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IMPROVING COST MANAGEMENT IN A MINING ENTERPRISE. IDENTIFICATION OF THE DIRECTIONS OF NECESSARY CHANGES IN THE CONTEXT OF THE CURRENT STATE DIAGNOSIS

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Abstract: The purpose of this article is to identify the desired changes in cost management in Polish mining enterprises, based on the results of the diagnosis made in the period of the years 2001-2016. To achieve this goal, the first part of the article describes the previous experience of Polish mining enterprises in the field of cost management, and then formulates the main directions of improving this process, aiming at improving their efficiency.

Keywords: cost management, mining enterprise, financial restructuring.

1. Introduction

Cost management is a process focused on enhancing the efficiency of the enterprise by optimizing the level of costs in all categories, which were more broadly characterized in the previous chapter. As part of cost management, the company collects information on the types and values of individual costs, analyses them and looks for opportunities to minimize them by:

- reducing the use of individual resources,
- rationalization of their current use,
- or indicating the possibility of their more favorable acquisition.

All these activities are supposed to improve the financial result and, as a result, also the effectiveness of the company's operations.

Therefore, cost management cannot be equated only to the records, settlement and analysis of costs, which is the subject of interest and activities undertaken within the field of financial accounting, as well as in economic and financial analysis. This is because the area at the joint of operational management and management accounting, is where costs are tested not only ex post, but, above all, ex ante. In connection with the above, cost management consists of planning, records, control and motivation, based on the obtained efficiency results.

The implementation of the mentioned stages allows to determine the deviations of the planned costs from the actual and indicate the reasons for the deviations, which, in turn, is the basis for making decisions regarding the possibilities of cost optimization. Analyzing historical costs categorized for the needs of financial accounting, does not create such opportunities for an enterprise (Magda, 2002, pp. 183-192).

The key problem of Polish mining is the issue of conducting economically profitable mining activities. The assessment of the efficiency of mining operations is important in two management aspects:

- planning – to make a decision about the commissioning of a pit or a group of selective pits,
- operational – to support decisions in the course of mining operations.

Economic efficiency, which describes the relationship between inputs and effects achieved, in a mining enterprise, due to the strong determination of revenues by global coal prices, can be realistically assessed and shaped almost exclusively from the perspective of cost management (Turek et al., 2018, pp. 157-169).

Given the above circumstances, the purpose of this article is to identify the desired changes in cost management in Polish mining enterprises, based on the results of the diagnosis made in the period of the years 2001-2016. To achieve this goal, the first part of the article describes the previous experience of Polish mining enterprises in the field of cost management, and then formulates the main directions of improving this process, aiming at improving the efficiency of these enterprises.

2. Diagnosis of cost management in Polish mining enterprises

The cost management process, in accordance with the theoretical assumptions presented, must include four basic functions. The first is planning the costs incurred in the enterprise. The second is to take actions aimed at achieving the assumed objectives related to cost optimization and achieving their planned level. The third is cost control, consisting primarily of analyzing the deviations between the costs actually incurred and planned costs, as well as identifying the reasons for the differences. The fourth function of cost management is motivating, consisting in stimulating employee activity in order to accept and co-implement tasks provided for as part of cost optimization. Planning decisions about long-term effects are critical for the functioning of the mining plant (Gawlik, 2006, pp. 22-44). This category includes decisions to take up operations, as they relate to full, long-term and very cost-intensive life cycles of select regions. Each of these cycles covers processes ranging from exploration of the deposit and its geological and mining conditions, through access, cutting of decks, commissioning, operation, up to the disposal. And it is here, where the lack of effective cost

planning methods and related unpretentious incentive systems can be felt (Jonek-Kowalska, 2013).

Regarding cost management is performed by mining companies in Poland only in the field of operational management, and generally only in relation to the mine as a whole. This is partly due to the fact that the cost management model used in mining is subordinated to financial accounting and financial controlling. Hence, the basic planning mechanism is based on annual technical and economic plans, with generic cost breakdowns, and this is an interpretation for assessing the current economic and financial situation, as well as for determining, at the level of management boards of mining enterprises, annual and then monthly production and cost tasks (budgets). Moreover, these are also the indicators on which some of the mine management's premium depends. The procedure for determining these tasks involves spreading them among individual mines in such a way that the enterprise can obtain the financial result adopted in the annual technical and economic plan. In practice, this procedure has the features of a typical tender-recognition procedure. There are no perspectives in these mechanisms that should characterize management accounting tools, including those reflecting the full life cycle of pits, operating on complete technological lines, using natural, legible cost measures.

