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Empirical characterisation of a mining production system

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ABSTRACT

The primary objective of any mining business unit is to make profit by extracting, processing and selling minerals from a particular mineral deposit. It is important to optimise the extraction of the mineral resource given time, space and resource constraints. The mineral extraction process is often associated with uncertainty due to variable technical and human factors. Technical factors such as grade distribution, ground conditions and equipment reliability influence the performance of the mining production system (MPS). The performance of the MPS is also impacted by human factors such as employee skills, health and attendance. Uncertainty associated with technical and human factors often leads to planned output being different to actuals obtained. Therefore an in-depth analysis of the significant causes of deviations from the planned outcomes becomes a very important exercise.

This research investigated the empirical relationships between inputs and outputs in a MPS in order assist management in directing efforts at key production drivers. A literature review revealed that production output is an end result of a chain of processes dependent and directly linked to each other, often referred to as the Mining Value Chain. The processes can be seen as milestones to be achieved within a production project. The process requires technical and human factors as resources. The literature review also highlighted that the production stage is the most obvious stage for

investors to realise their return on investment. The production stage which constitutes a MPS was chosen as a relevant research area for the reason mentioned. Once a MPS has been empirically characterised, more effort and resources can be focused on the key decision making variables (DMVs) in order to meet the planned outcomes. A production function was developed accordingly, based on the production logic and historical data.

The research concludes that for a typical platinum mine the face advance, face length mined, number of teams, and team size (independent variables) have a statistically significant relationship with the centares (m^2) (dependent variable / response variable) produced which is a key performance indicator (KPI) for a platinum mine. A statistically significant regression equation with a coefficient of determination $R^2 = 0.99835$ was obtained for the MPS. The production function can be used to align the physical, technical and human factors together to predict the optimal output level. The production function also highlights that the most significant production lever of the MPS is the face advance, contrary to a commonly held sentiment that lost blasts are the most significant.