ANALYSIS OF INCORPORATING OUTSOURCED TRANSPORT ACTIVITY BY THE FORESTRY COMPANY: AN ECONOMIC FEASIBILITY AND SENSITIVITY ANALYSIS

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Resumo

Análise da incorporação da atividade terceirizada de transporte pela empresa florestal: viabilidade econômica e análise de sensibilidade. A análise de viabilidade econômica no segmento de transporte florestal é fundamental para que as empresas possam subsidiar as tomadas de decisões. Objetivou-se com este trabalho avaliar o retorno econômico e simular um cenário de sensibilidade, com o auxílio da técnica de Monte Carlo, quando da incorporação da atividade terceirizada de transporte de madeira pela empresa florestal. O estudo foi realizado em uma empresa localizada no litoral norte da Bahia, a qual realiza o transporte com auxílio do Biminhão (caminhão + reboque). Foram analisados os custos, receitas e as incertezas envolvidas na atividade. Utilizou-se os seguintes critérios de viabilidade: VPL, VAE, TIR, CMP, RB/C e PayBack períod. Realizou-se análise de sensibilidade como forma de respaldar a segurança na tomada de decisão para análise proposta. A avaliação econômica mostrou-se positiva em todos os critérios analisados (VPL US$ 129.231,54); VAE (US$ 18.827,22); (CMP US$ 2,62/m³); B/C (1,08), TIR (75%) e PayBack period (3,55 anos). A probabilidade de gerar resultados de VPL's negativos na simulação realizada foi de 20,4%, tendo como principais variáveis influentes o valor do frete e a taxa de juros. Considerando os dados em estudo, a incorporação da atividade de transporte da madeira com o uso do Biminhão, por parte da empresa florestal, mostrou-se atrativa e não apresentou risco econômico significativo.

Palavras-Chave: Análise econômica, Biminhão, Monte Carlo.

Abstract

The analysis of economic feasibility in the forest transport segment is essential for companies to support decision-making. The objective of this work was to evaluate the economic return and to simulate a sensitivity scenario using the Monte Carlo technique when incorporating outsourced wood transport activity by the forestry company. The study was carried out in a company in the forestry segment located on the north coast of Bahia, Brazil, which uses a *Biminhão* (semi-truck with a flatbed trailer) as its base for transport. The costs, revenues and uncertainties involved in the activity were analyzed. The following viability criteria were used: NPV, EAV, IRR, APC, BCR and PayBack period. A sensitivity analysis was performed as a way to support the safety of the evaluated project. The economic evaluation was positive in all analyzed criteria (NPV US$ 129,231.54); VAE (US$18,827.22); (CMP US$ 2.62/m³); B/C (1.08), IRR (75%) and PayBack period (3.55 years). The probability of generating negative NPV results in the conducted simulation was 20.4%, with the main influencing variables being the freight value and the interest rate. Considering the data under study, incorporating wood transport activity with the use of a semi-truck with a flatbed trailer by the forestry company proved to be attractive and did not present a significant economic risk.

Keywords: Economic analysis, flatbed truck, Monte Carlo.

INTRODUCTION

Conducting an economic viability analysis is essential for rationally applying available resources in any enterprise. In the case of high-investment and long-term forestry projects, it is essential to analyze the risk factors which may influence the final result of the activity in addition to the economic evaluation.

Wood transport stands out among forestry activities given its high representation in the final cost of raw materials, representing up to 60% of the total logistical cost (ALVES *et al*., 2013). Wood transport is considered one of the costliest activities within the forestry stages (CHICHORRO *et al*., 2017; SOUZA *et al*., 2008). As the respective activity includes a large number of variables involved, the use of tools which can manage the risk linked to such variables becomes essential, especially for those with the greatest impact.

There are many variables in the forestry transport sector that can increase the risks of the enterprise, such as changes in internal policy with changes in interest rates, increase in fuel costs, increase in charges and toll values, changes in freight, distances between the plantations and the consumer center, weather conditions and maintenance costs. According to Bramucci and Seixas (2014), improving wood transport techniques becomes increasingly necessary to increase operational efficiency, productivity and reduce production costs, contributing to improve the production process and greater competitiveness of forest companies.

The assessment of economic viability in the forestry segment is essential to support decision-making by companies, especially those involved in the transport sector. Therefore, the objective of this work was to evaluate the economic return of the wood transport activity in a company in the forestry segment, as well as to carry out a sensitivity analysis using the Monte Carlo technique considering a scenario in which the company would incorporate outsourced wood transport activity (acquisition and maintenance of the fleet), having as a return the value that it would pay for the freight.