Attempts to improve cost management methods in Polish coal mines were carried out at the Central Mining Institute in the years 1965-1974. They were then continued with variable intensity in COIG. As part of this work, a pioneering way of identifying economic pasts was developed, which was to replace the previously used list of cost centers, and thus enable a thorough modernization of intra-mine settlements. The main disadvantage of the list of cost centers was that it allowed monitoring mine costs only on a macro scale. The proposed new way of identifying the past was to assign them to three integrated analytical systems, namely territorial (where?), process (what for?) and organizational (who?). The implementation attempts made at that time were partially successful. Two systems – territorial and organizational – were introduced to all coal mines. Thanks to this, conditions were created for the extension of the analytical layer, related to new cross-sections in the functioning IT systems, as well as for the introduction, although to a limited extent, of new cost accounting methods, including the Departmental Cost Accounting (ORK) or the Structural Cost Account (SRK) (Lisowski, 2001; Lisowski, 2003, pp. 3-11).

The ORK supplemented with a cost center and budgeting instrument was implemented in all mining enterprises and their mines in the second half of 2000. The solutions adopted at ORK constituted a step towards improving operational cost management. They make it possible to assess the effectiveness of the functioning of individual organizational units of the mine and, to some extent, motivate the medium and higher supervision to obtain more favorable results (Dźwigoł, 2001, pp. 15-20).

The second key system solution in the field of cost management in the hard coal mine is the Structural Cost Settlement (SRK) that was developed in 2002-2003. The idea of SRK was to record and settle costs in technological lines. Direct costs were referred to individual technological links, while indirect costs incurred in common areas were settled for individual longwalls and drivage mining faces, in accordance with the developed settlement keys, taking into account the specificity of mining production. The procedures used were to allow determining the profitability threshold of a given face. SRK did not go beyond the phase of pilot implementation in one of the coal mines. The main reason for the lack of interest in the use of the ORK system and the possibility of a wider implementation of SRK was the low practicality of these solutions, including their high labor intensity (filling in many forms manually) and relying solely on the financial accounting model, showing excessive meticulousness and interpretation problems in the management application class dedicated to production mining.

In the light of the above, the cost accounting practices functioning in Polish mining enterprises, and the solutions used in it do not go beyond the area of applications for operational cost management. None of the existing solutions includes (or includes incorrectly) the aspect of the full costs of drawing coal from a specific selective pit, i.e. the costs of preparation, maintenance and decommissioning of mining in this pit. Meanwhile, in the recent years, the hard coal mining industry in Poland has seen a systematic increase in unit production cost (Table 1). Production volume is also decreasing. Such a high growth rate of average unit production costs is a great threat to the economic and financial situation of mining enterprises and the competitiveness of Polish coal against other producers and other energy carriers (Michalak and Turek, 2009, pp. 11-15).

Table 1.
Unit production costs of coal in the years 2001-2016

Specification	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Unit cost in PLN	137.42	138.22	142.06	157.40	170.50	175.50	187.90	222.60
Change compared to the previous year	6.08%	0.58%	2.78%	10.80%	8.32%	2.93%	7.07%	18.47%
Specification	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Unit cost in PLN	262.20	261.00	286.60	304.60	302.90	309.42	302.90	268.98
Change compared to the previous year	17.79%	-0.46%	9.81%	6.28%	-0.56%	2.15%	-2.11%	-11.20%

Source: own compilation on the basis of data from the Ministry of Economy.

In addition to that, remuneration with overheads dominates in the structure of production costs. Material and energy usage, as well as external services, are also an important cost item. It should also be added, that the share of fixed costs in total costs exceeds 60% (Gawlik, 2007, pp. 471-482). The systematic increase in costs is primarily associated with the increase in unit wages not related to work effects over time. The circumstances presented above imply the need to rationalize mining production costs as the basic means of pro-efficiency measures that may

result in the improvement of the financial condition of Polish mining. The next two subsections present a proposal of actions that can be taken in this respect (Turek, and Jonek-Kowalska, 2015, pp. 475-488).

