COMPARISON BETWEEN ECONOMIC EVALUATION TOOLS ON DIMENSIONING OF EQUIPMENT FOR MINE *

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Resumo

The adequate selection of the production rate of a mining enterprise has a direct influence on the possibility of project success, as well as the definition of the size and quantity of equipment used in its operation influence the maximization of the Net Present Value (NPV). In this process, the risk analysis in the output variable allied to the sensitivity analysis provides more consistent results, since it considers the risks and uncertainties of a project over its lifetime. This study purposed to analyze the operation of an aggregate mine from the consideration of four different sets of excavator-truck using the Equivalent Annual Equivalent Value (EAUV) method, comparing it with the NPV method. The economic evaluations carried out in a previous study were reviewed, in which the NPV was obtained and the Risk and Sensitivity Analysis were performed in each of the scenarios, and the EAUV methodology was added to the analysis, which was also submitted to probabilistic analysis. The performance of each excavator and its corresponding trucks for different production rates was verified in both methodologies, allowing to conclude that for the same number of haul units and provided that the required production rate is possible, the smaller the equipment size, the more economical the scenario is. On the other hand, the higher the production rate of the enterprise, the more profitable this will be..

Palavras-chave: Mine planning; Equipment dimensioning; Risk Analysis; Equivalent Uniform Annual Value.

COMPARAÇÃO ENTRE FERRAMENTAS DE AVALIAÇÃO ECONÔMICA NO DIMENSIONAMENTO DE EQUIPAMENTOS PARA OPERAÇÃO DE MINA

Abstract

A seleção adequada da taxa de produção de um empreendimento mineiro tem influência direta na possibilidade de sucesso do projeto, assim como a definição do porte e quantidade de equipamentos empregados em sua operação influenciam a maximização do Valor Presente Líquido (VPL). Nesse processo, a análise de risco na variável de saída aliada à análise de sensibilidade fornece resultados mais consistentes, visto que considera os riscos e incertezas de um projeto ao longo de sua vida útil. Este estudo teve como objetivo analisar a operação em uma mina de agregados a partir da consideração de quatro diferentes conjuntos escavadeira-caminhões através do método do Valor Anual Uniforme Equivalente (VAUE), comparando-o com o método do VPL. Foram revistas as avaliações econômicas efetuadas em estudo anterior, no qual foi obtido o VPL e efetuadas as Análises de Risco e Sensibilidade em cada um dos cenários, e foi acrescida à análise a metodologia do VAUE, sendo esta também submetida à análise probabilística. Foi verificado o desempenho de cada escavadeira e seus correspondentes caminhões para diferentes taxas de produção em ambas as metodologias, permitindo concluir que, para um mesmo número de unidades de transporte e contanto que a taxa de produção requerida seja possível, quanto menor o porte do equipamento, mais econômico é o cenário. Por outro lado, quanto maior a taxa de produção do empreendimento, mais rentável este será.

Keywords: Planejamento de lavra; Dimensionamento de equipamentos; Análise de risco; Custo Anual Uniforme Equivalente.

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1 INTRODUCTION

The elaboration of a mining project usually involves three stages: conceptual, pre-feasibility, technical and economic feasibility. Although some of the information about mining is still speculation at the stage of project design, the studies that involve the viability of the enterprise depend on the definition of a production schedule and life expectancy. For these studies, technical, environmental and legal parameters should be considered in several scenarios. These parameters extend from the mining methods, different cut-off grades, mining and processing equipment, production rates, ore prices, recovery of the beneficiation plant, inputs, various costs, among other factors. After selecting parameter constraints, conventional economic analysis provides results for a given attractiveness rate from established production rate. Economic analysis can be carried out using several methods, for example the Net Present Value (NPV), the Equivalent Annual Uniform Value (EAUV), among other economic tools [1,2,3,4,5].

