INTERNATIONAL SEVEN JOURNAL OF MULTIDISCIPLINARY
ISSN: 2764-9547

Loan repayment systems

Sistemas de amortização de empréstimo

DOI: 10.56238/isevmjv2n4-012
Receiving the originals: 23/07/2023
Acceptance for publication: 14/08/2023

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ABSTRACT
The purpose of this study was to analyze the importance of the amortization systems used in financial loans through simulations in two banks Itaú and Bradesco, in order to facilitate the understanding of which of these systems becomes more feasible and generates more advantages to the client at the moment of a loan. Initially, a brief review was carried out on the capitalization of interest rates, followed by the theoretical basis for amortization systems, using, in particular, the constant and French amortization systems. As a final part of the study, a qualitative-descriptive survey was conducted with data collected from semi-structured interviews in the Amazonian bank in order to obtain a better understanding of the repayment systems where it was possible to simulate a loan, comparing the Amortization offered by banks with another system, as well as analysis by means of tables and graphs of the most suitable system to make the loan. With the

research, considerable information was obtained that allowed to analyze the care that should have a certain value, as well as interest rates and time, as very important factors to evaluate the value to be borrowed. It concludes by suggesting that depreciation systems have become essential tools used by banks to make profits and more profits and thus become large enterprises.

Keywords: Amortization systems, Loan, Simulation.

1 INTRODUCTION

This paper will look at amortization systems, more specifically the constant and French amortization systems. In order to check which of these systems is more viable for the customer when taking out a loan, two loans will be simulated and compared. Finally, a field study carried out at a financial institution will show which of these systems is used at the branch. The main objective of this work is to show the importance and benefits that financial mathematical knowledge (MATHIAS E GOMES, 2008), (PUCCINI, 2009) brings to society, so that the person acquiring a bank loan can analyze and understand the application of the calculations involved in these systems used by banks, and thus be able to weigh up better benefits at the time of negotiation.

Specifically, the topics relating to relevant financial mathematics (BIAOBOCK, 2020) will be shown; with the study of the main amortization systems used in financial institutions; in order to highlight the most viable for customers and banks; and in this way, bring greater clarity to those who deal with these everyday situations. The methods used will be bibliographical research, journals and searches on research sites. In addition to field research at the Banco da Amazônia branch, with a questionnaire addressed to a bank employee about the amortization systems corresponding to the Selic rate (BANCO CENTRAL DO BRASIL, 2020).

As for the specific objectives, to analyze the best advantage of taking out a loan, evaluating interest rates and time elapsed; To carry out a systematic study of financial mathematics, developing the different capitalization regimes and rates in order to obtain a better understanding of the branch of financial mathematics; To understand, based on field research carried out at Banco da Amazônia and with a semi-structured questionnaire, the simulation of a loan so that it is possible to ascertain the extent to which a given loan is satisfactory, taking into account interest rates and time.

As for the justification, financial mathematics, as an important area of mathematics, especially with regard to amortization systems in the area of compound interest, has been one of the great allies of countless banking companies that profit billions due to this capitalization system.

It is therefore advisable to know the most viable path to follow when faced with a loan situation so that it is possible to evaluate three important elements: interest rates, value and elapsed time.

2 CAPITALIZATION REGIME, RATE AND SIMPLE AND COMPOUND INTEREST

In this chapter, we take a brief look at the Simple and Compound Capitalization Regime (Simple and Compound Interest) and the concepts needed to understand this subject. Therefore, the following are covered: Interest capitalization regime, Concept of simple interest, Amount and capital, Proportional rate, Equivalent rate, Simple capitalization regime, Concept of compound interest, Proportional rate, Equivalent rate, Amount for non-integer periods, Nominal rate, Effective rate. Real rate and apparent rate and Compound capitalization. All of these topics are necessary in order to gain a better understanding of Chapter 2, where the compound interest capitalization schemes for bank loans will be developed.

2.1 CONCEPT OF SIMPLE INTEREST

Simple interest is interest that grows linearly because it is calculated only on the initial capital.

To calculate the amount of interest, use expression (1):

$$J = C.i.n. \tag{1}$$

Where J is the value of the simple interest; C is the initial capital or principal; i is the unit interest rate and n is the application period.

In addition, algebraic transformations of formula (1) lead to the basic formulas that are used to calculate both interest and other financial values, which will be discussed below: The simple interest formula can only be applied if the application period n is expressed in the same unit of time as the rate used. i considered.

2.2 AMOUNT AND CAPITAL

The amount is the sum of the principal and the accumulated interest. The principal is a given amount of money initially invested in a transaction. So, if we call the amount M, the principal by C and interest by J we get the expression (5):

$$M = C + J \tag{2}$$

Substituting formula (1) into (2), we obtain:

$$M = C + C.i.n \tag{3}$$

Putting C the following expression is obtained:

$$M = C(1 + i.n) \tag{4}$$

Isolating C in (4), we get

$$C = \frac{M}{(1+i.n)} \tag{5}$$

2.3 PROPORTIONAL RATE

Two fees i e i' are proportional when their respective values form a proportion with the time periods n e n' to them, reduced to the same unit (CRESPO,1999).