3. Cost accounting as an instrument of cost management – review of existing solutions and proposed modification in terms of the needs of the mining enterprise

The cost management process uses specific cost accounting, tailored to the needs of the enterprise (Piechota, 2005, pp. 12-15). They can be divided into two main groups. The first includes systematic accounts that are run to determine financial results and provide information for the needs of financial accounting. The second group includes problem accounts that are only used for the needs of management accounting and for supporting of decision-making processes in the enterprise (Kobiela-Pionnier, 2010, pp. 20-22). A synthetic review of separate accounts costs is provided in Tables 2 and 3.

Table 2.
Characteristics of systematic cost accounting

Account type	Characteristics
GENERIC	Organizes costs in the enterprise's records, taking into account the type of resources used in the enterprise. It is subject to accounting regulations. It distinguishes costs, such as depreciation, usage of materials and energy, salaries, taxes and fees, external services, social security and other benefits, as well as other cost types.
SUBJECTIVE	Allows to indicate the cost centers, taking into account the organizational structure and specificity of the enterprise's operations. It is also regulated by accounting regulations. It distinguishes the following groups of costs: costs of basic operations, costs of basic departments, sales costs, costs of ancillary activities, as well as general and administrative expenses.
OBJECTIVE	Enables the determination of unit costs of products, services, orders etc. In the traditional approach, this cost account separates direct costs, directly related to the production or provision of services, as well as indirect costs, related to ancillary processes and accompanying the main activity of the enterprise.
ACTUAL COSTS	Allows the determination of actual costs, determined on the basis of accounting history. It is currently used in corporate financial accounting.
NORMAL COSTS	Allows to plan costs based on cost patterns, developed based on the costs of previous periods. It can be developed with the help of statistical and econometric tools, such as: extrapolation of trends or regression function.
PROPOSED COSTS	Includes *ex ante* costs. These are costs, the level of which is assumed on the basis of planned, standard, budget or normative costs.

Source: Own study based on: (Dadacz, 2012, pp. 305-327; Kuchmacz, 2009; Czubakowska et al., 2006, pp. 112-120).

Table 3.
Characteristics of problem cost accounting

Account type	Characteristics
GENERIC	Organizes costs in the enterprise's records, taking into account the type of resources used in the enterprise. It is subject to accounting regulations. It distinguishes costs, such as depreciation, usage of materials and energy, salaries, taxes and fees, external services, social security and other benefits, as well as other cost types.
SUBJECTIVE	Allows indicating the cost centers, taking into account the organizational structure and specificity of the enterprise's operations. It is also regulated by accounting regulations. It distinguishes the following groups of costs: costs of basic operations, costs of basic departments, sales costs, costs of ancillary activities, as well as general and administrative expenses.
OBJECTIVE	Enables the determination of unit costs of products, services, orders etc. In the traditional approach, this cost account separates direct costs that are directly related to the production or provision of services, as well as indirect costs that are related to ancillary processes and which accompany the main activity of the enterprise.
ACTUAL COSTS	Allows the determination of actual costs, determined on the basis of accounting history. It is currently used in corporate financial accounting.
NORMAL COSTS	Allows planning costs based on cost patterns, developed based on the costs of previous periods. It can be refined with the help of statistical and econometric tools, such as extrapolation of trends or regression function.
PROPOSED COSTS	Includes *ex ante* costs. These are costs, the level of which is assumed on the basis of planned, standard, budget or normative costs.

Source: Own study based on: (Kaplan, 2000; Sobańska, 2006; Maciejowska, 2007, pp. 95-120; Ciechan-Kujawa, 2005, pp. 120-165; Sojak-Jóźwiak, 2004, pp. 82-97).

As already mentioned, one of the key problems of mining production is the unevenness of periodic cost burdens and their dependence on the conditions prevailing in a given selective pit. A characteristic feature of this process is also a significant burden of unit costs by indirect costs, which are associated with the need to maintain cost-intensive and extensive mining and surface infrastructure, which involves a number of ancillary and associated processes described in the first chapter of this monograph. In such conditions, cost accounting must be of a non-standard nature and refer to the life cycle of the selective pit, in which three repeatable phases can be distinguished: commissioning, operation and decommissioning. In such a defined cycle, direct mining production costs are generated and it is in the context of the cycle, thus defined, that the profitability of mining production should be assessed prior to the decision to commission a given selective pit.

