Economic analysis of a cosmetic initiative addressing stochastic aspects and risk quantification

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ABSTRACT. This paper evaluates the economic feasibility of a small/medium-scale cosmetic initiative in a typical Brazilian city. The Brazilian cosmetic sector is very promising for investors, particularly when e-commerce platforms are designed, as virtual sales are the new trend in the sector. Therefore, the required costs to implement an e-commerce platform are considered to guarantee demand for the factory's productive capacity. While deterministic analysis might provide initial overviews of economic feasibility, there are inherent risks associated with manufacturing. These risks are likely to influence considerably the outcome of economic evaluation, hence, stochastic analysis is performed based on the software Oracle Crystal Ball®. The proposed approach guarantees an accurate and detailed evaluation, as well as solid conclusions regarding the economic feasibility of cosmetic initiatives in Brazil. Results show that such initiatives are highly profitable.

Keywords: lipstick initiative; e-commerce; economic evaluation; stochastic analysis.

Introduction

Motivation and incitement

The cosmetic sector has been one of the fastest-growing sectors in Brazil (Serverdoin, 2009). The growth rate of cosmetic companies reached 3.89 times Brazil's GDP (gross domestic product) rate, and the country presents the fourth largest beauty and personal care market in the world (Weber, 2020). Figure 1 illustrates the sales growth of the Brazilian cosmetic market from 2006 to 2019.

In general, the production processes of cosmetics commercialized on a large-scale (e.g., lipsticks, powders, mascaras) are quite simple. Only a few machines are required for substantial production capacity. In fact, it is possible to manufacture homemade cosmetics without purchasing any industrial machines. Hence, for low/medium-scale factories, the initial investment is relatively low.
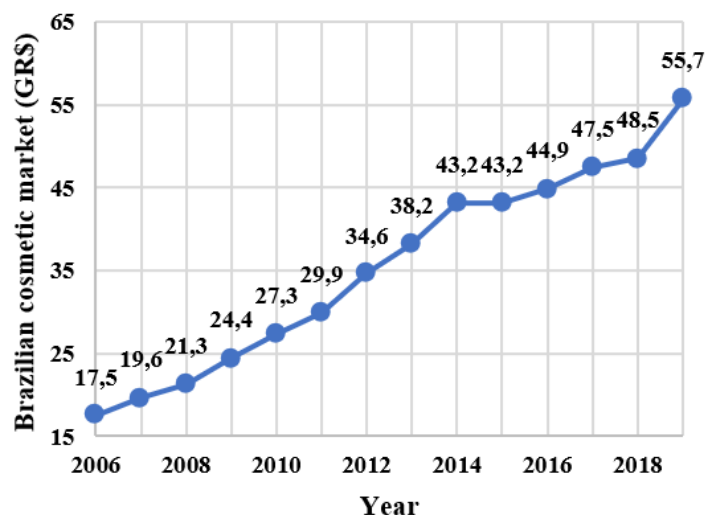

Figure 1. Sales growth of Brazilian cosmetic market. Source: adapted from (Statista, 2020).

The Covid-19 pandemic led to social isolation measures, severely harming the global economy in 2020. The Brazilian cosmetic sector was considerably affected, registering a 10-15% demand reduction (Talk Science, 2020). It should be emphasized, however, that vaccination of society is already advanced in Brazil; thus, the severe recession period is ceasing. According to (Universa, 2020), the Covid-19 pandemic transformed consumption habits permanently, as e-commerce gained space and now represents a considerable part of the market share. To put things into perspective, even before the pandemic transformed consumption habits (2017-2018), Brazilian e-commerce of cosmetics increased by 112% in one year (E-commerce Brazil, 2020). Currently, cosmetics represent 8.2% of the Brazilian e-commerce market share (Neotrust, 2020). In conclusion, cosmetic production is expected to continue to be a strong business in Brazil if combined with an e-commerce environment/platform.

Stochastic analysis and risk assessment are essential for assessing the feasibility of new investments, particularly due to the global pandemic scenario, which led to the transformation of consumption habits. Considerable exchange fluctuations (a massive variation of 1.07 (R\$ US\$$^{-1}$) or 18% occurred in a period of 26 days, i.e., between 05/12/2020 and 06/08/2020 (Trading View, 2020), as well as variations in raw materials price. Risk and uncertainties are involved in many steps of the production process, and they must be addressed in order to accurately calculate the economic indexes of the investment [e.g., net present value (NPV) and internal rate of return (IRR)].

The purpose of this study is thoroughly assessing the economic feasibility of cosmetic initiatives in Brazil, including risk quantification and e-commerce evaluation. Such analysis is of the utmost importance due to the high growth rate of the cosmetic sector. Hence, economic studies are expected to support/justify potential new investments in this field.

Literature review

In the global context, some studies that address the economics of the cosmetic sector were found. Ref. (Cosmetics Europe, 2019) presents in-depth research on the socioeconomic implications of the European cosmetic industry. Although the authors do not directly conduct an economic feasibility analysis, valuable information on the value chain of the sector is published, particularly regarding job creation, i.e., over two million jobs across Europe (directly or indirectly). Further research focuses on the economics of the organic cosmetic industry, which is a highly promising niche market due to the increasing concern regarding the environment. The potential demand for cosmetic face care products has also been thoroughly assessed, focusing on the determinant factors that lead to the economic transaction. The overall conclusion is that price and income are the main factors in the decision process. Ref. (Weber & Villebonne, 2002) focuses on the differences in purchasing behavior regarding the cosmetic sector in France and the USA, concluding that such differences are substantial due to cultural disparities. As verified, the literature review showed that in the global context most cosmetic studies focus on market trends and human behavior, and little emphasis is given to economic feasibility analysis.

In the Brazilian context, only undergraduate theses were found on the topic of economic analysis of cosmetic initiatives. As an example, one can mention an analysis of a small-scale industry of cosmetics in Florianópolis, State of Santa Catarina. The overall conclusion is that the project is economically feasible. However, stochastic aspects, risk quantification, and an e-commerce environment were not addressed. Moreover, a project of a lipstick industry in Curitiba, State of Paraná, was also found, but little emphasis was given to the economic aspect of the project. Additionally, a diagnosis of the Brazilian cosmetic market has been carried out in the literature, i.e., market research to better understand consumers' behavior. An interesting and promising conclusion is that 94.2% of the women interviewed buy cosmetics from retailers, which highlights the large potential of the sector.

Some studies that highlight the importance of introducing risk in economic feasibility analyses have been found (none of them in the context of the cosmetic sector). Ref. Lobos, Mora, Saens, Muñoz, & Schnettler, 2015) performed a stochastic economic feasibility analysis of blueberry production in Chile. The main outcome is that the deterministic approach does not adequately represent the implicit risk associated with different but correlated variables, i.e., the stochastic approach is fundamental for greater accuracy. In (Richardson et al., 2006), the risks associated with ethanol production in Texas are quantified, and the authors emphasize the usefulness of the Monte Carlo simulation approach. Ref. (del Giudice, Passeri, Torrieri, & Paola, 2014) also highlights the value of the Monte Carlo simulation approach when assessing the feasibility of constructing new roads. Costa et al. also apply Monte Carlo simulations in the context of electricity markets

in (Costa, Pereira, Andrade, & Bonatto, 2022; Costa & Bonatto, 2022). In (Wei et al., 2014), the risks associated with seismic activity/earthquakes were taken into account to assess the economic feasibility of strengthening buildings. (Benalcazar & Komorowska, 2022) carried out a techno-economic analysis for green hydrogen using a Monte Carlo approach. (Colantoni et al., 2021) assessed biomass gasification CHP systems of different sizes with a similar approach. (Gu et al., 2018) evaluated a solar photovoltaic/thermal concentrator for building application in Sweden. PV power plants and Monte Carlo simulation were further exploited in (Shahidirad, Niroomand, & Hooshmand, 2018). Therefore, it is fair to affirm that risk assessment is of the utmost importance and is covered in multiple areas (e.g., agribusiness and civil engineering). It is evident that the cosmetic sector also presents multiple risks (as further highlighted), and a stochastic analysis is essential for accurately assessing the economic feasibility of new projects.

