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A cost management model for economic sustainability and continuos improvement of mining operations

José A. Botín [a,*], Marcelo A. Vergara [b]

[a] Mining Engineering Department, Pontificia Universidad Católica de Chile, Vicuña Mackenna 4860, San Joaquin, Santiago 8940000, Chile
[b] Civil Engineer, Tercera Avenida 1260-53, San Miguel, Santiago 8920327, Chile

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ABSTRACT

The management of operating costs is essential to the efficiency and economic sustainability of mining operations and nevertheless, most cost management systems in the minerals industry are designed only and exclusively to meet financial accounting and reporting needs and lack of focus on decision taking and continuous improvement. This paper describes the result of a research program aiming to develop an innovative cost management methodology that applies Activity-Based Costing (ABC) and PDCA's Deming cycle tools to develop a cost management system for continuous improvement of operational efficiency and cost reduction. The implementation of this methodology in a mining operation would imply a breakthrough in the corporate approach to operations managements, from the conventional top-down approach to budgeting and control to a bottom-up integration of cost management and accountability. In this regard, the methodology was tested in the Andina underground mine III Panel sector of Corporation del Cobre (CODELCO), in Chile. The results of this test and its potential are also discussed.

1. Introduction

Cost management is fundamental to profitability of any industrial project. Even more essential in mining, an industry that deals with commodities, which prices are dictated by the market and are beyond the management capacity of the company.

The end of the mining "super cycle" and the advent in 2008 of the Global Financial Crisis (GFC), placed an end to a decade of production focused strategies, with operating cost growing at rates higher than production. The sector was placed on a tough ride and forced to shift focus to cash preservation and efficient cost management. Many mining companies have seen themselves into the urgent need of cost management systems capable of achieving sustainable productivity gains and consistent profitability.

Cost management is composed of three processes: estimation, budgeting and control (Moen and Norman, 2006). A number of conventional techniques, such as benchmarking (Turney, 2008) and expert criteria (Govindarajan et al., 2008) are available and have been used for cost estimation and budgeting for many years. However, most cost control systems in the minerals industry cannot be referred to as "cost management" since they are conceived to fulfill accounting and reporting needs, rather than to improve operational efficiency (Michalska and Szewieczek, 2007; International AACE, 2011). In general, conventional cost budgeting and control systems in mining are designed and implemented "top-down" and lack detail and consideration for the management decisions driving cost. Therefore, they fail as a management tool and often, lead to undesirable results (Lind, 2001).

Here is where Activity-Based Cost (ABC) models arises. ABC models are built on the concept that resources usage is not a function of the amount of final product, but rater, resources are "consumed" by the elementary tasks and processes required to produce a unit of the final product. Under this philosophy, operating costs are allocated to the elementary production activities and total operating cost is generated through bottom-up consolidation of activities, sub processes and processes. Therefore, an ABC cost model is suitable to accommodate the management structure of the operation so that managers and supervisors understand – and take responsibility for – the value drivers of the operation and the impact that day-to-day decisions have on operating costs (Michalska and Szewieczek, 2007; Turney, 2008).

While the ABC models lend to a manageable cost estimation and budgeting process, the problem is how to develop the cost model into a practical management system that will guarantee results. To achieve this objective, a powerful continuous improvement methodology, the Plan-Do-Check-Act (PDCA) cycle (Moen and Norman, 2006; Sokovic et al., 2010), was introduced. PDCA, often referred to as the Deming Cycle, contemplates four repetitive stages which, using the available information, leads to the continuous improvement of operational efficiency.

* Corresponding author.
E-mail addresses: jbotin@ing.puc.cl (J.A. Botín), msvergar@uc.cl (M.A. Vergara).

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This paper summarized the result of a research program aiming to develop and test a powerful and innovative methodology for cost management of mining operations. The methodology combines ABC cost modeling and PDCA management tools into a sustainable cost management system for continuous improvement of operational efficiency and cost reduction.

It is worth mentioning that the implementation of the proposed system would imply changes in the corporate strategy and policies. Specifically, it implies a breakthrough in the corporate approach to operations managements, from the conventional top-down approach to budgeting and control to a bottom-up integration of cost management functions and accountability. In this regard, the research program comprised the validation and testing of the methodology in a real Block Caving mining operation. This were carried out at Andina underground mine III Panel sector of Corporation del Cobre (CODELCO), in Chile.