Given the above circumstances, cost accounting is proposed for being put into practice in Polish mining enterprises, in the life cycle of a selective pit, developed on the basis of adaptation and modification of existing cost accounts to the specifics of mining production. To meet the presented requirements, the review and selection of the existing cost accounting management accounts described at the beginning of this chapter was used. The following criteria were taken into account when choosing solutions useful in mining production:

- adaptation to the specificity of the coal mining sector (the unique nature of each pit and the need to plan and settle indirect costs for several levels of associated processes) – specifics,
- taking into account the individualized approach to cost planning – individualization,

- taking into account the processing approach to cost planning – process,
- enabling cost planning in the medium and long term – perspective,
- creating the basis for assessing the efficiency of mining before making a decision on operations – assessment of efficiency,
- enabling assessment of the implementation of plans and linking the effects of work obtained with a motivation system – enabling motivation,
- enhancing the ability to quickly implement and adapt to existing solutions in the field of cost management in mining enterprises – adaptability.

The concept of cost accounting in the life cycle of a selective pit was primarily based on inspiration of cost accounting in the product life cycle. It was also decided to use process cost accounting, target cost accounting and continuous improvement cost accounting. The compilation of these accounts made it possible to meet all the needs of cost accounting in coal mining.

Product life cycle cost accounting is based on the assumption of there being different cost behavior in different phases of the product life cycle. Therefore, it is assumed that these costs should be grouped and recorded in accordance with the life cycle phases. This makes it possible to assess the effectiveness of the entire cycle and its individual phases in a prospective perspective. The target cost account is for long-term future costs incurred. It is designed to shape the level and structure of costs before deciding to commence production. The last of the problem cost accounts is the case of continuous improvement costs (kaizen costing), which assumes continuous improvement of all processes in the enterprise focused on cost reduction. These accounts meet the requirements of management accounting.

As part of cost accounting in the life cycle of a selective pit, three key stages are activated:

1. planning direct costs of mining works in a coal mine,
2. settling planned and incurred indirect costs for individual selective pits, preparatory drivage and technological links,
3. assessing the effectiveness of designed and active selective pits, taking into account the full mining costs throughout the life cycle.

The systematization of direct costs planning is the starting point in cost planning in the entire coal mine. Currently, direct costs are planned by the incremental method, based on historical costs incurred in previous periods. Meanwhile, mining production is discontinuous and unconventional, because starting a new excavation is always a project of an individualized character. This approach requires the application of planning based on the use of alternative resource schemes as a cost carrier used for a specific mining project. The costs under the scheme are already planned by the "from scratch" method, depending on the specific technologies and resources planned to be used. This approach takes into account the sequence of phases (drilling, reinforcements, operation, decommissioning) appropriate for mining production, and the need to use different patterns of the use of human and material resources within them.

Direct costs in coal mines are only about 30% of total costs. This implies the need to precisely calculate planned indirect costs for individual selective pits, preparatory walkways and technological links. This is a complex task, because the currently exercised cost management model and related IT systems are not adapted to full settlement of indirect costs in terms of process and in the rolling costs. Therefore, a two-step model for solving the problem is proposed in the cost accounting over the life cycle of the selective pit. The first is the simplified option of settling indirect costs, which enables the use of functioning accounting systems. The second option is more advanced, using the operation of cost accounting and modifying the existing records and the cost settlement model. Both options complement the existing gap in terms of indirect cost planning at the coal mine.

Efficiency assessment is the basis for making rational decisions in the enterprise. Due to the lack of cost planning in the life cycle of the selective pit, it is not currently carried out. The decision to commission a given selective pit is therefore made only on the basis of an analysis of geological and mining parameters, without proper economic justification. The implementation of this task, thanks to the development of a method for assessing the efficiency of planned selective pits and the creation of rules for its practical implementation will allow for making pro-effective management decisions.