Due to the popularization of e-commerce, studies on the topic have become more common, mainly associated with market research or case studies. Ref. (Andrade & Silva, 2017) assessed the experience of e-commerce consumers, concluding that lack of security is the main concern when purchasing online. Alternative research also inferred that e-commerce is highly promising to increase the number of sales. In (Capelli et al., 2015), a case study regarding the Renner® stores is analyzed. The conclusion of (Capelli et al., 2015) is similar, i.e., e-commerce is highly promising. However, no study quantifying the risks associated with e-commerce has been found.

In conclusion, there is an undeniable lack of economic studies in the field of cosmetic initiatives, mainly studies that address risk quantification and an e-commerce environment. Given the economic potential of the sector highlighted in Figure 1, more research/work is required to enable new investments.

Contributions

This paper performs an economic analysis of a cosmetic initiative, focusing on a small/medium-scale factory. More specifically, a lipstick initiative is assessed in the city of Itajubá, State of Minas Gerais (Brazil). These considerations are because, among the several existing cosmetic products, lipsticks stand out as the best sellers (Globe News Wire, 2019), ensuring high demand. Moreover, the city of Itajubá is assumed as the connection site since it is a typical Brazilian city, guaranteeing high generalization/applicability for the study. In order to carry out a complete and accurate analysis while following the trends of the cosmetic sector, risk assessment and e-commerce means are considered. It is assumed that a portion of the sales is performed physically, i.e., distributing products to local stores, while the other portion is performed virtually through an e-commerce environment. Although the city of Itajubá is analyzed, a similar methodology can be applied to any location (while some numbers are likely to change, the structure of the analysis remains the same). The study is expected to be promising and provide an original overview of the feasibility of cosmetic initiatives, as the literature review showed that there is a lack of economic studies in this field.

Material and methods

This section is dedicated to exposing the required information to perform a stochastic economic analysis.

The approach used to quantify risks (often used by experts in the field) is as follows:

1. If a large historical series is available, Oracle Crystal Ball® is used to assign the most accurate probability distribution (the software automatically calculates it);

2. If a historical series is available, but it is not large enough for the software to assign the most accurate probability distribution (Oracle Crystal Ball® requires 15 or more values), a normal probability distribution is assumed by calculating the average and standard deviation;

3. If no historical series is available, but we know the minimum and maximum expected values, a triangular probability distribution is adjusted;

4. If only the expected value is available, the quantity is addressed as deterministic.

This approach guarantees that the maximum amount of data available is being used in the analysis. The exception to this approach is the yes-no probability distribution.

Before presenting the methodology and its concepts, it is essential to emphasize that unless mentioned otherwise, financial units are represented in R\$$_{2020}$ and US\$$_{2020}$. Moreover, the compound annual growth rates (CAGR), i.e., the annual growth estimations of the variables, are always specified as the rates above inflation. According to Statista (2022), the expected inflation in Brazil is 5.74% (data from 2009 to 2019).

Risks associated with the following topics are considered in this paper: initial investment; e-commerce (layout implementation, fraud protection, gateway, and monthly fee); production process reliability (maintenance, power outages, and human errors); employment costs; rental costs; electricity costs; lipstick price; fuel costs; raw materials costs; packaging costs.

By considering multiple types of risks, the economic analysis is expected to be complete and accurate.

Production process and initial investment

Figure 2 exhibits the proposed production process based on information from (Trevizan, 2017). Some steps that use machinery in large-scale factories have been rethought to be performed manually, as this paper focuses on a small/medium-scale factory.
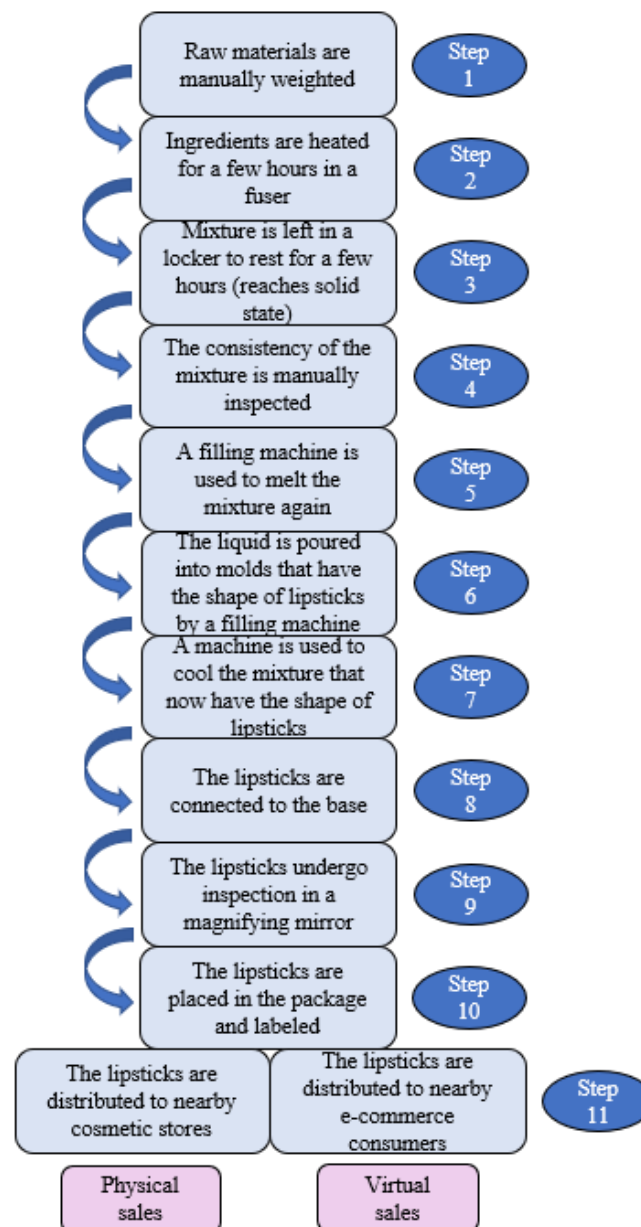

Figure 2. Production process. Source: adapted from (Trevizan, 2017).

Throughout the paper, several tables with valuable information are provided. They are important to indicate the assumed references/data so that the study's results can be replicated (data represented in the tables are used to adjust the probability distributions). Moreover, they demonstrate that the applied methodology is accurate. In turn, the figures are essential to display the results intuitively, except for Figs. 1 and 2, which are used for better contextualization.

Table 1 describes the machinery. The linear depreciation rate is used to reduce taxes in Brazil.

Table 1. Required machinery/equipment. Sources indicated in the table.

Machine/equipment	Step of the production process	Expected cost (R$)[b]	Linear depreciation rate (%)[c]	Assigned maintenance (days year⁻¹)
Precision scale	1	1117.81 (Americanas, 2020a)	10	0.5
Fuser [a]	2	9250.00 (*Mercado Livre*, 2020a)	10	1.0
Plastic containers	3	473.08 (Americanas, 2020c)	10	0.0
Locker	3	3450.08 (*Ferramentas Kennedy*, 2020)	10	0.0
Filling machine	5 and 6	8910.00 (Alibaba, 2020b)	10	1.0
Aluminum molds	6	16067.61 (Wish, 2020)	10	0.0
Cooler	7	5789.52 (Submarino, 2020)	10	0.5
Magnifying mirror	9	251.11 (Alibaba, 2020c)	10	0.0
Labeling machine	10	1431.00 (Alibaba, 2020a)	10	0.5
Light truck	11	65000.00 (*Mercado Livre*, 2020b)	25	1.0
All machines/equipment		111740.21		

[a]20 L capacity; [b]Adapted to the productive capacity; [c]Legally permitted by the Brazilian Federal Agency.

The cost of the machinery/equipment is highly volatile, particularly due to the considerable exchange variations (regarding US$ and R$) observed recently. In the short-term, it is reasonable to assume that the initial investment depends solely on the exchange rate (the equipment is mostly imported). Based on data from (Trading View, 2020) and with the support of the software Oracle Crystal Ball® it was verified that the Weibull probability distribution is the one that best characterizes the exchange rate in (R$ US$⁻¹). The obtained parameters of the probability distribution are: local = 5.05 (R$ US$⁻¹); scale = 0.59 (R$ US$⁻¹); form = 5.45 (R$ US$⁻¹) (data from 01/Oct./2020 to 16/Nov./2020).