However, a conventional economic analysis assumes that the imposed constraints are known with precision and immutable throughout the development of the project, when in fact the estimates of contents, costs, sales prices, among other factors, are subject to constant variations. The risk inherent to the assumptions, therefore, plays a preponderant role in the success of the decision making, being possible to consider it properly through techniques like the sensitivity analysis and the stochastic analysis of risk. Another alternative of evaluation is the use of EAUV, which is a technique applicable to any circumstance where the NPV can be used and can be defined as the transformation of all cash flows (investments, operating costs, residual value, etc.) in uniform annual series. The technique consists in the uniformization of the unequal cash flows considering the Minimum Acceptable Rate of Return (MARR) established, when the scenario presenting the highest EAUV can be considered the most economical option for the enterprise [4,5,6,7]. In this context, this study aimed to compare the results obtained through two conventional economic evaluation methodologies (NPV and EAUV) and their respective stochastic analyzes of risk and sensitivity in order to identify the influence of the size selection of an excavator and its respective haul units in the economic viability of the operation of *Pedreira Esperança Ltda*, a quarry mine focused on production of aggregate for civil construction.

2 LITERATURE REVISION

2.1 Equipment Dimensioning

Equipment dimensioning is a process of selection and compatibility of these for the ore and/or overwhelm movement in an enterprise, considering the characteristics of the equipment, the operational conditions and the mine planning. After deciding the types and size of the loading and haul equipment to be used, the quantity and costs of these are determined so that they meet the annual production established in the project. The lack of harmonization of this relationship can lead to over or underestimation of equipment set, generating waste of capital, decreasing productivity and increasing operating and capital costs. [4,8,9].

In order to guarantee the productivity of haul equipment, it is necessary to keep them in motion, avoiding queues and idleness, thus optimizing the operation. In addition to the individual capacity of the equipment, their capacity should be checked when operating together, since this will represent the actual production. Thus, considering the maximum production capacities of each equipment individually, it would be possible to verify how many haul units would attend a given loading unit to a given production rate. The application and size of the load and haulage set are directly related to the production scale, pit geometry and local geology [4,8,9].

2.2 Net Present Value

The economic evaluation of mineral deposits is a dynamic and interactive process of identifying economic viability, which involves investments and the decision-making process. As financial resources are limited, it is necessary to prioritize attractive investment opportunities. In addition, the uncertainties and risks inherent to any enterprise oblige the institutions to have qualified instruments to make decisions and create possibilities to anticipate events. The most used economic assessment tools are Cash Flow, Minimum Acceptable Rate of Return (MARR), Net Present Value (NPV), Internal Rate of Return (IRR), Payback Time and Break-Even Point. Cash flow can be described as the set of inputs and outputs over a given period. MARR represents the minimum return expected for an investment and its selection considers the source of capital and the expected profit margin; in Brazil, a general reference for the MARR is the SELIC rate, the basic interest rate of the Brazilian economy. NPV can be understood as the sum of benefits minus costs in years $\mathbf{0}$ to $\boldsymbol{n}$, adjusted to the present with a certain discount rate, which adjusts the annual cash flow to the time value of money, according to equation 1 [10,11,12, 13,14].

$$\boldsymbol{NPV = I_o + \frac{(R_1 - C_1)}{(1+i)^1} + \cdots + \frac{(R_n - C_n)}{(1+i)^n}} \quad (1)$$

where $\boldsymbol{I_o}$ represents the initial investment, $\boldsymbol{R_n}$ the revenue in year $\boldsymbol{n}$, $\boldsymbol{R_n}$ the costs in year $\boldsymbol{n}$ and $\boldsymbol{i}$ represents the discount rate. In cases where NPV is positive, the project has a profit; when negative, the project has a loss; when null, is indifferent [12,14].

2.3 Equivalent Annual Uniform Value

The Equivalent Annual Uniform Value (EAUV) or Annualized Net Present Value (NPVa) consists of a uniform annual series that equates to the cash flows of the investments discounted to a MARR. The project that achieves the highest positive balance will be the most interesting. The acquisition cost of an equipment can be transformed into a uniform series according to equation 2; the residual value, in turn, can be described as in equation 3; the fixed operating expense of each equipment is already an uniform serie until the useful life is reached, although the increase in maintenance costs after continuous use of the equipment should be described as equation 4; finally, the company's annual revenue is also an uniform serie [15]. The sum of all these uniform series represents the EAUV of a given scenario.

$$\boldsymbol{A = P\left(\frac{A}{P}; i; n\right) = P * \frac{i(1+i)^n}{(1+i)^n - 1}} \quad (2)$$

$$\boldsymbol{A = F\left(\frac{A}{F}; i; n\right) = F * \frac{i}{(1+i)^n - 1}} \quad (3)$$

$$A = G\left(\frac{A}{G}; i; n\right) = G * \left[\frac{1}{i} - \frac{n}{i} * \frac{i}{(1+i)^n - 1}\right] \quad (4)$$

In equations 2, 3 and 4 the term **n** represents the years of operation at a given MARR and **i** represents this MARR [15].

