INDEPENDENT JOURNAL OF MANAGEMENT & PRODUCTION (IJM&P)
http://www.ijmp.jor.br *v. 11, n. 4, July - August 2020*
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

FINANCIAL VIABILITY ANALYSIS OF A NEW LUBRICANT FOR ENGINES ASSEMBLED IN PRODUCTION LINE IN A BRAZILIAN AUTOMOBILISTIC FACILITY: CASE STUDY

Gustavo Antunes Maia
Universidade Federal Fluminense, Brazil
E-mail: gamaia.uerj@gmail.com

Nilson Brandalise
Universidade Federal Fluminense, Brazil
E-mail: nilson_01@yahoo.com.br

Submission: 7/1/2019
Revision: 9/18/2019
Accept: 10/2/2019

ABSTRACT

This study aims to analyze the economic and financial viability of an investment project aiming at building a new solution to provide oil to car's engine production line. The study arises from de need of integrate a second type of oil to fill engines produced to exportation market. The objectives are essential for the company to remain in the market facing the limited resources and the strong competition. Thus, a case of study done, with typical view to data collect and analysis. The results indicate the use of feasibility technique, as NPV, IRR, Payback, LI and NUV are decisive for a good financial analysis. Adding to these techniques, a Monte Carlo method used to simulate a variable production condition.

Keywords: Economic and financial viability; Engine; Lubricant oil; Monte Carlo Simulation

http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

1. INTRODUCTION

The evolution of the productive process, the improvement in the cost of production is usually been at the top of the main goals of large companies. According to Slack et al. (2009), and to the companies, which compete directly on price, cost will be its main objective in production. The lower the cost of producing your goods and services, the lower can be the price to the consumer. Every dollar removed from the cost of the operation added to the chain.

In the first decade of the 1970's in Japan, and the cost to the goal, began to applied to, and was intended to reduce costs, and strategically plan for the proceeds (SAKURAI, 1997). The author is to set a cost goal as being:

> "a strategic cost management process to reduce costs in the planning stages and product design. To reach this goal by focusing on the combined efforts of all the departments of a company, such as marketing, engineering, manufacturing, and accounting. In this process, the costs reduction applied in the early stages of production. The result is the encouragement of innovation."

The scenario of the last twenty years has changed a lot in relation to some emerging countries such as India and China, which until then had their products labeled as cheap due to their low quality. Between 2005 and 2010, China became the world's largest exporting country, and the second largest importer, after the USA only (FAROOKI; KAPLINSKY, 2012). While industrialized economies have the largest trade flow with China, China's trade with developing countries has increased substantially in the same way as Chinese foreign investment and financing has increased substantially, exceptionally concentrated on mining and oil (MEDEIROS, 2015).

According to Gomel and Sbragia (2011), in 2008, the annual revenue of the software industry (in US$) was 15 billion in Brazil, 107 billion in China and 52 billion in India.

From the 1990s on, the continuity of the intensification of the competition required strategic reevaluations by the automakers. Greater reductions in production costs sought in order to reduce the offer price of vehicles and shorten their technological life cycle, through the acceleration of the process of introducing innovations, aiming at obtaining leadership in differentiation and in time for market launch (lead-time) (COSTA; HENKIN, 2016).

The vast majority of companies currently work in constant search for cheaper inputs to keep their products competitive in the market. It is each day easier the consumer to compare prices of what he wants to buy, be it a person consulting search engines or in applications that compare prices of products in several stores or large companies that need to give a greater

ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

return of profit to their shareholders and seek to improve their production conditions - producing cheaper - within a series of conditions so that it is maintained the quality of the product that their customers already know and, suddenly, get even more consumers, for being able to pass on a cheaper final price.

The general objective of this article is to implement a new lube oil system for engines assembled in production lines in an automobile industry in Brazil.

According to Azevedo et al. (2005), every machine wears out over time, by operation and by the countless contaminants with which it put in contact. According to Souza, (2000) the useful life of all equipment can be increased with the use of lubricants. Due to its multiple functions and the access to various points of the machine, the oil is an extremely important agent in the reduction of wear elements and contamination of the equipment.