The cost of each piece of equipment (random variable C_e) is given by:

$$C_e = E_c \frac{A_c}{C_r} \tag{1}$$

where:

E_c is the expected cost (Table 1);

A_c is the random cost ruled by the Weibull probability distribution;

C_r is the current exchange rate (5.40 R$ US$⁻¹ in 10/Nov./2020).

Equation 1 assumes that the cost of equipment is perfectly correlated to the dollar Asuero, Sayago, & González, 2006).

E-commerce

The implementation and continued operation of an e-commerce environment present several types of costs. Although the costs related to e-commerce might vary depending on the company characteristics (e.g., revenue and sales amount), Table 2 describes commonly deployed costs in this sector (E-commerce Brazil, 2015).

Due to the lack of a large database, triangular probability distributions are assumed for the e-commerce costs. Based on data from (E-commerce Brazil, 2015), the following parameters of the probability distributions are obtained:

• Layout implementation: min = R$20,000.00; most likely = R$30,000.00; max = R$40,000.00;

• Fraud protection: min = 1.00 (R$ e-commerce sale⁻¹); most likely = 2.50 (R$ e-commerce sale⁻¹); max = 4.00 (R$ e-commerce sale⁻¹);

• Gateway: min = 0.30 (R$ e-commerce sale⁻¹); most likely = 0.50 (R$ e-commerce sale⁻¹); max = 0.70 (R$ e-commerce sale⁻¹);

• Monthly fee: min = 0.01 (% of revenue); most likely = 0.03 (% of revenue); max = 0.04 (% of revenue).

Table 2. E-commerce costs. Source: (E-commerce Brazil, 2015).

	Description	Type of cost
Layout implementation	Creation of the online platform, including its design and features	Initial investment
Fraud protection	Responsible for validating payment data	Variable cost
Gateway	Mainly responsible for communication between the platform and the card operator	Variable cost
Monthly fee	Monthly operating cost of the platform	Variable cost

Production process reliability

As described in Table 1, in order to avoid equipment failures, maintenance is performed regularly. It is assumed that if one piece of equipment is in maintenance, the production process is interrupted. One day per year of preventive maintenance is assigned for the fuser, filling machine, and light truck, as they are more exposed to adverse conditions (e.g., high temperature), while 0.5 day per year of maintenance is assigned for the precision scale, cooler, and labeling machine, as they are less exposed to adverse conditions. Maintenance can be modeled as a yes-no probability distribution, where in this case, the probability of maintenance (interrupted process) is equal to 0.0123, i.e., on average, the process is interrupted for 4.5 days per year due to maintenance issues.

It is also assumed that the production process is interrupted due to power outages. According to (*Agência Nacional de Energia Elétria* [Aneel], 2020a), the equivalent length of interruption per consumer unit (DEC) in the state of MG is 10.64 (hours year^{-1}). Hence, it is reasonable to affirm that the probability of interrupted process due to power outages is equal to 0.0012, which is equivalent to 10.64 (hours year^{-1}).

Maintenance and power outages are independent events. Hence, the probability of proper operation is given by (Harripersaud, 2022):

$$P(A \cap B) = P(A)P(B) = 0.9877 \cdot 0.9988 = 0.9865 \qquad (2)$$

where:
$P(A)$ is the probability of all equipment being available (0.9877);
$P(B)$ is the probability of power supply availability (0.9988);

From Equation 2, the probability of process interruption is 0.0135.

Human mistakes, (e.g., wrong weighing of raw materials, misjudgment of the mixture's consistency, wrong time control, etc.) have not been considered thus far. However, they are quite influential in process interruption. According to (Kananesan, 2019), human error is responsible for 23% of all unplanned downtime in manufacturing. Thus, as 0.0135 is the probability of process interruption due to non-human error-related events, the probability of downtime due to human error can be estimated as 0.0040. Finally, since all events are independent of each other, the overall reliability of the production process (no maintenance, no power outage, and no human error) is given by (Harripersaud, 2022):

$$P(A \cap B \cap C) = P(A)P(B)P(C) = 0.9877 \cdot 0.9988 \cdot 0.9960 = 0.9826 \qquad (3)$$

In conclusion, there is a 98.26% probability of a proper production process and a 1.74% probability of an interrupted process. In Oracle Crystal Ball®, such probabilities can be modeled as a yes-no distribution (also called Bernoulli distribution), i.e., on average, 98.26% of the simulations have full production capacity, while the remaining 1.74% have no production whatsoever.

Productive capacity

The factory is expected to produce typical solid cylindrical lipsticks with dimensions 6.6 (height) and 2.4 cm (diameter), resulting in a volume of 0.03 (L lipstick^{-1}). Hence, the estimated productive capacity (N) is given by:

$$N = \frac{R V_D}{V_L} = 658.19 \left(\frac{Lipsticks}{day} \right) = 240239 \left(\frac{Lipsticks}{year} \right) \qquad (4)$$

where:
R is the production process overall reliability (0.9826);
V_D is the daily volume of lipstick produced by the machinery (20 L day^{-1} as pointed out in Table 1);
V_L is the volume of each lipstick (0.03 L).

Employment costs

Table 3 summarizes the employment costs (including taxes). Based on data from (*Guia Trabalhista*, 2020), salaries have a CAGR of 0.11% (above inflation as previously discussed) and a standard deviation of 2.96% (average of the last few years). The growth tendency and the standard deviation of Table III were calculated based on the historical series of the Brazilian minimum salary (Table 4).

Table 3 indicates that two engineers, four technicians, one cleaner, and one truck driver are required for the proper operation of the cosmetic initiative. The expected salary in (R$ year^{-1}) associated with these jobs is also indicated in Table 3, as well as the salary growth tendencies and their standard deviations.

A normal probability distribution is assumed for the total employment cost, as it was possible to calculate its standard deviation. Based on Table 3, the following parameters are obtained: mean = 632,184.83 (R$ year^{-1}); standard deviation = 18,712.67 (R$ year^{-1}). Such parameters are valid for the first year of simulation as CAGR $\neq$ 0. For the following years, the mean values and standard deviations are recalculated according to the procedure described below.

Equation 5 describes the employment costs growth tendency in (kR$) [concept comparable to (Gallo, 2014)]:

$$\mu_S(t) = 551.35(1 + 0.0011)^t \tag{5}$$

where:

t is the time in years;

$\mu_S(t)$ is the mean value of employment costs in year t;

As presented in Equation 6, in order to correct the error margin over time, it is assumed that the standard deviation (risk) is a fixed percentage of the mean value of employment costs:

$$\sigma_S(t) = 2.96\%\mu_S(t) \tag{6}$$

where:

2.96% is the calculated standard deviation (Table 3);

$\sigma_S(t)$ is the standard deviation of the employment costs in year t;

Equation 6 is important since estimating random variables becomes more difficult over time; hence, risks tend to increase.

It is important to emphasize that the structure described in Equation 5 and 6 is used for all random variables that have a growth tendency (naturally, numerical values are different). In order to avoid unnecessary repetitions, growth equations will no longer be exposed (only numeric values of the growth tendencies).

Rental costs

The factory's location shed with 230 m^2 (Live Real, 2020) presents a rent of 39,600 (R$ year^{-1}). Table 5 presents the annual growth of the FipeZap index in the last few years (Fipe. & Grupo ZAP, 2020 – Brazilian index for monitoring the rental cost). A CAGR of 0.23% (above inflation) and a standard deviation of 7.16% are obtained. As it was possible to calculate the standard deviation of the rental costs, a normal probability distribution is assumed, resulting in the following parameters (first year of simulation): mean = 39,600 (R$ year^{-1}); standard deviation = 2,835 (R$ year^{-1}). In order to follow the trend of the last few years (2018-2020) and the expectations of the rental cost for the upcoming years, it is also assumed that such cost always increases (it is possible to limit the generation range of random numbers based on Oracle Crystal Ball®).

Table 3. Employment costs. Sources indicated in the table.