This gives the proportion:

$$\frac{i}{i\prime} = \frac{n}{n\prime} \tag{6}$$

In (6), the rates i e i' must be both percentage or both unit rates and the periods n e n' must refer to the same unit of time.

Thus, the rates of 24% per year and 2% per month, for example, are proportional:

$$\frac{24}{2} = \frac{12}{1} \text{ or } \frac{0{,}24}{0{,}02} = \frac{12}{1} \text{ (1 year = 12 months).}$$

From the example above, you can determine a formula to obtain a rate proportional to another given rate more quickly. Simply take i as the interest rate for a given period and i_k the proportional rate to be determined, relative to the fraction $\frac{1}{k}$ of the period. From relation (6) we have:

$$\frac{i_k}{i} = \frac{\frac{1}{k}}{1} \Longrightarrow \frac{i_k}{i} = \frac{1}{k},$$

That is:

$$i_k = \frac{i}{k} \tag{7}$$

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ISSN: 2764-9547

2.4 EQUIVALENT RATE

Two rates are equivalent when, applied to the same capital over the same period, they produce the same interest. Given the interest rates i, for one period, and i_k, relative to $\frac{1}{k}$ period, we have:

$$j_i = C \cdot i \cdot 1 \text{ e } j_{i_k} = C \cdot i_k \cdot k$$

Assuming i e i_k equivalent rates, the expression follows:

$$j_i = j_{i_k} \Longrightarrow Ci = Ci_k k \Longrightarrow i = i_k k,$$

That is:

$$i_k = \frac{i}{k}$$

The formula above shows us that the rates i e i_k are proportional. Therefore, it can be concluded that in a simple interest regime, two proportional rates are equivalent.

2.5 SIMPLE CAPITALIZATION

In this system, interest is only charged on the initial capital of the operation, and there is no interest on the balance of the accumulated interest. As a result, interest tends to grow linearly over time, as in an arithmetic progression (AP). An understanding of the simple capitalization system will be based on an analysis of the following example using a table: A person invests R$1,000.00 in a savings fund at a bank for a period of 5 months, receiving 1% simple interest at the end of each month.

Putting the data from this problem into table 1, we have:

Table 1- Representation of the calculation of the simple capitalization regime

Month	Balance at the beginning of each month ($)	Monthly interest ($)	Monthly growth ($)	Balance at the end of each month ($)
1	1.000,00	0,01 x 1.000,00 = 10,00	10,00	1.010,00
2	1.010,00	0,01 x 1.000,00 = 10,00	10,00	1.020,00
3	1.020,00	0,01 x 1.000,00 = 10,00	10,00	1.030,00
4	1.030,00	0,01 x 1.000,00 = 10,00	10,00	1.040,00
5	1.040,00	0,01 x 1.000,00 = 10,00	10,00	1.050,00

Source: Author

The table shows the growth of the monthly balance and the amount to be received at the end of this investment, as well as the incidence of interest only on the initial capital of R$ 1,000.00, which consequently represents the linear growth of interest, which is R$ 10.00 at the end of each month, thus showing the behavior of an arithmetic progression.

2.6 CONCEPT OF COMPOUND INTEREST

Compound interest is interest that is calculated in each financial period, starting from the second, on the amount of the previous period, i.e. in this type of capitalization system, the interest earns interest. To obtain the formula for the amount, first consider an initial capital C, applied at compound interest at the rate $i$as follows:

Period	**Interest**	**Amount**
1º	$j_1 = C \cdot i$	$M_1 = C + j_1 = C + Ci \Longrightarrow M_1 = C(1+i)$
2º	$j_2 = M_1 \cdot i$	$M_2 = M_1 + j_2 = M_1 + M_1 \cdot i = M_1 \cdot (1+i) =$ $= C(1+i)(1+i) \Longrightarrow M_2 = C(\,1+i)^2$
3º	$j_3 = M_2 \cdot i$	$M_3 = M_2 + j_3 = M_2 + M_2 \cdot i = M_2(1+i) =$ $= C(1+i)(1+i\,)^2 \Longrightarrow M_3 = C(1+i)^3$

Thus, it can be written for the nth period:

$$M_n = C(1+i)^n \tag{8}$$

In (8), we have the formula for the amount of compound interest, also known as the fundamental formula for compound interest, for an integer number of periods. It should also be noted that the factor $(1+i)^n$ is called the capitalization factor or capital accumulation factor.

In order to calculate the amount under compound interest, it is necessary to determine the value of the capitalization factor, which can be calculated using a scientific calculator that displays the key X^yOtherwise, you should use a financial table or logarithms. In particular, in this final project, we will use a scientific calculator to make it easier to calculate the amount at compound interest.