MATERIAL AND METHODS

Study characterization

The data were collected in a company that provides a forest transport service located on the north coast of Bahia, Brazil. The outsourced company uses a *Biminhão Florestal* (semi-truck + a flatbed trailer unit), responsible for transporting wood from the planting area to the processing center (coal ovens). The transport distance is 20 km and the road does not have asphalt paving, being exclusively used for transporting wood and other circulations of the company itself. The load capacity of the truck is 50 cubic meters. The total cycle has an average durability of 97 minutes, with 15 minutes in loading, 40 minutes in transport, 12 minutes in unloading and 30 minutes for the return trip (1h:37min).

The study involved a scenario of incorporating the transport fleet by the forestry company with the activity currently carried out by third parties. The costs related to the acquisition and maintenance of trucks were evaluated to prepare the cash flow. Revenue was projected based on the amount that the company would not pay for the current contract signed with third parties for transporting wood. In addition to the economic variables, uncertainties that influence the feasibility of the enterprise were also evaluated.

Costs and revenues

The operational cost for the vehicular load composition was evaluated using the FAO methodology (Food and Agriculture Organization of the United Nations), 1956, proposed by Freitas *et al*. (2004) and adapted to the reality of the study. The respective cost was classified as fixed (costs independent of the distance covered) and variable (costs which vary according to the distance covered), according to (MINETTE *et al*., 2008).

The freight paid for each cubic meter of wood transported was considered regarding revenues, according to the company's technical information, considering a distance of 20 kilometers. The quotation of the values was established in dollars, aiming to give a less temporal character to the conducted analyzes. The quotation of 02/21/2018 was adopted (R$3.26 = US$1.00).

Economic analyses

An economic analysis was carried out after determining the costs and revenues inherent to the evaluated activity using the following criteria: Net Present Value (NPV), Internal Rate of Return (IRR), Equivalent Annual Value (EAV), Benefit-Cost Ratio (BCR), Payback Time (PayBack) and Average Production Cost (APC) according to Silva *et al*. (2005) and Rezende and Oliveira (2013).

The analysis was performed considering the 10-year useful life for transport vehicles. A factor of 0.1% was added for maintenance costs, fuel consumption, greases and lubricants. However, there was a reduction of 0.1% for the insurance cost.

Risk analysis

With the economic indicators in hand, a sensitivity analysis was performed using the Monte Carlo technique. A triangular distribution was adopted, with the input variables being the number of trips made by the truck, and having the quantity of: five trips (for the maximum value); three trips (for the minimum value); and four trips (for the probable value) as parameters. The freight values of: US$2.41 (minimum value); US$3.62 (maximum value); and US$3.02 (probable value) were also used as input variables; and the interest rates of: 9% (maximum value); 6% (minimum amount); and 7.5% (probable amount) for distribution parameters. Next, 10,000 iterations were carried out using the triangular distribution as a basis, according to Cordeiro *et al*. (2010) and Silva *et al*. (2014). Furthermore, according to Souza and Frizzone (2003), triangular and uniform distributions are the most used in agricultural sciences and economics, as they are simpler and have the benefit of not needing much data for a given event. Finally, the NPV economic viability criterion was evaluated as an output variable.

Based on the respective criteria, descriptive and qualitative statistics were carried out in the order of minimum, maximum, average values, mode and standard deviations for risk management. From the data generated in the sensitivity, it was possible to classify the order of importance of the respective input variables in the financial return of the evaluated activity.

RESULTS

Cost and revenue analyses

An average of 4 (four) trips per day are carried out for each truck to meet the demand of the evaluated company, with a distance of 20 km between the cutting areas and the processing center (furnaces). The company has a goal of 1000 m³ of wood transported per day, needing 5 (five) semi-trucks with trailers to supply its daily demand. Table 1 presents the hourly costs for the evaluated transport vehicle, considering the daily demands of the company.

Table 1. Costs of the road transport (US$ h^{-1}) using the semi-trucks with trailers.
Tabela 1. Relação dos custos de transporte florestal rodoviário (US$ h^{-1}), com uso do Biminhão.

Costs	Hourly cost/vehicle	Hourly cost of the fleet (5 truck)
Fixed	12.986	64.93
Variable	47.11	235.55
Personnel	10.20	51.00
Administrative	5.69	28.45
Total	75.99	379.95

Economic analyses

A cash flow was prepared through cost estimates and annual revenue data with current and discounted values for year zero based on a 10-year planning horizon, as shown in Table 2.

Table 2. Discounted cash flow for the evaluated forest road transport activity.
Tabela 2. Fluxo de caixa descontado para a atividade de transporte florestal avaliada.