Position	Salary per employee (R$ year^{-1})	Number of employees	Expected salary (R$ year^{-1})	Growth tendency (% year^{-1})	Standard deviation (% year^{-1})
Engineer	141,453.86 (*Guia Trabalhista*, 2020; *Conselho Regional de Engenharia e Agronomia* [Crea], 2020)	2	282,907.72	0.11	2.96
Technician	70,788.64 (*Salário*, 2020a)	4	283,154.69	0.11	2.96
Cleaner	23,773.75 (*Guia Trabalhista*, 2020)	1	23,773.75	0.11	2.96
Truck driver	42,348.67 (*Salário*, 2020b)	1	42,348.67	0.11	2.96
All employment positions			632,184.83	0.11	2.96

Table 4. Minimum salary over time. Source: (*Guia Trabalhista*, 2020).

	2015	2016	2017	2018	2019	2020
Minimum salary (R$ year^{-1})	10,244	11,440	12,181	12,402	12,974	13,585

Table 5. FipeZap index. Source: (Fipe. & Grupo ZAP, 2020).

	2009	2010	2011	2012	2013	2014
FipeZap annual growth (%)	9.46%	18.56%	17.30%	10.58%	7.86%	2.83%
	2015	2016	2017	2018	2019	2020
	-3.34%	-3.23%	-0.69%	2.33%	4.93%	5.15%

Electricity costs

Table 6 summarizes the electricity costs. Due to lack of data, the electricity consumption of both the fuser and the filling machine was calculated by the equation of thermodynamics represented in Equation 7 [more information in (Truesdell, 1984)]:

$$E = \frac{NmC\Delta\theta}{\eta}$$ (7)

where:

E is the electricity consumption (cal year^{-1});

N is the productive capacity [240,239 lipsticks year^{-1} as mentioned in (4)];

m is the mass of the raw materials per lipstick (40.05 g as further mentioned in Table 11);

C is the specific heat of the raw materials (0.43 cal g^{-1} °C^{-1}) (The Engineering ToolBox, 2003). For simplicity, the specific heat of the mixture was addressed as being equal to the specific heat of the castor oil (the main raw material used in the process);

$\Delta\theta$ is the temperature variation [approximately 70°C to reach the melting point of all raw materials (Mettler Toledo [MT], 2020)];

η is the thermal efficiency of the machinery described in Table 1 (40%).

The cost of electricity was obtained by multiplying the electricity consumption by the electricity tariff [1.09 (R\$ kWh^{-1})] ((*Agência Nacional de Energia Elétria* [Aneel], 2020b).

Table 7 describes the behavior of electricity tariffs in the last few years (Aneel, 2020b). There is a CAGR of -0.58% (above inflation) with a standard deviation of 7.39%. A normal probability distribution is assumed, resulting in the following parameters (first year of simulation): mean = 6,819.13 (R\$ year^{-1}); standard deviation = 503.93 (R\$ year^{-1}). The energy consumption is addressed as constant so that only the electricity tariff influences the cost.

Market research and price stipulation

Table 8 describes the average price of the main lipstick brands in the market. While Table 8 presents relatively high prices, such brands are greatly consolidated and benefit from high-fidelity customers besides already dominating the production process. To ensure high demand and market consolidation, the lipstick initiative must be able to compete with low-cost brands. According to (V. G., 2020), the price is the determining factor for 77% of women. Prices in the order of R\$15.00 are quite common for less-known brands on e-commerce platforms (Eudora, 2020; Amazon, 2020); thus, R\$14.00 is the assumed initial price for virtual sales (e-commerce). Since physical sales present fewer variable costs (e.g., absence of fraud protection, gateway, monthly fee), a lower initial price of R\$10.00 is assumed. In the economic analysis section, a sensitivity analysis will be performed regarding the price of the products to verify if the assumed initial prices are proper. Based on Figure 1, a CAGR of 3.49%, above inflation, is expected for the cosmetic market with a standard deviation of 3.68%. Hence, it is fair to assume that the lipstick initiative will be able to yearly increase the price of its products by 3.49% on average, following the market growth tendency. In conclusion, the following parameters are obtained for the normal probability distributions of the lipstick prices (first year of simulation):

- Lipstick price in physical sales: mean = 10.00 (R\$ lipstick^{-1}); standard deviation 0.37 = (R\$ lipstick^{-1});
- Lipstick price in virtual sales (e-commerce): mean = 14.00 (R\$ lipstick^{-1}); standard deviation 0.52 = (R\$ lipstick^{-1}).

Table 6. Electricity cost. Sources: (The Engineering ToolBox, 2003; MT, 2020; Submarino, 2020).

Machine/equipment	Electricity consumption (kWh year^{-1})	Cost (R\$ year^{-1})
Fuser	842.04	917.82
Filling machine	842.04	917.82
Cooler	1692.00 (Submarino, 2020)	1844.28
lighting	2880.00[a]	3139.20
All machines/equipment	6256.08	6819.13

[a]Assuming 500 lux (industrial lighting).

Table 7. Electricity tariff over time. Source: (Aneel, 2020b).

	2015	2016	2017	2018	2019	2020
Electricity tariff[a]	0.86	0.90	0.84	0.99	1.06	1.09

[a]Assuming 41% of taxes.

Table 8. Price per lipstick of the main brands. Sources indicated in the table.

Brand	Price per lipstick (average of advertised lipsticks)
Natura®	R$31.37 (Natura, 2020)
O Boticário®	R$26.66 (O Boticário, 2020)
MAC®	R$85.74 (MAC, 2020)
AVON®	R$24.43 (Avon, 2020)
Mary Kay®	R$41.78 (Mary Kay, 2020)
Lancôme®	R$156.33 (Lancôme, 2020)
Chanel®	R$295.91 (Chanel, 2020)
Dior®	R$52.16 (Beleza na Web, 2020)

As previously mentioned, the lipstick factory is designed to supply the city of Itajubá and its nearby cities, i.e., São José do Alegre, Maria da Fé, Wenceslau Braz, Piranguçu, Piranguinho, Delfim Moreira, Santa Rita do Sapucaí, and Pouso Alegre. Table 9 summarizes the estimated populations of each city (reference date: July 01, 2020).

Table 9. Estimated populations. Source: *Instituto Brasileiro de Geografia e Estatística* (IBGE, 2020).

City	Population (thousands)	Female population (thousands)
Itajubá	97.33	48.67
São José do Alegre	4.21	2.11
Maria da Fé	14.06	7.03
Wenceslau Braz	2.55	1.28
Piranguçu	5.49	2.75
Piranguinho	8.64	4.32
Delfim Moreira	8.02	4.01
Santa Rita do Sapucaí	43.75	21.88
Pouso Alegre	152.55	76.28
All cities	336.60	168.30

The male population is disregarded in this paper since the number of men who consume lipsticks is negligible compared to the number of women.

According to the market research conducted at (Mintel, 2017), nearly 53% of women use lipsticks routinely. Therefore, the number of frequent buyers is approximately equal to 89.20 thousand, comprising the city of Itajubá and its nearby cities. In conclusion, it is fair to assume that, as long as the product presents competitive price and quality, there is enough demand for all the factory's productive capacity (19745.7 lipsticks month^{-1}). The e-commerce environment is essential to ensure demand for the factory's productive capacity, as virtual sales are the new tendency of the sector. It is also important to emphasize that there are more cities relatively close to Itajubá, which can be supplied if necessary (e.g., Paraisópolis, Cristina, etc.).

Fuel costs

Table 10 describes the traveling distances required for product distribution. Two factors were considered when designing the distribution map: distance and city population. The initial idea is to deliver products to e-commerce customers directly, but there is also the possibility of delivering them to local stores. According to (Vrum, 2020), the light truck model used in the process presents an efficiency of 8 – 11 km L^{-1} of diesel. Therefore, a triangular probability distribution is assumed. Currently, the cost of a diesel liter in Brazil is approximately R$4.18 (R7, 2021). A CAGR of 2.50% above inflation, and a standard deviation of 16.17% are estimated for the diesel cost in R$ L^{-1} (*Tabelas de Frete*, 2020). It is also assumed that the truck completes the route described in Table 10 every other day. In conclusion, the following parameters are obtained:

• Truck's efficiency: triangular distribution with min = 7,730.70 (liters of diesel year^{-1}); most likely = 9,180.67 (liters of diesel year^{-1}); max = 10,630.63 (liters of diesel year^{-1});

• Diesel cost (first year of simulation): normal distribution with mean = 4.18 (R$ L^{-1}); standard deviation = 0.68 (R$ L^{-1}).