The specific objectives are to study the hypotheses of oil supply, through the tools of financial management, for better evaluation of the projected conditions and different from the current mode used. Do not stop production during implementation and commissioning. Do not increase the cycle time of the line also give condition so that it can be reduced in case of future need. Do the filling without changing the setup, keeping two types of oil available to any need for the assembly. Do all the preparation within the available budget to maintain the estimated gain for each engine assembled with the new oil.

For the company mentioned, all the engines produced, currently use 5W30 synthetic oil and, for financial reasons, implement 10W40 oil, which is less expensive, for engines that are export to Latin America.

For the line production adaptation, the amount of 350 thousand reais was made available for investment, since this is the maximum for which the project remains profitable, taking as reference the price of the new oil and the annual quantity of engines produced. With this resource, the company that will provide the implementation service should be hired, with all the labor plus the necessary inputs to assemble this new supply strategy.

In addition to having the investment value as a constraint, time is another constraint either. The deadline for delivery of the project is the end of 2019, according to the company's strategy for general application of the value gains built in the current year. The earlier a study becomes a reality, the faster the financial return for the company.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

2. THEORETICAL BASIS

2.1. Production line

Within the period of the first industrial revolution (1780 - 1860), there was the creation of the concept of the use of interchangeable parts. The concept of exchanging parts was originally applied to manufacturing and muskets sold to the American army, but ended up allowing the process of mass production, with workstations and uninterrupted production flow in the most diverse industries (PEINADO; GRAEML, 2007).

Already in the middle of 1870, there was the improvement of the combustion engine in Germany. Gottlieb Daimler and Wilhehm Maybach created the first European patent after many studies and research on the four-stroke engine cycle. Also, according to Peinado and Graeml (2007), a little more than a decade later, the automobile was invented in Germany. Gottlieb Daimler and KarlBenz developed in parallel and without any influence of one invention on the other. By 1875 around 2000 engines had been sold in Europe.

Following the idea of a mobile assembly line, proposed by Ford in the 1913s, the product in process moves along a route, while the operators remain stationary. This innovation in the production process has had astonishing consequences for production, maximizing the advantages of economies of scale. In Ford's logic, typical of a moment in the history of organizations in which demand was much higher than supply, the more cars were produced, the lower the unit cost.

2.2. Engine Lubricants: Types and Features

Lubricants can be categorized as liquid, gaseous, solid or semi-solid. Liquid lubricants are generally the most widely used in industry. A liquid to be considered a good quality lubricant must be able to form a fluid film of good thickness between the friction surfaces, being this film able to absorb the shocks caused by external forces, keep the solid surfaces separated and have adherent characteristics in order to always keep in close contact to be lubricated (RIBEIRO; GOMES, 2016).

The SAE (Society of Automotive Engineers) classifies oils according to their viscosity and are subdivided into three groups: summer oils, winter oils and multiviscous oils.

The summer oils work at high temperatures without breaking the lubricant film. This type of oil has its viscosity measured at high temperatures; the tests carried out on summer

http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

grade oils ensure the operability of the lubricant at high temperatures, thus guaranteeing protection in extreme regimes. Summer oils are SAE 20, 30, 40, 50 and 60.

Winter oils allow easy and fast movement of the moving parts of the engine and the oil itself at low temperatures or when starting the engine cold. Viscosity is measured at low temperatures and following the classification number has a letter "W" of winter, which translated from English means winter. Winter oils are SAE 0W, 5W, 10W, 15W, 20W, 25W.

Multiviscous oils, on the other hand, follow the SAE 5W30, 10W40, 20W40, 20W50 classification. They are able to work under both conditions - winter and summer - according to the characteristics marked on the left and right of the letter "W", which respect the conditions of fluidity when subjected to temperature variation, within the appropriate reference, as if it were a specific winter oil or summer oil.

