness among participants, traceability of material and energy flows, prices. Unfortunately, there are very suitable sites in mining companies, but there are too many limiting factors. The study of the regulatory framework revealed a trend for updating it, which proves that the implementation of DLT in all sectors of production is a matter of time and prestige. According to the sustainability criteria, despite the difficulties of implementing DLT, companies that have taken action will have increased competitiveness and profits, and expanded market share. Naturally the parameters and schemes for communication via the DLT for the specific sites in the mining industry will be the next topic of work. It is unambiguously clear that sharing and storing data through the blockchain will improve the quality of work, despite the difficulty of entering it. Therefore, DLT will be a necessity in the foreseeable future.

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