2.4 Probabilistic economic analysis

The Monte Carlo method is a set of experimental mathematical techniques that uses random variables in their solutions, being applied in problems with stochastic (probabilistic) variables or when the resolution is beyond the resources available in theoretical (deterministic) mathematics. It should be taken into account that the Monte Carlo method has an uncertainty attached to the number of observations of the random *data* and, consequently, the representativeness of the sampling of the domain; generally, the greater the observation of random *data*, the greater the representativeness and the smaller the errors [2].

Sensitivity analysis is the process of determining the sensitivity of project results to the change of an input variable and can be used to investigate the influence of a shift in the value of one or more parameters or variables (investments, operating costs, revenues, lifetime, etc.) on the different indexes that measure the profitability of the project (NPV, EAUV, etc.). It is also possible to identify the variables that have the greatest impact on the result against different degrees of error in their estimation, helping to decide to deepen the studies in the critical variables in order to improve the estimates, reduce the risk degree by error or to seek another strategy of action. Although it contributes to understanding the effects of uncertainties, sensitivity analysis does not give a project value adjusted for perceived uncertainties [6,10,12,16].

Risk analysis based on Monte Carlo simulations is a technique by which the main variables of a mathematical model are subjected to several simulations to estimate the impact of the risk on the projected results. Successive scenarios are created using random input values in the project variables, for which probability distributions are assigned to represent the behavior of each. With the frequency diagrams resulting from the analysis, it is expected to quantify the project risk [12].

3 CHARACTERIZATION OF THE STUDY AREA, CONVENTIONAL AND PROBABILISTIC ECONOMIC EVALUATION ATTACHED TO THE SELECTION OF THE LOADING EQUIPMENT SIZE

Cavalcante et al. [4] carried out a preliminary study in the area where the granite deposit of the *Pedreira Esperança Ltda* is located, in *Vitória de Santo Antão - PE*. The authors estimated the extraction of 5,559,986.28 m³ of ore *in situ*, or 8,339,979.42 m³ blistered until the achievement of the final pit. Considering the commercialization of 12,000 m³ per month, the life of the mine was estimated at 58 years. In addition, using Metso's software BRUNO, was verified that the maximum capacity of the primary crusher, in a 44-hour weekly regime, is 49,147.96 m³/month, where inefficiency should be given by the utilized excavator-truck combination. The secondary crushing, in turn, would produce 23,513.38 m³/month considering one turn of operation or 44,845.11 m³/month considering two, whose considered efficiency was 90%. Therefore, primary crushing has the capacity to comply with secondary

crushing, and maximum production from the mine cannot exceed this maximum estimated production of 49,147.96 m³/month.
For this study was considered the immediate replacement of the excavator-truck set actually used in quarrying (one Liugong 936 excavator and three Ford Cargo trucks) by sets composed by Caterpillar 320, 323, 336 and 349 excavators and its related haul units. Table 1 presents capacity, consumption and productivity of excavators and trucks when operated together. In order to obtain these characteristics, the restrictions were considered, namely: (i) bulking factor ($\boldsymbol{f_l}$) of 1.50; (ii) coefficient of yield ($\boldsymbol{E}$) of the excavators and trucks of 0.83 and 0.70, respectively; (iii) charge factor ($\boldsymbol{F}$) of 1.1 for excavators; (iv) excavators cycle time of 30 seconds; (v) Average Haul Distance of the trucks obtained from three points at the ends of the final estimated pit.