2.3. Cash flow

Cash Flow is a financial management instrument that projects to future periods all the company's inflows and outflows of financial resources, indicating how the cash balance will be for the projected period. The Discounted Cash Flow - DCF is a method of analysis widely used by financial analysts to estimate the value of a company. The DCF determines the estimated future value of cash flows, discounting them from the appropriate cost of capital. The main representatives of the DCF are the Net Present Value (NPV) and the Internal Rate of Return (IRR) (SAITO et al., 2010).

2.4. Financial viability techniques

2.4.1. Net Present Value - NPV

The Net Present Value represents the difference between the Cash Flows brought to present value at the opportunity cost of capital and the initial investment. The NPV is obtained by subtracting the initial investment of a project (CF_0) from the present value if its cash inflows (CF_t), discounted at a rate equal to the opportunity cost of the company (k), Gitman (2004). As a decision criterion, if the $NPV > 0$ the project is economically viable.

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+k)^t} - CF_0 \quad (1)$$

2.4.2. Internal Rate of Return - IRR

http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

The IRR represents the value of the cost of capital (k), which equals the NPV to zero, thus becoming a rate that remunerates the value that is invest in the project. According to GITMAN (2004), the IRR is the value of k in the NPV equation, which makes it equal to zero. The rate will be attractive if it is greater than or equal to zero.

$$0 = \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - CF_0 \qquad (2)$$

2.4.3. Profitability index - PI

The PI measures the return on the company's activities provided to investors and owners, since it shows the available rate of income from the activity after payment of all operating costs, charges, etc., including depreciation (ARAÚJO, K.D et al., 2012). The profitability index has specificity to indicate how long the project offers of return for each invested unit.

$$PI = \frac{present\ value\ of\ net\ diminishing\ benefits}{present\ value\ of\ cash\ in\ hand} \qquad (3)$$

The criteria for accepting or rejecting an investment proposal based on the Profitability Index follow the following scheme:

- $PI > 1$: the project must be accepted ($NPV > 0$);
- $PI = 1$: indicates a $NPV = 0$; in principle, the project is considered attractive Because it remunerates the investor at its required rate of attractiveness;
- $PI < 1$: the project presents a negative NPV and should, therefore, be rejected.

2.4.4. Discounted Payback

The Discounted Payback shows the time it takes for a project's investment to be return. According to (BRUNI; FAMÁ, 2007; FREZATTI, 2008; ASSAF NETO; LIMA, 2009) the Discounted Payback is more complete than the simple Payback because it considers the value of money over time. The Payback method consists of determining the value of T in the equation below, where I is the investment, CF_t is the cash flow in period t and k is the cost of capital.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

$$I = \sum_{t=1}^{T} \frac{CF_t}{(1+k)^t} \tag{4}$$

2.4.5. Net Uniform Value - NUV

The cash flow of an investment usually results in a series of different values. By providing a discount rate, it is possible to transform such different value distributions into equal uniform values, thus forming an equivalent uniform series that will greatly assist in the analysis of economic alternatives (HIRSCHFELD, 1998).

$$NUV = \frac{NPV}{\frac{(1+i)^n - 1}{(1+i)^n * i}} \tag{5}$$

Where:

$i = discount\ rate$

$n = number\ of\ periods$

2.5. Monte Carlo Method

Monte Carlo sampling refers to a traditional technique that uses random and pseudo-random numbers to draw samples from a probability distribution. The term Monte Carlo was initially use in World War II as a code name for simulation problems associated with the development of the atomic bomb. The name comes from the famous Monte Carlo roulette in Monaco (CARDOSO; AMARAL, 2000).

This technique began to be use in the evaluation of capital investments from the studies of David Hertz, McKinsey & Co., published in an article of the Haward Business Review of 1979, in fact a republication of the original article of 1974.

The term simulation refers to any analytical method designed to imitate a real system, especially when other methods of analysis are mathematically very complex or very difficult to reproduce. Without simulation's help, a spreadsheet reveals only a simple output, or the most likely output, or an average scenario. This is the major cause of divergences between budgeted (or predicted) and actual values when certain environmental variables are not considered. Monte Carlo simulation randomly generates values for these uncertain variables hundreds or thousands of times in order to simulate a model.

http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

Although sensitivity analysis is sometimes use to estimate a model for a known probability distribution, this method calculates the effect of changing a single variable at a time. It is limited, a priori, to creating an optimistic and a pessimistic scenario. With the use of Monte Carlo simulation, all possible combinations can be consider, with the creation of thousands of scenarios, generating a probability distribution of results.