Table 10. Fuel costs. Sources: Google Maps (2021), *Distancia Cidades* (2020).

City	Round trip distance from Itajubá
São José do Alegre	50.00 (km)
Maria da Fé	48.00 (km)
Wenceslau Braz	30.00 (km)
Piranguçu	28.00 (km)
Piranguinho	26.00 (km)
Delfim Moreira	58.00 (km)
Santa Rita do Sapucaí	88.00 (km)
Pouso Alegre	138.00 (km)
Total distance	466.00 (km)
Liters of diesel per route	42.36 – 58.25 (liters of diesel complete route^{-1})
Liters of diesel per year	7730.70 10,630.63 (L of diesel year^{-1})

Raw materials costs

The raw materials of lipstick production might vary slightly, considering that there are several types of lipstick. However, lanolin, cocoa butter, beeswax, paraffin, castor oil, and pigment are frequently used. Table 11 summarizes the most important information regarding these materials. The cost of R$ lipstick^{-1} is obtained by Equation 8:

$$C_{R\$/lipstick} = C_{R\$/liter}PV_L \tag{8}$$

where:

$C_{r\$/lipstick}$ is the cost of R$ lipstick^{-1};

$C_{R\$/liter}$ is the cost of R$ L^{-1}, calculated by multiplying the cost of (R$ kg^{-1} by the density of kg L^{-1}, except for the castor oil, in which $C_{R\$ L-1}$ was directly found in Americanas (2020b) no need for data of (R$ kg^{-1}); P is the raw material's proportion; V_L is the lipstick volume (0.03 L).

In conclusion, the raw materials result in a cost of 2.46 (R$ lipstick^{-1}). However, there are inherent risks related to the cost of the raw materials, e.g., a supplier may be unavailable, or the product demand might vary. Therefore, these risks must be considered for higher accuracy. Based on market research mentioned in Table 11, a standard deviation of 0.10 (R$ lipstick^{-1}) is assumed around the mean value of 2.46 (R$ lipstick^{-1}), i.e., a normal probability distribution is considered. As the raw materials described in Table 11 are produced nationally, import taxes are disregarded.

Based on the CAGR of each raw material described in Table 11, an overall CAGR of -0.30% (above inflation) is obtained, i.e., expenses on raw materials tend to decrease by 0.30% yearly.

Table 11. Raw materials. Sources indicated in the table.

Material	Cost (R$ kg^{-1})	Density (kg L^{-1})	Cost (R$ L^{-1})	Proportions (%)	Mass (g lipstick^{-1})	Cost (R$ lipstick^{-1})	Estimated CAGR (above inflation) (%)
Lanolin	184.90 (*Império das Essências*, 2020)	0.94 (Carlroth, 2015)	173.81	19.64	5.51	1.02	–0.27 (Cision, 2017)
Cocoa butter	111.22 (*Zona Cerealista Online*, 2020)	0.89	98.99	24.14	6.41	0.71	0.62 (The Courier, 2020)
Beeswax	65.57 (Apicola, 2020)	0.95 (GM Ceras, 2017)	62.29	9.96	2.83	0.19	–3.54 (Report Linker, 2020)
Paraffin	19.20 (Solven, 2020)	0.82 (Chemical Book, 2020)	15.74	4.79	1.17	0.02	–1.55 (Grand View Research [GVR], 2017)
Castor oil	–	0.96 (Inchem, 2003)	22.80 (Americanas, 2020b)	31.90	9.14	0.22	0.91 (Grand View Research [GVR], 2019)
Pigment (Iron oxide – Fe$_2$O$_3$)	20.00 (*Mercado Livre*, 2020c)	5.24 (San Francisco Portal, 2020)	104.80	9.58	14.99	0.30	–1.34 (WBOC, 2020)
Total mass and cost					40.05	2.46	

Packaging costs

Besides the costs of the raw materials, the packaging costs must also be accounted for. Based on data from Made-in-China (MiC, 2020), a normal probability distribution is supposed with a mean value of 1.37 (R$

lipstick^{-1}) and a standard deviation of 0.05 (R$ lipstick^{-1}) in the first year of simulation. Moreover, a CAGR of -0.51% (above inflation) is expected, according to Market Research Future (2020).

Summary of risk assessment

For simplicity, Table 12 summarizes the risk assessment (CAGR is quantified above inflation).

Table 12. Risk assessment summary. Source: authors.

	Probability distribution	Parameters	CAGR (%)
Machinery/equipment	Weibull	Local = 5.05 (R$ US^{-1}); scale = 0.59 (R$ US^{-1}); form = 5.45 (R$ US^{-1})	0.00
Layout implementation	Triangular	Min = R$20,000.00; most likely = R$30,000.00; max = R$40,000.00	0.00
Fraud protection	Triangular	Min = 1.00 (R$ e-commerce sale^{-1}); most likely = 2.50 (R$ e-commerce sale^{-1}); max = 4.00 (R$ e-commerce sale^{-1})	0.00
Gateway	Triangular	Min = 0.30 (R$ e-commerce sale^{-1}); most likely = 0.50 (R$ e-commerce sale^{-1}); max = 0.70 (R$ e-commerce sale^{-1})	0.00
Monthly fee	Triangular	Min = 0.01 (% of revenue); most likely = 0.03 (% of revenue); max = 0.04 (% of revenue)	0.00
Production process reliability	Yes-no	Yes = 98.26%; No = 1.74%	0.00
Employment costs	Normal	Mean = 632,184.83 (R$ year^{-1}); standard deviation = 18,712.67 (R$ year^{-1})	0.11
Rental costs	Normal	Mean = 39,600 (R$ year^{-1}); standard deviation = 2,835 (R$ year^{-1})	0.23
Electricity costs	Normal	Mean = 6,819.13 (R$ year^{-1}); standard deviation = 503.93 (R$ year^{-1})	-0.58
Lipstick price (physical)	Normal	Mean = 10.00 (R$ lipstick^{-1}); standard deviation 0.37 = (R$ lipstick^{-1})	3.49
Lipstick price (virtual/ e-commerce)	Normal	Mean = 14.00 (R$ lipstick^{-1}); standard deviation 0.52 = (R$ lipstick^{-1})	3.49
Truck's efficiency	Triangular	Min = 7,730.70 (L of diesel year^{-1}); most likely = 9,180.67 (L of diesel year^{-1}); max = 10,630.63 (L of diesel year^{-1})	0.00
Diesel cost	Normal	Mean = 4.18 (R$ L^{-1}); standard deviation = 0.68 (R$ L^{-1})	2.50
Raw materials costs	Normal	Mean = 2.46 (R$ lipstick^{-1}); standard deviation = 0.10 (R$ lipstick^{-1})	–0.30
Packaging cost	Normal	Mean = 1.37 (R$ lipstick^{-1}); standard deviation = 0.05 (R$ lipstick^{-1})	–0.51

It is noteworthy that the parameters of the Weibull probability distribution were calculated by Oracle Crystal Ball®; the parameters of the normal probability distributions were obtained by calculating the means and standard deviations of the historical series displayed in previous tables; the parameters of the triangular probability distributions were estimated by assessing ranges of possible values in cases where historical series are limited; the parameter of the yes-no probability distribution were obtained by calculating the probability of occurrence of independent events (Harripersaud, 2022), as previously discussed in detail.

Results and discussion

Initial observations

Some initial observations are required to perform an economic analysis of the lipstick initiative:

• The ICMS (Tax on Circulation of Goods and Provision of Services) in the state of Minas Gerais is equal to 18% of the revenue (Ricardo, 2019);

• The IRPJ/CSLL (Income Tax and Social Contribution) is nearly equal to 34% of the profit before tax (PBT);

• As previously mentioned, it is assumed that the initial lipstick price is equal to R$14.00 and R$10.00 for virtual (e-commerce) and physical sales, respectively. Then, a sensitivity analysis will be carried out for the prices;

• It is initially assumed that half of the production is sold physically, and the other half is sold virtually (through e-commerce). Then, a sensitivity analysis will be performed regarding the sales proportion;

• It is initially assumed that no financing is required for purchasing the machinery/equipment nor for e-commerce layout implementation. Then, a sensitivity analysis will be addressed in this regard. Such consideration results in an initial weighted average capital cost (WACC) of 11.26%.