Table 1. Information on excavators and trucks

Parameters	Cat. 320 Set 1	Cat. 323 Set 2	Cat. 336 Set 3	Cat. 349 Set 4
Bucket capacity (m³)	1.40	1.56	2.40	3.21
Fuel consumption (L/h)	21.00	21.65	40.00	53.00
$Q_{ex.ef}$ (m³/h)	101.23	112.80	173.54	232.11
$Q_{ex.máx}$ (m³/h)	121.97	135.91	209.09	279.66
tc_{min} (min)	8.40	7.96	6.61	5.98
$Q_{truck.ef}$ (m³/h)	39.62	41.81	50.32	55.63
$Q_{truck.máx}$ (m³/h)	56.60	59.73	71.89	79.48
Theoretical number of trucks	2.15	2.28	2.91	3.52

Most of the *data* used in this study came from the company's management, such as average production rate, average selling price of products, freight costs, inputs, equipment operating costs, fixed costs, among other information. The acquisition and operation costs of the different excavators studied were obtained directly from the supplier, as well as other mobile machinery and crushing equipment. This information was used in the composition of the annual cash flows until the ore exhaustion.

Taxes, contributions and compensation on the revenue in each cash flow were considered, such as Income Tax for Corporations (IRPJ), Tax on Circulation of Goods and Services (ICMS), Contribution for Social Security Financing (COFINS), Social Integration Program and the Program for the Formation of Civil Servants' Assets (PIS/PASEP), Social Contribution on Net Income (CSLL) and Financial Compensation for the Exploration of Mineral Resources (CFEM). It was also considered the incentive of the *Pernambuco* Development Program (PRODEPE), offered by the State of *Pernambuco* for mines whose ore is destined for civil construction. Tax incentives such as depreciation, amortization or depletion were not employed, since the company works at presumed profit system and this scheme does not take into account these incentives. After the end of the useful life of each equipment, it was considered the acquisition of a new ones and the sale of the previous with a residual value of 30% of the new ones. It was considered that the life of the crushing plant (crushers and sieves), mobile machinery (excavators and loaders) and trucks would be 15, 10 and 5 years respectively [4].

After the composition of the cash flows considering revenues, costs and taxes, the MARR was defined as three times the Selic rate (22.5%) and the project NPV was calculated for four scenarios, where each of the four excavators studied and their respective trucks were evaluated according to the production of 12,000 m³ blistered rock monthly. Table 2 presents the NPVs obtained in each scenario considering the four excavator-truck assemblies for this production rate, in addition to presenting the maximum production rate that each excavator can perform, which ensures that the defined production rate can be reached in all scenarios [4].

Table 2. NPVs obtained in the four scenarios with excavator-truck assemblies and the production rate of 12,000 m³ blistered monthly

Set operations	NPV (R$)	Maximum production rate (m³/month)
Set 1	4,519,838.40	19,639
Set 2	4,344,972.68	21,883
Set 3	4,371,065.34	33,667
Set 4	2,981,258.28	45,029

A probabilistic economic evaluation was carried out, including the sensitivity analysis and the risk analysis from the Risk Simulator 2017 software. 100,000 initial Monte Carlo simulations were performed, considering the parameters arbitrarily selected as most influential, according to table 3, which presents these parameters, the statistical distributions used to represent each domain and its limits. From the sensitivity analysis, the variables that effectively influenced the final result (Production Rate (m³/month) and Average Selling Value (R$/m³)) were determined, according to table 4, with a further 100,000 simulations and the results compared to those obtained through conventional economic analysis (table 5) [4].

Table 3. Statistical distributions and limits used in each simulated variable

Variable	Function	Minimum	Probable	Maximum
Production Rate (m³/month)	Pert	8,000	12,000	Variable
Average Sales Value (R$/m³)	Triangular	42.525	47.250	56.700
Fuel Cost (R$/L)	Triangular	3.375	3.750	4.500
Cost of Electric Energy (R$/kWh)	Triangular	0.828	0.920	1.104
Cost Pumped Emulsion (R$/kg)	Triangular	3.357	3.730	4.476

Table 4. Percentage of variation explained and means obtained in the sensitivity analysis.

Variable	Set 1	Set 2	Set 3	Set 4	Mean
Production Rate (m³/month)	81.96%	85.19%	92.96%	95.22%	88.83%
Average Sales Value (R$/m³)	15.39%	12.53%	5.82%	4.14%	9.47%
Fuel Cost (R$/L)	0.48%	0.37%	0.22%	0.13%	0.30%
Cost of Electric Energy (R$/kWh)	0.08%	0.07%	0.02%	0.02%	0.05%
Cost Pumped Emulsion (R$/kg)	0.05%	0.02%	0.00%	0.02%	0.02%

Table 5. NPV obtained through the conventional analysis for the four scenarios studied, followed by the probability of the NPV being greater than zero and being greater than the conventional NPV.