2.6. Case Study

According to Chizzotti (2006), the case study as a research modality originates in the anthropological studies of Malinowski and the Chicago School and, later, had its use expanded to the study of events, processes, organizations, groups, communities, etc. According to Gil (1995), its origin is quite remote and relates to the method introduced by C.C. Laugdell in legal education in the United States. Its diffusion, however, is link to the psychotherapeutic practice characterized by the reconstruction of the history of the individual, as well as to the work of social workers with individuals, groups and communities. Currently, it is adopt in the investigation of phenomena from the most diverse areas of knowledge, and can be seen as a clinical case, psychotherapeutic technique, didactic methodology or research modality.

3. METHODOLOGY

An engine assembly line of an automobile industry chosen as the object of study in order to verify the best conditions to have a financial gain with a reduction in the cost of the engines, making an analysis of the best hypothesis of implementation of a new oil supply system, which would be used concomitantly with the existing one.

The work categorized as a descriptive case study. According to Yin (2001), the case study is a research strategy that comprises a method that covers everything in specific approaches to data collection and analysis.

The work was carried out according to the following methodology, first the data for the construction of a cash flow were collected, according to the possible oil supply alternatives, and also, with 2 possible engine production volumes per year. One of 144 engines per week, and a second of 432 engines per week.

After the construction of the cash flow, each of the investment techniques described in the theoretical basis of the article - NPV, IRR, PI, NUV and PAYBACK - were use as the basis for the calculation to create the scenario and later analyze the results.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

Some values such as the cost of each one of the investments or the value of the gain per engine are of strategic nature and, therefore, confidential. Thus, the calculation to arrive at each of these values cannot be reveal.

Then, the Monte Carlo Method was implement, making a simulation using Microsoft Excel software, with a series of 1000 interactions. The simulation through the Monte Carlo Method is necessary because it is a tool that helps in cases of a possible random variation, treating in an adequate way the uncertainties of the project, helping on the decision-making.

This way we will have conditions to make a good evaluation inside of what was foreseen in the specific objectives of the project.

4. DATA GATHERING

This article was developed based on a company in the automotive industry, located in the South-Fluminense region. At the time of the development of this work, it produced 5 different types of vehicles and 5 different types of engines, which were marketed in Brazil and also exported to Latin America and Africa.

When this mechanical plant was built, it was decided to use only one type of oil for all engines, the 5W30, which was bought and delivered by trucks that supplied a power plant, which in turn took the oil to the final point of consumption in the line and production.

A previous study carried out within the company showed that a financial gain could be made by applying another oil, at a lower cost, without the need to change any of the mechanical properties of the engine and without any loss of quality in performance. Only this application would be executed in a partial way. Only engines manufactured for export would be filled with the new oil - 10W40.

At the time the study carried out, the opportunity arose to change the way this oil was taken to the point of consumption in the production line also the way the engine was filled. The initial condition was automatic filling at the station with the oil being sent through a pipe from the storage center.

The amount available for the entire project was R$350,000.00. This investment value is what kept the project profitable. In other words, all the new physical structure required for implementation, plus the purchase of new means of production, including all the equipment that would manage the new oil autonomously - also the labor for the execution of the third company that would provide the installation and commissioning service.

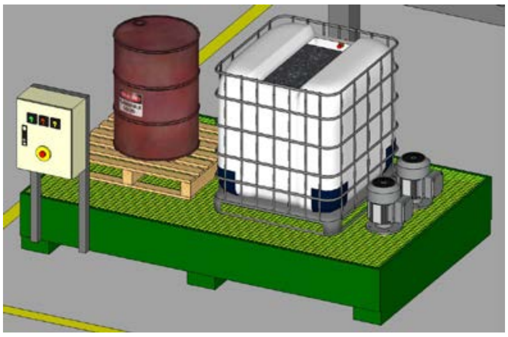
http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

From these data came some ideas that were analyzed:

1st Hypothesis: Construct a second oil reservoir in the same existing external power station, which is approximately 400m from the point of consumption, assemble a piping structure to pump this new 10W40 oil between the collection point and the point of consumption, in exactly the same way as it was already done with the 5W30 oil.