• It is assumed that the complementary fixed costs (e.g., internet connection, water bill, etc.) represent 20% of the fixed costs directly addressed in this paper;

• Additional working capital of R$30000.00 is considered;

• The machinery/equipment used in the process is typically robust. Hence, a life cycle of ten years is expected for the project;

• No residual value for the machinery/equipment is assumed;

• For more solid conclusions, the analysis is separated into deterministic and stochastic so that the risk influence on the economic feasibility of the lipstick initiative can be verified. The growth tendencies (CAGR) are not considered in the deterministic analysis since it regards a simplified evaluation.

The WACC is given by (Sarmento & Oliveira, 2018):

$$WACC = \frac{E}{E + D} R_E + \frac{D}{E + D} R_D (1 - \tau) \tag{9}$$

where:

E is market value of the company's equity;

D is market value of the company's debt;

R_E is the cost of equity;

R_D is the cost of debt. In Brazil, a cost of deduction of 15% p.a. is quite usual (*Banco Central do Brasil*, 2021);

τ is the Income Tax and Social Contribution aliquot (34%).

In this paper, the Capital Asset Pricing Model (CAPM) is assumed since it is widely used in economics. For more information on the cost of equity see Dempsey (2013):

$$R_E = R_f + \beta \frac{D(1 - \tau) + E}{E} (R_m - R_f) \tag{10}$$

where:

R_f is the risk-free rate. In Brazil, the investment NTN-B, emitted by the government with virtually no risk, can be assumed, i.e., $R_f = 3.23\% \, p.a.$;

β is a systematic risk indicator (unlevered beta). For the cosmetic sector, β is approximately equal to 0.84 (NYU, 2000);

R_m is the market rate. In Brazil, the Ibovespa (São Paulo Stock Exchange Index) can be assumed, i.e., $R_m = 11.26\% \, p.a.$

Deterministic analysis

Based on Equations 9 and 10, Figure 3 illustrates the WACC as a function of the financing.
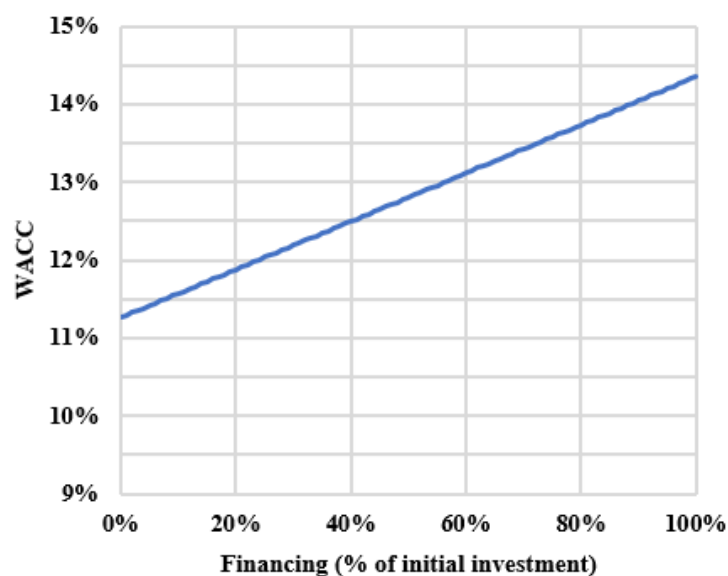
Figure 3. WACC as a function of the financing. Source: authors.

Assuming only equity (WACC = 11.26%), the deterministic analysis of the lipstick initiative resulted in a net present value (NPV) of R$561,042.95 and an internal rate of return (IRR) of 73.13%. Hence, the project is economically feasible (disregarding the risks). However, it is important to understand the effects of the

lipstick price, sales proportion, and financing characteristics on the feasibility of the investment. Figure 4 presents the NPV as a function of the lipstick price. It should be emphasized that a price variation leads to a demand variation, which is not considered in Figure 4. As verified, the lipstick initiative becomes unfeasible for prices lower than R$10 (physical) and R$14 (virtual).
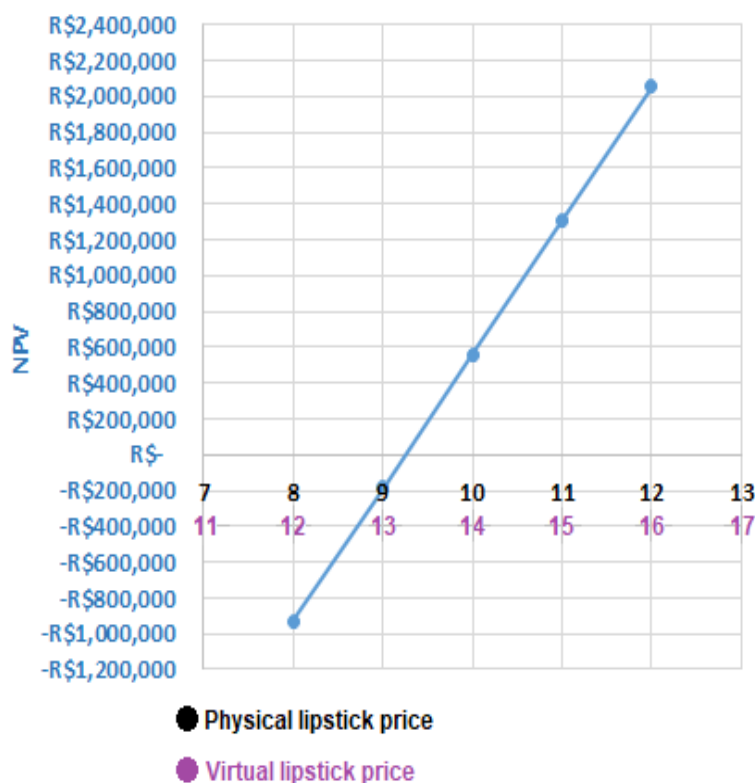

Figure 4. NPV as a function of the lipstick price. Source: authors.

The influence of the e-commerce sales proportion on the NPV is illustrated in Figure 5. As verified, the sales proportion has a modest influence on the NPV; however, e-commerce provides a slightly lower profit margin compared to physical sales (due to the additional variable costs required for virtual sales). If the investor decides to nearly eliminate the influence of sales proportion on the NPV, prices of 9.97 (R$) and 14.05 (R$) can be applied, as illustrated in Figure 5.
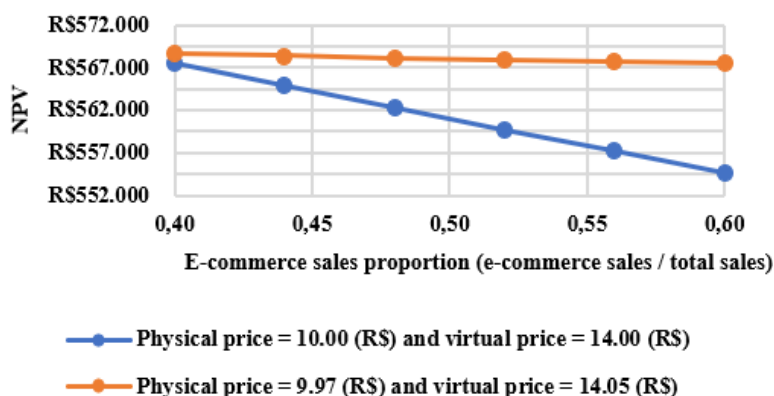
Figure 5. NPV as a function of the e-commerce sales proportion. Source: authors.

Figure 6 illustrates how financing affects the NPV. It can be verified that the lipstick initiative is economically feasible for any percentage of financing.