2. ABC and PDCA cycle, a powerful tool

The philosophy of the proposed ABC cost model lies in collecting cost data down to the elementary mining activity level, two or three levels down the conventional systems. This philosophy has been widely adopted in the manufacturing industry but, perhaps due to the particular features of mining, there are very few examples of its applications in the minerals industry (Lind, 2001; Michalska and Szewieczek, 2007). In fact, its implementation may be costly, but it is far superior to traditional models (International AACE, 2011). The main advantages comes down to three: (i) It lends to a more precise, "bottom-up", cost estimation and budgeting processes; (ii) It may be designed to reflect the management structure of the operation at its lowest level of accountability so that first line managers and operators understand the value drivers of the operation and the cost impact of their day-to-day decisions and to notice the weaknesses and strengths of their parcel of operation (Turney, 2008); and (iii) It focus on efficiency at activity levels, thus allows sustainable costs reductions without affecting the quality and safety (Michalska and Szewieczek, 2007).

The PDCA cycle has been widely used in different industries – including mining – as a continuous improvement and quality control tool in matters of environment, safety and maintenance (Watzman, 2014). Fig. 1 represents the PDCA model for cost management.

The combination of ABC and PDCA's Deming cycle generates a very powerful management tool for continuous improvement of the mining operations process (Bunch, 2010; Croser, 2004). The objective is to optimize the different operational activities starting from the deviations detection that the ABC model allows. The way the model must be complemented with the PDCA cycle is shown in Fig. 1 and explained below.

The "PLAN" stage (Fig. 1) refers to the construction of annual budget through the bottom-up integration of elementary mining activities. The data is obtained from historical records and is fed into the cost model. The budget generated this way becomes a cost baseline for the year under the expected operational conditions and the results demanded by the company. Since the model can achieve the detail that deemed appropriate at its construction – in the next section this will be explained in depth – it allows to analyze thoroughly the current state of the operation not only in order of detecting problems, but also to track their possible causes.

At the "DO" stage, the actual operational results are captured and registered. If it is the first PDCA cycle in study, the real operational parameters under current operational conditions will be obtained. Otherwise this stage allows to register the real operational parameters after the changes implemented in the Act stage of the previous cycle.

The "CHECK" stage allows to detect, quantify and understand the deviations relative to the budget – in the next section this will be explained in depth. With the information provided it is possible to inquire into the deviations sources and identify a set of problems and potential solutions, evaluate its economic impact. Finally, a plan of action is decided and implemented in the "ACT" stage. Once the plan of action is implemented, a new cycle starts to detect other deviations and new enhancement opportunities, thus pointing to the continuous improvement of the entire operational process.

2.1. Model construction

The first step in the construction of the cost model consists of identifying the activities which integrate the value chain of operations and characterizing them with the desired level of detail. In the proposed model, these activities are integrated at three levels: unit activities, mining sub-processes and mining process. A unit activity is defined as the elementary unit of operation which resource consumption is directly related to one, and only one, measurable unit element of production (e.g., a rock bolt, a meter of drill hole, etc.). A mining sub-process integrates all unit activities contributing to produce one unit of mining sub-product (e.g., meter of tunnel). Finally, the mining process integrated all sub-processes which are required to produce a unit of mining process (e.g. tons mined). Therefore, the model will determine the total cost bottom-up as shown in Fig. 2:

Once the activity model has been determined, the next step is the detailed bottom-up integration of cost elements by its nature into the total operating cost. A nature of cost is defined by the fraction of the cost element which can be quantified by the consumption of a certain resource. The natures of cost included in the

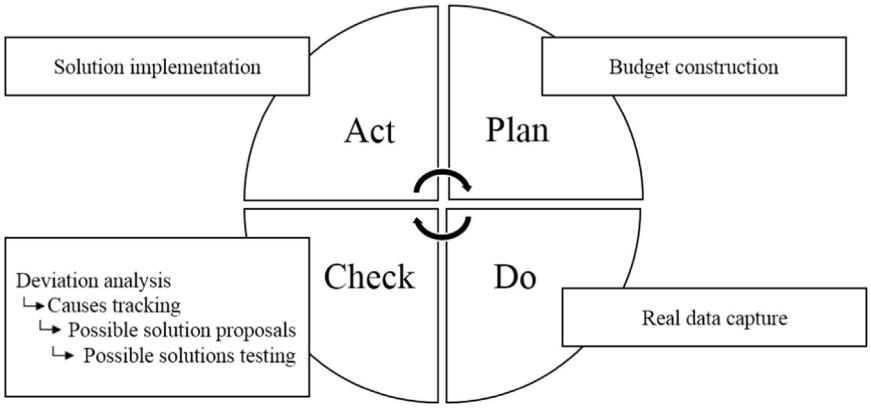

Fig. 1. PDCA cycle.