Scenario	NPV	Probability NPV >0	Probability NPV > NPV conventional
Set 1	R$4,519,838.40	97.23%	66.61%
Set 2	R$4,344,972.68	96.61%	70.76%
Set 3	R$4,371,065.34	92.90%	74.33%
Set 4	R$2,981,258.28	89.19%	78.72%

After the simulations, an analysis was performed on the *data* considering the four excavators studied to indicate in which production rates each of them presented better performance in the maximization of profits, thus indicating which equipment size would be more appropriate for each suggested production rate. Figure 1 shows the trend lines of the *data* sets of each simulated scenario. It is possible to conclude that the smaller the size of the excavator, if the desired production rate is compatible with the demand, the higher the NPV, since the capital and operating costs are lower. On the other hand, the higher the production rate, even though capital and operating costs are higher, the higher the economic performance of the scenario [4].

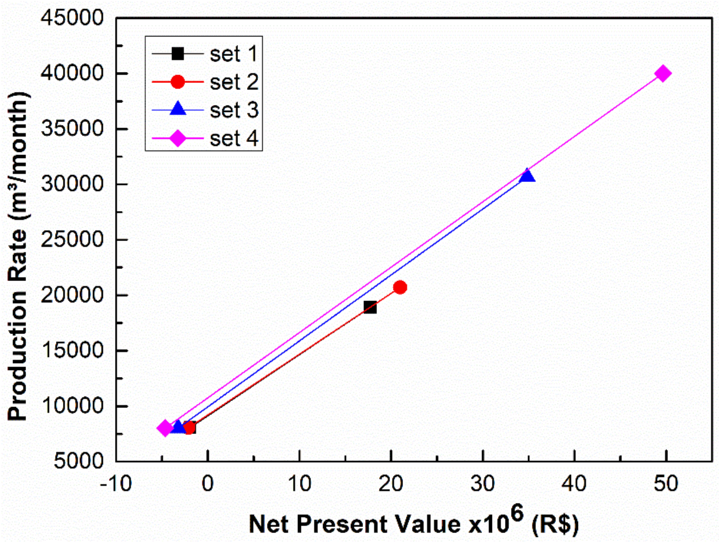

Figure 1. Comparison of the scenarios evaluating the performance of the NPV when increasing the production rate

4 MATERIALS AND METHODS

In order to perform the evaluation through the EAUV method and to compare the results with those previously obtained by the NPV method, the same *data* of the enterprise used in Cavalcante et al. [4] such as information on reserves, costs related to all unit operations and company management, maximum production rates for each equipment and overall operation, taxation on revenue, among other factors, were utilized. The assumptions considered in the deterministic economic scenario were also the same, where the production rate was 12,000 m^3/month, the average sales value was 67.00 R$/$m^3$, the fuel cost was 3.75 R$/L, the cost with electric energy equivalent to 0.92 R$/kWh and the cost with emulsion pumped was 3.73 R$/Kg.

The cost of purchasing the equipment was obtained through research with suppliers, as well as the annual costs with preventive maintenance and fuel consumption of the equipment. The residual value was considered as 30% of the acquisition value. The costs of corrective maintenance were obtained through equipment of similar sizes present in the other mines of the group. The increase in maintenance cost was considered to be 5% per year for excavators and 10% per year for trucks, so that at the end of the life of each equipment (10 and 5 years, respectively) the maintenance cost was approximately 50% of the acquisition cost.

The cash flows of each scenario were composed of revenues, costs and taxes. The EAUVs took into account part of these cash flows and the MARR of 22.5%, considering revenue, the acquisition costs of trucks and excavators, residual value, fixed maintenance costs, the increase in maintenance over the years and the costs with the team; those who were not uniform series were turn into ones according to equations 2 to 4. The sum of all these values composes the EAUV of a given scenario, the most promising being the one with the highest value, as mentioned above.