The advantage of the proposed solution over those currently used is primarily due to filling the methodological gap (planning, assessment of effectiveness by applying management cost models) in the area of cost management solutions. This is particularly manifested through:

1. enabling planning, settlement and control of direct and indirect costs in the full life cycle of a selective pit in micro and macro perspectives, which is currently not applicable in the practice of coal mining, but is necessary from the point of view of rationality of management,
2. modifying accounting and IT rules and tools in order to precisely plan, settle and control indirect costs, taking into account individual links in the technological process. This is not currently used, but is necessary for conducting a full profitability account in a prospective and retrospective perspective,
3. creating the basis for cost rationalization in mining enterprises and designing a pro-effective motivation system.

The principles of using the presented concept of cost management in the life cycle of a selective pit are described in more detail in the next section.

4. Case study in the field of cost management in a mining enterprise

In order to document the problems related to planning, accounting and cost control in the mining production process, the first part of this case study presents the amount of direct costs

incurred in the life cycle of the selective pit, taking into account the individual phases of this cycle, presented synthetically in Figure 1 (Turek, and Jonek-Kowalska, 2014, pp. 103-111).

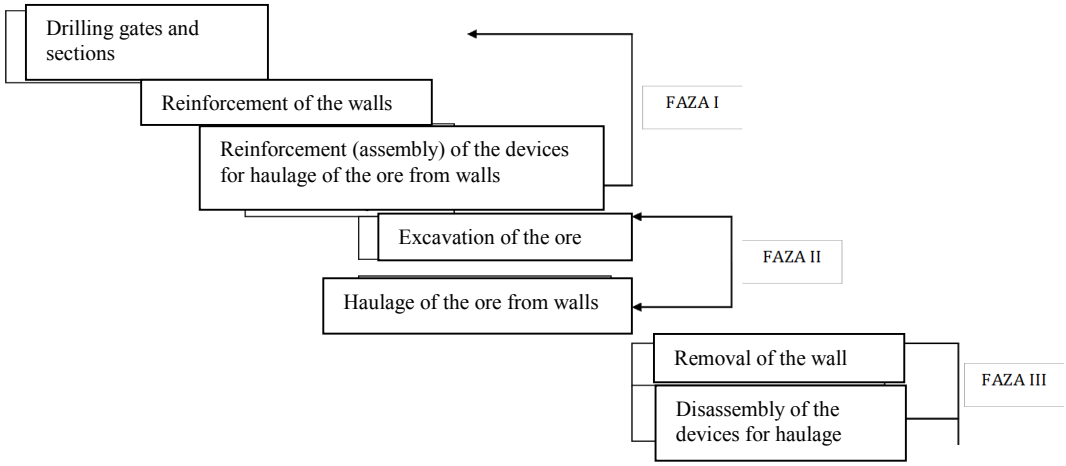

Figure 1. Life cycle of a selective pit. Source: own work.

In the analyzed case, the whole cycle lasted 32 months, in accordance with the schedule presented in Tables 3, 4 and 5.

Table 3.
Life cycle of the tested selective pit – first year

Stage in life cycle of a selective pit	YEAR 1							
	V	VI	VII	VIII	IX	X	XI	XII
Drilling of top gate								
Drilling of sections								
Drilling of drivage with ramp								
Drilling of drivage								
Reinforcement								
Reinforcement of haulage from walls								
Operation								
Operation of haulage from walls								
Removal								
Removal of haulage from walls								

Source: own work.

Table 4.
Life cycle of the tested selective pit – second year

Stage in life cycle of a selective pit	YEAR 2											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Drilling of top gate												
Drilling of sections												
Drilling of drivage with ramp												
Drilling of drivage												
Reinforcement												
Reinforcement of haulage from walls												
Operation												
Operation of haulage from walls												
Removal												
Removal of haulage from walls												

Source: own work.

Table 5.
Life cycle of the tested selective pit – third year

Stage in life cycle of a selective pit	YEAR 3											
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
Drilling of top gate												
Drilling of sections												
Drilling of drivage with ramp												
Drilling of drivage												
Reinforcement												
Reinforcement of haulage from walls												
Operation												
Operation of haulage from walls												
Removal												
Removal of haulage from walls												

Source: own work.