The problem situation for this hypothesis was the mobilization of a large structure to execute this project, which requires a time of approximately 42 weeks for completion and has a cost above the amount of the investment made available, approximately R$540,000.00.

2nd Hypothesis: The mechanical part of the project consists of creating an oil conservation unit, approximately 20m from the station where the oil will be supplied. This unit should contain the basic items for the filling process to occur, such as: a base that serves as a containment in case of leakage, a reservoir of 1000L capacity and 2 pumps to pressurize the oil flow lines. Picture 1 is an outline of what the conservation unit would be. For this condition, the oil would be purchase in barrels.



Picture 1: 10W40 oil conservation unit
Source: Adapted by authors (2019).

The entire automation part would also be incorporated into the system so that this supply would be automated and integrated into the same system that was already used for managing the main oil. The only part that could not be automated was the logistical part of supplying the full and empty barrels at the line edge.

The problem situation for the development of this project was to be able to make all the integration and commissioning of the 2nd supply flow of the new oil without affecting the production. No shutdown was planned during the working days, and there is also no previous schedule of work on weekends, because in any situation other than this, the chance to burden the cost of the project is very great.

http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

3rd Hypothesis: Buy a portable system (Picture 2) that can be easily used by an operator with a simple and fast training. This portable supply unit has a 1,000L IBC, a volumetric counter, a reel with automatic retraction, level sensor, lollipop-type signalize, a gun-type trigger, a pump to pressurize the oil outlet system. The provisioning of the barrels is according to the previous to the 2nd hypothesis, which need to be changed from time to time in a manual way.

The problem situation is that this system requires one more operator so that the function can be distributed with the employee who operates the previous station. That is, it needs to hire an extra employee. This adds to the annual standing cost of engine manufacturing.

Picture 2: Portable supply kit.
Source: Adapted by authors (2019).

5. DATA ANALYSIS

Based on Table 1, we can start the analysis by the first line of the NPV. According to the decision criteria, for the project to be economically viable, the NPV must be greater than zero. Thus, all alternatives with positive NPV are economically viable. Only alternative A, for production of 7,200 pieces/year was not feasible because its NPV was negative. The sequence from best to worst viable alternative would be first alternative A, then alternative C and finally alternative B, for production and 21,600 pieces/year. For the production of 7,200, the best alternative was C and then alternative B.

Following the analysis of IRR values, the sequence from best to worst was the same for both quantities of production volume. Starting with alternative C, then B and finally alternative A.

The next item analyzed was Payback, with the unit of the return on investment time in days. As, the faster the return on investment is obtained, the better the sequence of the best alternatives was from C, then from B and finally from alternative A, for both production

http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

volume situations. Alternative A for the production of 7,200 pieces/year was not viable because there was no return on investment.

Following the techniques presented in Table 1, we have the NUV, which for the project to be accepted must be greater than zero. The same alternative A that was no longer viable for the previous techniques was also not accepted in this one, because its result was less than zero. The others, in both production volumes, had as best alternative C, then alternative B and then alternative A.

As a last technique, the profitability index, in order to make the project acceptable, must be higher than 1. Alternative A (7,200 pieces/year) was the only one rejected, because it had a result lower than 1. The others were accepted, in both production volumes, with the best alternative being C, then alternative B and finally alternative A.

Table 1: Financial viability alternatives

Technique	Amount parts/year	Alternative A	Alternative B	Alternative C
NPV	21,600	R$96,451.00	R$72,273.90	R$85,675.68
	7,200	-R$18,563.68	R$7,495.28	R$28,641.34
IRR	21,600	17.85%	22.54%	146.86%
	7,200	10.62%	11.48%	40.75%
PayBack	21,600	4.06	2.43	0.45
	7,200	Projeto inviável	10.59	1.39
NUV	21,600	R$26,096.78	R$29,575.42	R$95,100.00
	7,200	-R$2,042.01	R$1,207.64	R$16,724.64
PI	21,600	1.18	1.21	2.22
	7,200	0.97	1.02	1.41

Source: Adapted by authors (2019).