Finally, a sensitivity analysis is illustrated in Figure 7. The economic feasibility is highly dependent on the lipstick price, variable and fixed costs. The initial investment and e-commerce sales proportion barely influence the economic feasibility.
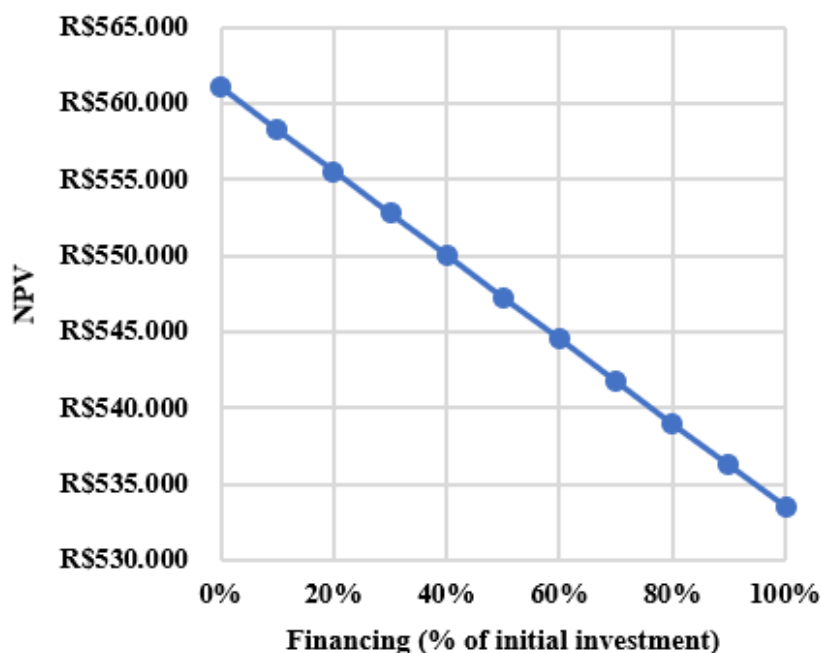
Figure 6. NPV as a function of the financing percentage. Source: authors.
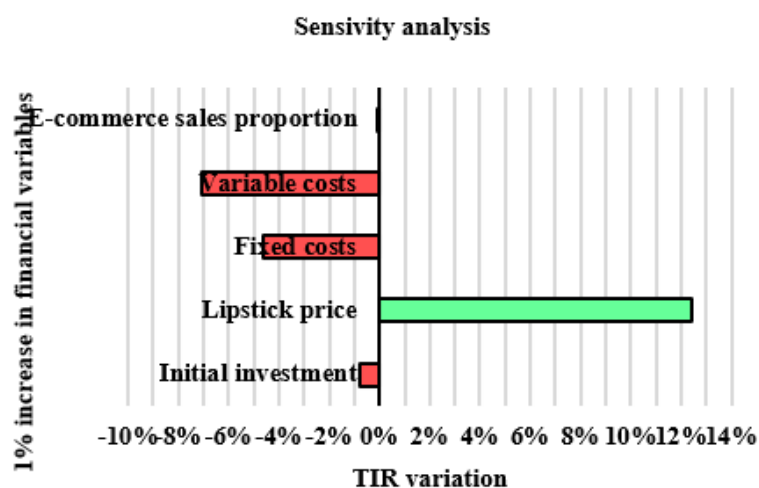

Figure 7. Sensitivity analysis. Source: authors.

Stochastic analysis

Figure 8 illustrates a histogram of the NPV once the risks are introduced into the problem, along with the growth tendencies of the variables (CAGR). The software Oracle Crystall Ball® was used to quantify the risks and perform the economic analysis. The algorithm executes a Monte Carlo simulation, which is a type of simulation that relies on repeated random sampling and statistical analysis to compute the results. Therefore, in each iteration, random values among the probability distributions are assigned for the variables, and the software calculates the NPV based on such values. The process is repeated thousands of times, allowing to obtain a histogram for the NPV. For more solid conclusions, 100,000 evaluations were performed. As verified, the probability of positive NPV (economic feasibility) is equal to 99.99%, and the mean NPV is equal to nearly 1.78 (MR$). The results were highly satisfactory due to the considerable CAGR of the lipstick market (3.49%). Figure 9 illustrates the feasibility probability and the mean NPV as functions of the lipstick prices. As observed, prices in the order of 8.5 (R$ lipstick⁻¹) and 12.5 (R$ lipstick⁻¹) also result in low risk.

Figure 10 illustrates what would have happened if the cosmetics market was not in an upward trend (CAGR = 0). In this case, there is a minor but existent risk associated with establishing a cosmetic initiative. In conclusion, the rising trend of the cosmetic market represents business opportunities for potential investors, as it massively increases the NPV project and reduces the risk. However, as future

work, it is essential to perform in-depth market research studies to ensure that the upward trend in the cosmetics sector will remain.