It should be added, that each mining excavation has a different lifetime, so one cannot standardize the duration of individual phases. The cost burden for each of the analyzed periods is also different, as illustrated in Figure 2. Most of the costs are taken up by the operating phase lasting 12 months, from July of the second year to July of the third year. In such conditions, it is very difficult to even determine the direct unit cost from a given selective pit, both ex post and ex ante. Meanwhile, in addition to direct costs, it is also necessary to assign to the individual pits indirect costs related to ancillary and associated processes, which constitute about 60%-0% of total costs incurred in a given mining plant. These costs are usually attributable to several or a dozen selective pits and should be planned and accounted for, taking into account the periodicity and different lifetime of individual pits.

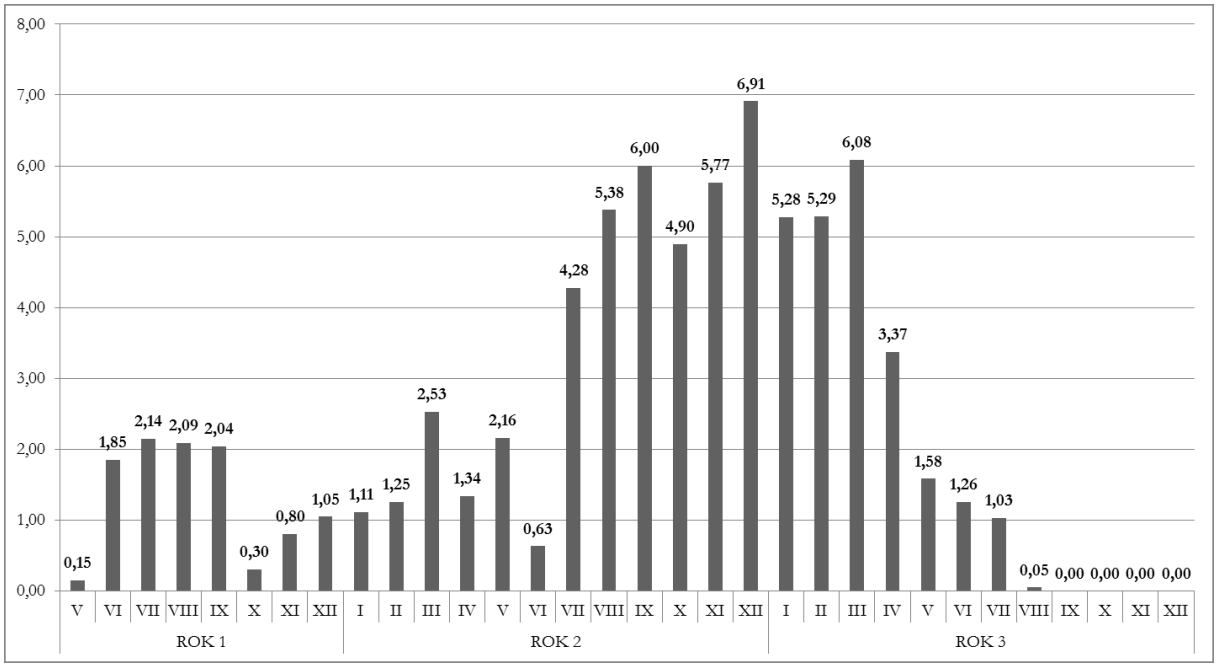

Figure 2. Costs in the life cycle of the researched selective pit. Source: own work.

The cost accounting proposal primarily uses the product life cycle concept as an inspiration to develop individual stages. It also provides for the abandoning of annual planning and development of cost management principles in a mining enterprise in the long term, taking into account the life cycles of the existing and future selective pits. The costs of individual usage of resources relate to two groups of processes:

- basic, related to the commissioning, operation and decommissioning of a selective pit,
- ancillary underground and surface areas related to ensuring the continuity of the mining plant operations as a whole.

The costs of basic processes are treated as direct costs, and their planning is always carried out in an individualized manner, taking into account the geological and mining conditions prevailing in a given pit. The costs of ancillary processes are indirect costs settled for individual selective pits, in accordance with the adopted key for accounting. The simplest solution in this area is to use the volume of mining for settlement (Turek, 2013a).

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