Tables 2 and 3 show the values of the statistical measures for a theoretical production of 21,600 and 7,200 parts/year, respectively. Theoretical because after the simulation was finalized, the estimated volume of parts to be produced varied for each alternative. This Monte Carlo simulation was performed with 1,000 NPV interactions, with the possibility of varying the number of engines. The company carried out shows that, depending on the demand, a work shift can produce 144 to 432 units per week, dedicated to exports.

Table 2: NVP's statistical measures

NPV's statistical measures for production of 21,600 parts/year			
	Alternative A	**Alternative B**	**Alternative C**
Minimal	-$329,316	-$209,242	$28,641
Maximum	$94,973	$71,296	$225,239
Expected value	-$118,885	-$70,029	$124,950
Median	-$120,868	-$71,417	$125,913
Standard Deviation	$125,030	$83,146	$55,972
V. Coef.	-1.05	-1.19	0.45

http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

Source: Adapted by authors (2019).

Table 3: NVP's statistical measures

NPV's statistical measures for production of 7,200 parts/year			
	Alternative A	**Alternative B**	**Alternative C**
Minimal	-$18,564	$7,495	$28,641
Maximum	$1,025,073	$720,003	$225,239
Expected value	$505,316	$365,157	$124,950
Median	$505,073	$364,991	$125,913
Standard Deviation	$298,133	$203,540	$55,972
V. Coef.	0.59	0.56	0.45

Source: Adapted by authors (2019).

In addition to the statistical measures as a result, the simulation generated another important information for analysis, which was the probability of NPV being greater than zero, presented in tables 4 and 5.

Table 4: NVP statistical probability, 21,600 parts/year production

21,600 parts/year production probability			
	Alternative A	**Alternative B**	**Alternative C**
P(VPL) > 0	17.10%	20.10%	86.20%

Source: Adapted by authors (2019)

Table 3: NVP statistical probability, 7,200 parts/year production

7,200 parts/year production probalitily			
	Alternative A	**Alternative B**	**Alternative C**
P(VPL) > 0	95.20%	96.20%	98.70%

Source: Adapted by authors (2019)

In both situations presented above, the result indicated alternative C as the best choice for the investment.

6. CONCLUSION

This article presented a methodology that integrates traditional methods of project evaluation, such as NPV, IRR, Payback, PI and NUV, combined with the Monte Carlo method as a simulation tool for investment feasibility analysis in a large multinational company. The first step was to use the situations of certainty, with the application of traditional methods, while the second step verified which would be the best condition of production for each of the alternatives, indicating an optimal situation of production volume per year.

Applying the proposed methodology in the analysis of investments for the implementation of the lube oil supply project, it was possible to obtain simple information for strategic decision making with greater precision and reliability, seeking to make the necessary inferences for analysis of the project's reliability. In addition, the Monte Carlo method was able

http://www.ijmp.jor.br v. 11, n. 4, July - August 2020
ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

to reduce uncertainty, without significant addition of time and cost, being necessary only for statistical knowledge to apply the methodology and read the data.

As already stated in the first paragraph of this article, maintaining a product with competitive prices in the market is essential for a company to be well in the market. Any variation in price, quality or even in the way the company conducts its business can generate a loss of part of the market share or generate a wave of customers who no longer identify with the product they used to buy. Loyalty is lost.

But, in the case of this project, it was worked to improve the cost of a "piece" as part of a great challenge established in the company, so that there would be more expressive gains in the overall profit of the factory in Brazil.

As recommendations for future work, it would be a good option to work with some more methods of feasibility analysis, also evaluating the risks in each type of viable technical hypothesis for execution. Thus, in addition to the economic feasibility, it may be added points of quality, term and risks of use, thus making the study more robust.