Year of occurrence	Discounted revenue	Discounted costs	Cash flow
0	$239,184.00	$248,683.41	$-9,499.41
1	$222,496.74	$222,196.01	$-9,198.68
2	$202,834.24	$198,224.19	$-4,588.63
3	$184,909.35	$176,523.79	$3,796.93
4	$168,568.53	$156,892.39	$15,473.06
5	$153,671.77	$139,145.41	$29,999.42
6	$140,091.48	$123,114.39	$46,976.51
7	$127,711.30	$108,645.51	$66,042.30
8	$116,425.19	$95,598.25	$86,869.23
9	$106,136.45	$83,844.24	$109,161.44
10	$96,756.95	$76,686.85	$129,231.54

The economic evaluation was positive in all evaluated criteria, as follows: NPV US$129,231.54; EAV US$18,827.22 per year; APC US$2.65 per cubic meter transported; BCR 1.080; IRR 75%; and a payback period of 3.55 years. The results of the analyzes therefore configured economic viability for all evaluated indicators, considering a discount rate of 7.50% p.a. The production cost was US$2.65 per cubic meter transported, considering a distance of 20 kilometers. The freight price, meaning the value earned by the outsourced company in transporting the wood, was higher than the average production cost, which conditioned the feasibility for all analyzed indicators.

Sensitivity analyses

Next, simulations of possible scenarios were carried out through the Monte Carlo method in order to contextualize the projections of economic viability or unfeasibility for the forest transport segment. It is possible to observe the statistics generated by the simulations in Table 3.

Table 3. Statistics for the NPV indicator (US$) in the risk analysis considering the evaluated forest transport activity.

Tabela 3. Estatísticas para o indicador VPL (US$) na análise de risco considerando a atividade de transporte florestal avaliada.

Description	Output variable			
	NPV	Nt	I	F
Minimum	- 224,913.20	3.20	0.06	2.41
Maximum	492,121.70	4.79	0.09	3.61
Mean	127,800.40	4.00	0.08	3.02
Standard deviation	144,254.70	0.33	0.01	0.25
Skewness	0.00	0.00	0.00	- 0.01
Mode	136,862.10	4.00	0.08	3.03
Percentages				
5%	- 113,381.50	3.45	0.06	2.60
10%	- 68,666.39	3.56	0.07	2.68
15%	- 32,215.63	3.64	0.07	2.74
20%	-2,487.92	3.71	0.07	2.79
50%	128,350.50	4.00	0.08	3.02
95%	367,111.10	4.55	0.09	3.43

In which: Nt: number of trips, I: interest, F: freight.

The illustration of the investment risk scenario can be seen in the NPV simulated probability density function for forest transport, as shown in Figure 1.

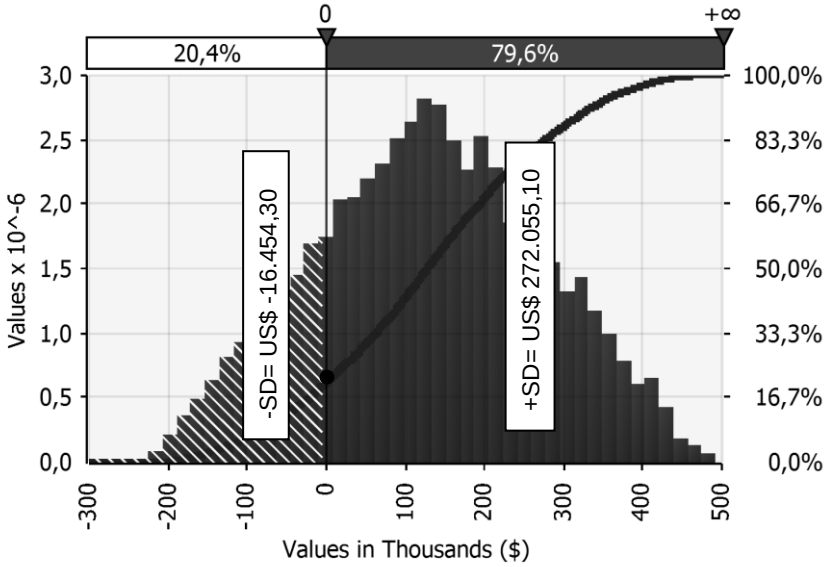

Figure 1. Probability of relative and cumulative distribution of the NPV for the scenario of incorporating the outsourced transport activity by the forestry company.

Figura 1. Probabilidade de distribuição relativa e acumulada do VPL para o cenário de incorporação da atividade terceirizada de transporte pela empresa florestal.

Regarding the elasticity analysis, according to Castro *et al*. (2007), it is understood that positive values indicate a direct relationship between the variables, with an inverse relationship occurring when the values are negative. The variables that affected the NPV in their order of importance are shown in Figure 3.