A probabilistic economic analysis of the EAUV, composed by sensitivity analysis and risk analysis, was performed using the Risk Simulator 2017 software. Initially, 100,000 Monte Carlo simulations were performed, considering arbitrarily chosen parameters as the most influential (Production Rate (m³/month), Average Sales Value (R$/m³) and Fuel Cost (R$/L)). The most influent variable was identified (Production Rate (m³/month)) and another 100,000 simulations were performed considering only the randomness in this one. Considering the four excavators-trucks sets, an analysis was performed on the *data* to indicate in which production rates each of them presented better performance in the EAUV, likewise in NPV stochastic analysis. Its also possible to compare the results of both methodologies, its behavior, results, pros and cons.

5 RESULTS AND DISCUSSION

From the restrictions imposed and the *data* obtained by suppliers and the companies of the group, the table 6 was elaborated, in which it is possible to verify the results provided by the EAUV method in each one of the proposed scenarios for the monthly production of 12,000 m³ blistered rock. The results were evaluated by inserting the annual revenue or not (columns 3 and 2 of table 6), and in both it was possible to verify that, as in the NPV methodology, provided that a set meets the demanded production, generally the smaller the size of equipment, the more economical the scenario will be. Scenarios 1 and 2 require two haul units, while scenarios 3 and 4 require only 1 to reach the requested monthly production. However, even with the reduction of the annual costs of removing one truck, the costs of operating and purchasing the larger excavators impact in such a way that their scenarios present lower results.

Table 6. EAUV obtained through the conventional analysis for the four scenarios studied, considering the annual revenue or not

Set operation	EAUV (R$) without Revenue	EAUV (R$) with Revenue
Set 1	-1,043,466.32	5,760,533.68
Set 2	-1,090,012.08	5,713,987.92
Set 3	-1,092,693.33	5,711,306.67
Set 4	-1,464,777.70	5,339,222.30

As in the conventional economic evaluation for obtaining the NPV of a given scenario, the risks and variations of the parameters in time are not taken into account, but rather than all values assigned to the parameters are constant until the end of the project. A probabilistic analysis, however, containing Monte Carlo stochastic simulations and sensitivity analysis, provides a histogram of the analysis output (EAUV) from the transformation of the proposed variables into statistical distributions and from determination of the boundaries of these domains. The production rate (m³/month), the average sales value (R$/m³) and the fuel cost (R$/L), whose distributions and limits were presented previously in table 3, were considered as variables in this analysis.

Were performed 100,000 initial Monte Carlo simulations and, prior to proceeding to the risk analysis, the sensitivity analysis was performed, which indicates through a graph of percentage of variation explained how much each variable influences the result, as can be verified in the table 7. Similar to the NPV analysis (table 4), it was verified that the production rate (m³/month) stands out from others (92.08%), which indicates that the new 100,000 Monte Carlo simulations should only consider this variable.

Table 7. Percentage of variation explained and means obtained in the sensitivity analysis.

Variable	Set 1	Set 2	Set 3	Set 4	Mean
Production Rate (m³/month)	86.82%	89.43%	95.21%	96.84%	92.08%
Average Sales Value (R$/m³)	11.60%	9.34%	4.02%	2.79%	6.94%
Fuel Cost (R$/L)	0.03%	0.01%	0.01%	0.03%	0.02%

The second battery of simulations provided the results from risk analysis, in which histograms presenting the probabilistic distribution of the EAUV values in each scenario were obtained. These histograms alone, unlike in NPV analysis, have no direct utility, since the purpose of this method is to compare the sets of excavators and trucks, and not to obtain individualized absolute results. However, *data* from each EAUV for each random production rate were extracted from simulations, so that it was possible to compare the performance of each equipment in graphs shown in figure 2.