REFERENCES

ARAÚJO, K. D.; VILELA, M. C.; MACHADO, L. S.; MACHADO, M. R. R. (2012) Análise da viabilidade econômico financeira de projeto de piscicultura em tanques escavados. **Anais**.. Congresso USP de Iniciação Científica em Contabilidade. v. 9, p. 1-17.

ASSAF NETO, A.; LIMA, F. G. (2009) **Curso de administração financeira**. São Paulo: Atlas.

AZEVEDO, J. B.; CARVALHO, L. H.; FONSECA, V. M. (2005) Efeito da degradação do motor automotivo nas propriedades termogravimétricas de óleos lubrificantes minerais e sintéticos. In **Anais** do 3o Congresso Brasileiro de P&D em Petróleo e Gás, Salvador.

BRITO, P. (2006) **Análise e viabilidade de projetos de investimentos**. São Paulo: Atlas. 100p.

BRUNI, A. L.; FAMÁ, R. (2007) **As decisões de investimentos**. 2. ed. São Paulo: Atlas.

CHIZZOTTI, A. (2006) **Pesquisa qualitativa em ciências humanas e sociais.** Petrópolis: Vozes, v. 135.

COSTA, R. M.; HENKIN, H. (2016) Estratégias competitivas e desempenho da indústria automobilísticano Brasil. **Economia e Sociedade**, v. 25, n. 57, p. 457-487. http://doi.org/10.1590/1982-3533.2016v25n2art7

FAROOKI, M.; KAPLINSKY, R. (2012) **The Impact of China on Global Commodity Prices**. New York, Routledge.

FREZATTI, F. (2008) **Gestão da viabilidade econômico-financeira dos projetos de investimento.** São Paulo: Atlas.

GIL, A. C. (1995) **Como elaborar projetos e pesquisa**. 3a ed. São Paulo: Atlas.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v11i4.1090

GITMAN, L. J. (2004) **Princípios de administração financeira**, 10 ed. Tradução técnica Antônio Zoratto Sanvicente. São Paulo: Addison Wesley.

GOMEL, M. M.; SBRAGIA, R. (2011) A competitividade da indústria brasileira de software e a influência da capacitação tecnológica no desempenho exportador. **Revista de Administração e Inovação**, v. 8, n. 1.

HIRSCHFELD, H. (1998) **Engenharia econômica e análise de custos: aplicações práticas para economistas, engenheiros, analistas de investimentos e administradores.** 6 ed. São Paulo: ed.: Atlas.

LIMA, J. D. (2010) **Proposição de um sistema de planejamento da produção olerícola nas unidades de produção familiar**. Tese (Doutorado). Programa de Pós-Graduação em Engenharia de Produção. Universidade Federal do Rio Grande.

PEINADO J.; GRAEML A. R. (2007) **Administração da Produção** (Operações industriais e de serviços).

RIBEIRO, J. B.; GOMES, M. C. (2016) **Manutenção Preditiva em Motores de Combustão Interna Por Análise do Óleo Lubrificante**. Monografia (Tecnologia em Manutenção Industrial). Instituto Federal de Educação, Ciência e Tecnologia Fluminense.

SAKURAI, M. (1997) **Gerenciamento Integrado de Custos**. São Paulo: Atlas.

SAITO, M. B.; JÚNIOR, J. L. T.; OLIVEIRA, M. R. G. (2010) A teoria das opções reais: uma aplicação a projetos de investimento em inovação tecnológica considerando-se o valor da flexibilidade gerencial. **Anais**... VII Simpósio de Excelência em Gestão e Tecnologia. Pernambuco.

SLACK, N.; JOHNSTON, R.; CHAMBERS, S. (2009) **Atlas Administração da Produção**. 3ª Ed.

SOUZA, M. S. M. (2000) Métodos analíticos para lubrificantes e isolantes. **Química e Derivados**, n 382, p. 20-28.

YIN, R. K. (2001) **Estudo de caso: planejamento e métodos**. 2 Ed. Porto Alegre. Editora: Bookmam.