As illustrated in Figure 11, if the cosmetics market was not in an upward trend (CAGR = 0), prices in the order of 10.5 (R\$ lipstick^{-1}) and 14.5 (R\$ lipstick^{-1}) would result in extremely low risk. As previously mentioned, prices in the order of R\$15.00 are quite common for less-known brands in e-commerce platforms (Eudora, 2020; Amazon, 2020). Hence, it is fair to affirm that the stipulated prices are in line with market standards.
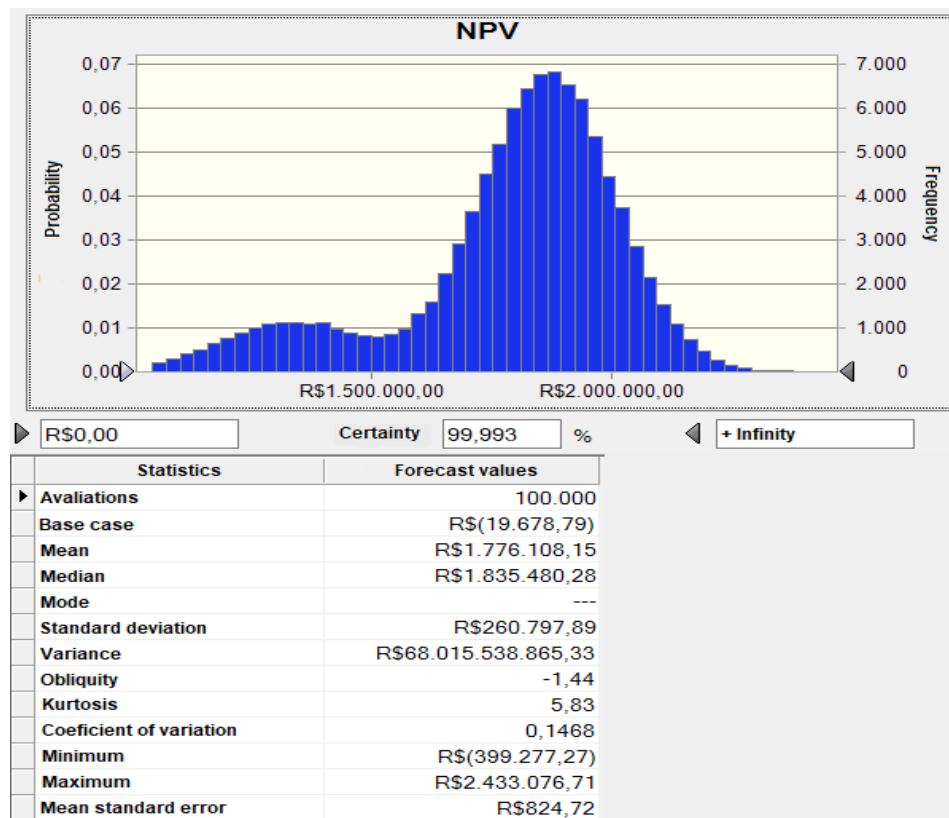
Figure 8. Histogram of the NPV. Graph provided by Oracle Crystal Ball®.
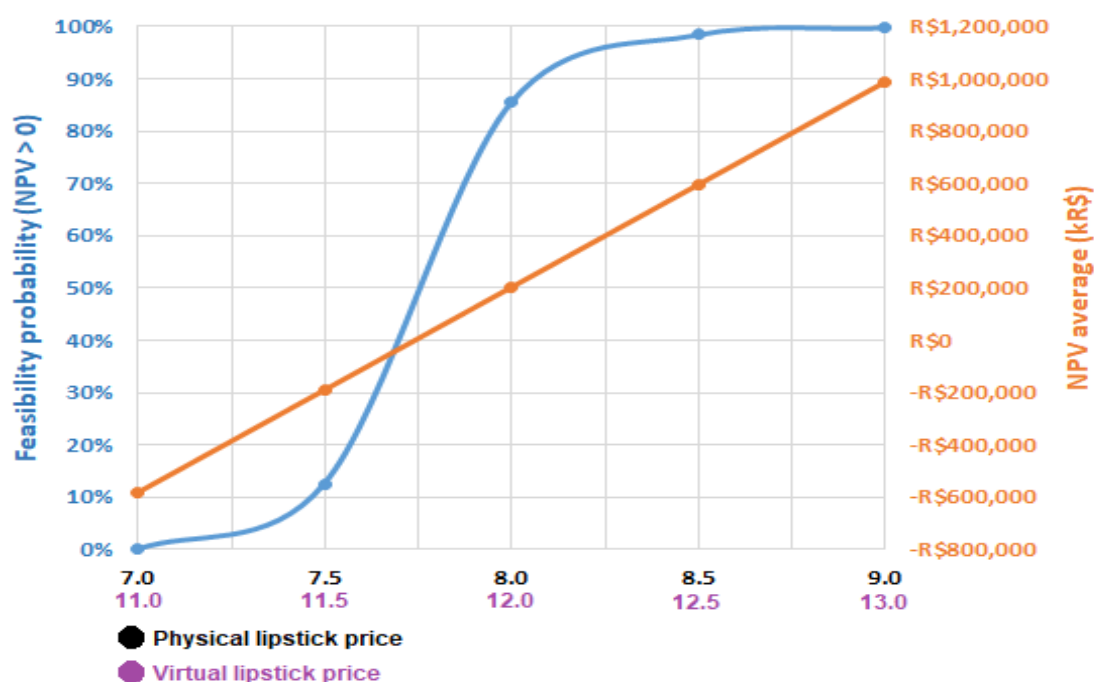
Figure 9. Feasibility probability. Source: authors.
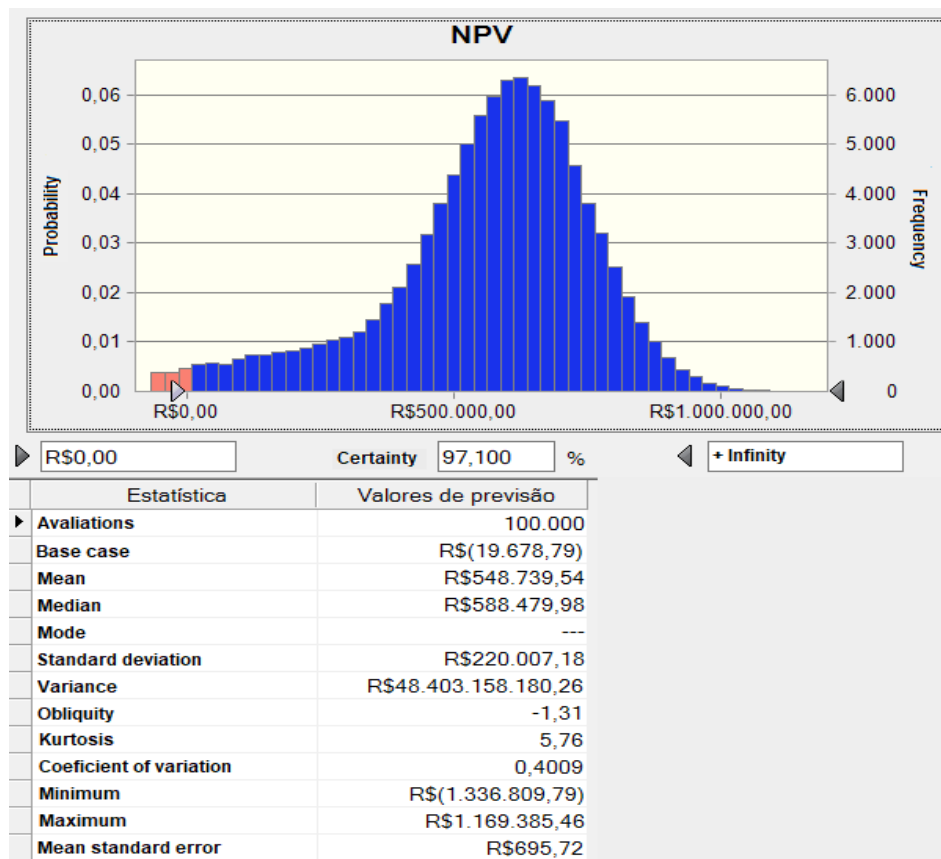
Figure 10. Histogram of the NPV for CAGR = 0. Graph provided by Oracle Crystal Ball®.
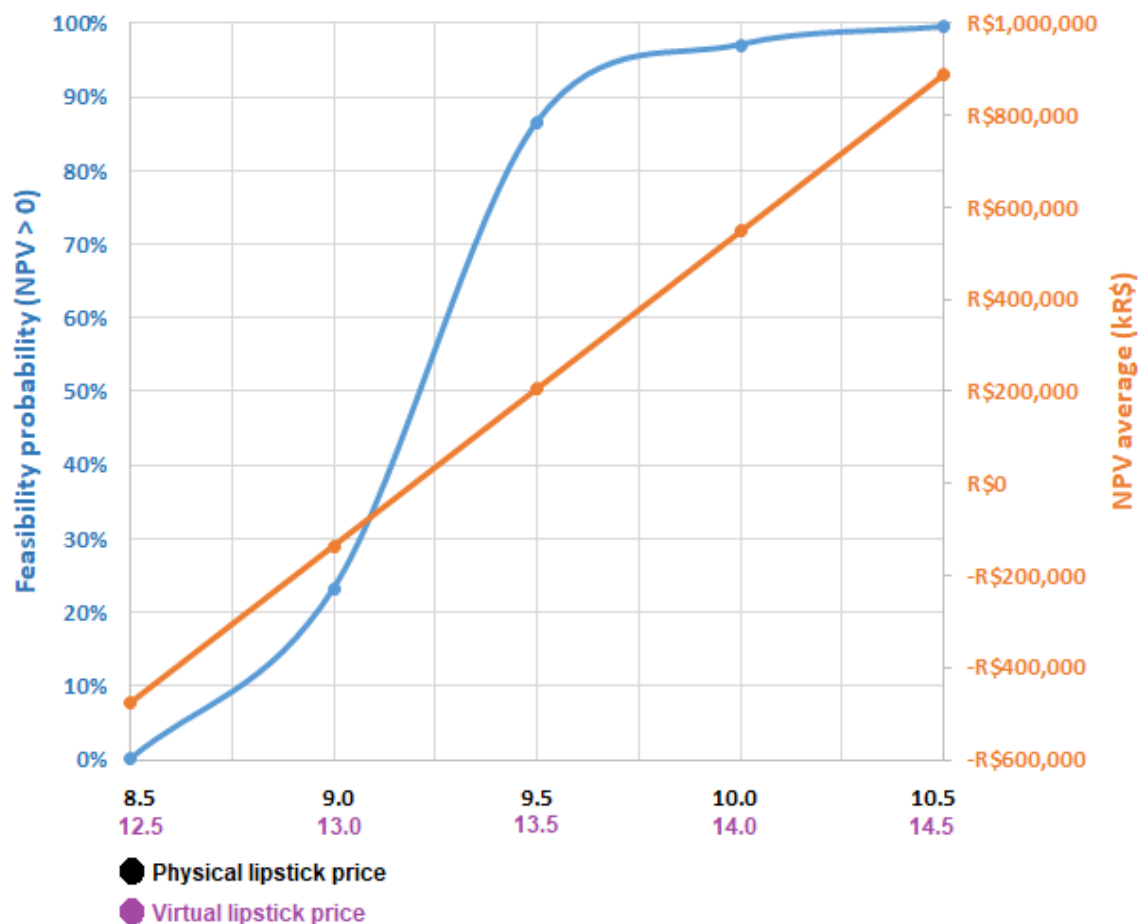

Figure 11. Feasibility probability (CAGR = 0). Source: authors.

Conclusion

Based on the proposed methodology, it was possible to verify the economic feasibility of a lipstick initiative in the city of Itajubá, State of Minas Gerais, which is similar to most Brazilian cities. By quantifying the risks inherent to the production process, stochastic analysis was performed using the software Oracle Crystal Ball®. The results indicate that the probability of economic feasibility is equal to 99.99% and the mean NPV is equal to nearly 1.78 (MR$) (given the analysis considerations), which is quite promising. The excellent result is related to the rising trend of the cosmetic sector (compound annual growth rate = 3.49%).

Acknowledgements

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