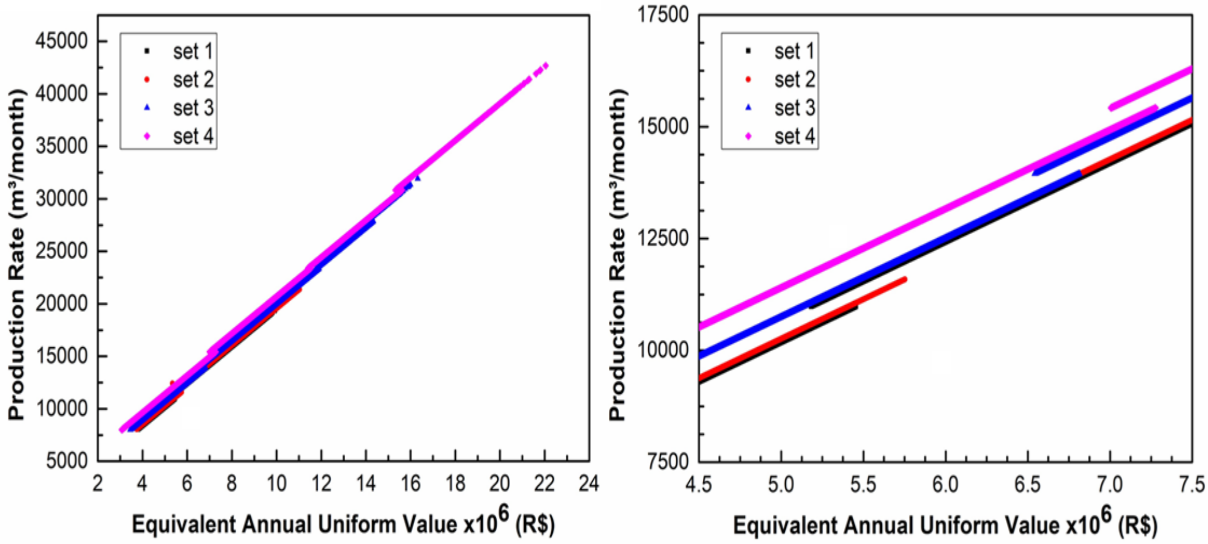

Figure 2. Comparison on different scales between the *data* sets of the four scenarios evaluating the performance of the Equivalent Annual Uniform Value as function of the increase of the production rate.

In this analysis, instead of the trend lines, all the 100,000 points obtained in the simulations of each scenario were plotted on the graph. In its largest portion, the result is similar to that obtained by the analysis performed in the NPV (figure 1), where it was possible to verify that the smaller equipment is the most indicated, as long as it meets the demanded production rate. However, when there is an increase of a unit of haulage to allow an increase in production in a given scenario, it is possible to verify a shift in the linear behavior of the results, where scenario 2 with one truck becomes more economical than scenario 1 when it demands two, for example (figure 2). The displacement of *data* from trend lines would also occur in NPV analysis if the *data* were extracted at the same way. Thus, the investor must carefully select the size of the excavator for intervals of production rates in which certain equipment does not meet the demand or when there is a need to add a truck to the operation, because operations without flexibility demand unforeseen costs when an increase of production is required.

6 CONCLUSION

In the previous study, the economic performance of each excavator-truck as a function of the production rate was evaluated, where it was verified that, generally, the smaller the excavator size, if it reaches the desired production rate, the higher the NPV. However, the higher the production rate, to the detriment of higher capital and operating costs, the greater the economic performance of the scenario.

The EAUV methodology was similar, where the scenarios that have smaller excavators were more economical, if the desired production rate was reached. Again, higher production rates produce more profitable scenarios, as the increase in revenue exceeds the increase in costs. However, this analysis did not consider the trend lines of the *data*, but rather the actual *data* extracted from each simulation in each scenario evaluated. Therefore, it is possible to perceive that there is a displacement to the left in the adherence of *data* to the trend lines due to the adding of haul units in the scenarios when there is an increase of demand for production, increasing also the capital and operational costs and reducing the revenues and general EAUVs.

The conclusion that the lower the capital and operational cost, the better the economic result of the scenario remains if they present the same number of haul units. The investor should consider a margin of safety regarding the production expected for the enterprise, since acquiring an excavator that is not able to meet any higher productive demand or that requires the acquisition of another truck if it arises would result in greater costs than the adequate selection of the equipment still in the planning phase.

Regarding the comparison between methodologies, the EAUV method requires less *data* and is useful for comparing certain scenarios, but does not provide absolute results. The NPV, in turn, demands that all *data* from the enterprise be considered, but provides absolute and comparable results. If both are carried out in a deterministic manner, without considering the risks and uncertainties of the project, they provide limited results and will hardly present adherence to reality. When considering probabilistic analyzes, the methods provide more consistent and assertive results, giving the investor greater security in the application of his capital and anticipating possible difficulties that the enterprise may suffer until its exhaustion.

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