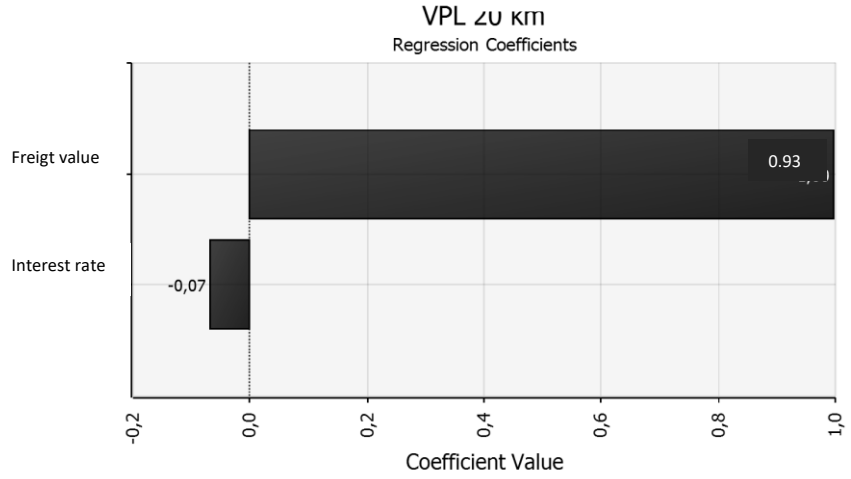

Figure 2. Influence of the input variables (freight value and interest rate) on the NPV indicator (output variable), considering the forest transport activity evaluated.

Figura 2. Influência das variáveis de entrada (valor de frete e taxa de juros) no indicador VPL (variável de saída), considerando a atividade de transporte florestal avaliada.

DISCUSSION

Cost analyses

The variable costs were more expressive in the forest transport activity, as already observed by Freitas *et al*. (2004).

Economic analyses

In the aforementioned analysis, the high initial investment to acquire transport vehicles caused the first three years to represent losses for the forestry company, with the discounted payback being evaluated at 3.55 years, meaning the time to receive the return on capital occurred from the third year after the initial investment. The financial return was evident after this period, with this trend being observed in works carried out for the economic analysis of transport, as reported by Tarichi *et al.* 2013 and Savi *et al.* 2012.

Sensitivity analyses

It is possible to observe the probability of having positive and negative values for the NPV through the accumulated frequency curve. There was considerable dispersion of data around the mean, as expressed by the standard deviation of the mean. This greater amplitude in relation to the mean (variation) conditioned the occurrence of negative values for the NPV (left side of the graph), providing a small margin of risk to the project. This can be better understood from the estimate that 20.4% of NPV values are lower than zero. According to Hacura *et al*. (2001), the project is generally quite safe when the probability of obtaining a negative Net Present Value (NPV) is less than 20%. The modal values were a little distant from the mean values, but they did not differ significantly to promote negative values for the evaluated indicator. The difference between the modal value of the indicator calculated in the deterministic analysis under risk emphasizes the importance of considering the risk factors in the evaluation, since the deterministic calculation can lead to wrong conclusions depending on the probability distributions of the risk variables (MOREIRA *et al.* 2017).

In analyzing the economic viability of charcoal production in Minas Gerais from eucalyptus plantations under risk conditions of charcoal price, forest productivity, implementation cost, charcoaling and transport costs, Castro *et al.* (2007) came to the conclusion that the system was economically viable and there was a 12% probability of obtaining non-viable values. It was possible to observe that the respective authors considered a greater number of variables, such as: implantation costs, driving, cutting, harvesting, coal price, in addition to different conditions in relation to transport distance. Such a situation may condition a safer and more comprehensive analysis regarding the risk of the enterprise.

It was possible to observe that the freight value in the elasticity scenarios was the variable which most influenced the final NPV result, meaning that in the proportion of the system on a scale of 0 to 1, the oscillation of this variable

positively influences the NPV at 0.93% (correct this percentage according to Figure 2). On the other hand, the interest rate value influences the decrease of the NPV by 0.07% in the same proportion.

CONCLUSION

The studies carried out allowed us to conclude that:

- The sensitivity analysis proved to be a strategic tool in helping to make decisions about the investment of the forestry company in the transport segment.
- The forest transport activity proved to be attractive for all scenarios evaluated considering the NPV, EAV, IRR, APC, BCR indicators.
- Incorporating the wood transport activity by the forestry company having the value that it would pay for freight as a return if the service were outsourced proved to be low risk and capable of recovering the capital invested in a short period of time.

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