Also as a consideration, to obtain the formula that calculates the capital, just use (8), so you get:

$$M_n = C(1+i)^n$$
$$C(1+i)^n = M_n$$
$$C = M_n \cdot \frac{1}{(1+i)^n}$$

As $\frac{1}{(1+i)^n} = (1+i)^{-n}$you can write the formula that gives us the value of the initial capital or principal as follows:

$$C = M_n(1+i)^{-n} \tag{9}$$

The $(1+i)^{-n}$ is called the decapitalization factor.

2.7 PROPORTIONAL AND EQUIVALENT RATES

The concept of proportional rates in compound interest is similar to that of simple interest, i.e. two rates are proportional when their values form a proportion with the times referred to them, reduced to the same unit. So, if i_a is an annual rate and i_s, i_t, i_b, i_m e i_d semi-annual, quarterly, bimonthly, monthly and daily rates respectively, we have:

$$i_s = \frac{i_a}{2};\ i_t = \frac{i_a}{4};\ i_b = \frac{i_a}{6};\ i_m = \frac{i_a}{12};\ i_d = \frac{i_a}{360}$$

Thus, for a period $\frac{1}{k}$ of the year, the proportional rate will be $\frac{i_a}{k}$i.e:

$$i_k = \frac{i_a}{k} \tag{10}$$

Equivalent rates refer to different periods of time, so that a capital produces the same amount in the same amount of time. It is worth noting that unlike simple interest, compound interest does not have equivalent proportional rates.

2.8 CALCULATING THE EQUIVALENT RATE

Taking into account the concept of equivalent rates, it can be said that the amount produced by the capital Cat the annual rate $i_a$for one year must be equal to the amount produced by the same capital C, for 12 months, at the monthly rate $i_m$equivalent to the annual rate i_a. This gives us

$$M_1 = C(1+i_a)^1$$
$$M_{12} = C(1+i_m)^{12}$$

Since M_1 has to be equal to M_{12}, we consider $M_1 = M_{12}$ and we get

$$C(1+i_m)^{12} = C(1+i_a)^1$$
$$(1+i_m)^{12} = (1+i_a)^1$$

So we have:

$$(1+i_m)^{12} = 1+i_a \tag{11}$$

To calculate other fractions of the year, use the following formulas:

$$(1+i_d)^{360} = (1+i_m)^{12} = (1+i_t)^4 = (1+i_s)^2 = 1+i_a \tag{12}$$

2.9 AMOUNTS FOR NON-INTEGER PERIODS

There may be situations in which the number of financial periods is not an integer, in which case the fundamental formula won't work, because when determining it, an assumption was made that interest would only be formed at the end of each capitalization period. Therefore, additional conventions will have to be made to obtain the amount for non-integer periods. Among these conventions, the linear and exponential conventions are commonly used.

In the linear convention, the interest for the non-integer period is calculated by linear interpolation and in the exponential convention, the interest for the non-integer period is calculated using the equivalent rate. In particular, because it is more logical, the exponential convention will be used. To deduce the formula for the amount for non-integer periods, assume a capital Capplied at compound interest at the rate $i$during the period $n+\frac{p}{q}$, where $p<q$.

By the exponential convention, the capital C will earn compound interest at the rate i during the first n periods. Then its amount M_n will then earn compound interest at the rate i_q (equivalent to the rate i and relative to the fraction $\frac{i}{q}$ of the period) during the p periods equal to $\frac{1}{q}$. Thus, by deduction, we arrive at the formula (13) for the amount for non-integer periods:

$$M_{n+\frac{p}{q}} = C(1+i)^{n+\frac{p}{q}} \tag{13}$$

2.10 NOMINAL RATE AND EFFECTIVE RATE

A nominal rate is one whose interest capitalization period does not coincide with that defined for the interest rate. In general, the nominal rate is an annual rate. To solve problems that include a nominal rate, it is a convention that the rate per capitalization period is proportional to the nominal rate. The effective interest rate is the interest rate calculated over the entire term. nIn other words, the effective interest rate is the process of compounding interest over the capitalization periods.

To obtain the formula for the effective rate, the following idea will be taken into account: When we offer 6% per year and capitalized every six months at 3%the rate of 6% is the nominal rate and the effective rate is the annual rate equivalent to 3% half-yearly. Therefore, if i_f is the effective rate, we have

$1 + i_f = (1 + 0{,}03)^2 \Longrightarrow i_f = 1{,}06090 - 1 \Longrightarrow i_f = 0{,}06090$i.e. the effective rate is $0{,}0609 a.a$ or 6,09% $a.a$.

Thus, being i the nominal rate; i_f the effective rate; k the number of capitalizations for one period of the nominal rate; and i_k the rate per capitalization period $\left(i_k = \frac{i}{k}\right)$.

Since i_f is equivalent to $i_k$we have:

$$1 + i_f = (1 + i_k)^k$$

If $i_k = \frac{i}{k}$ the formula (14) calculates the effective rate:

$$1 + i_f = \left(1 + \frac{i}{k}\right)^k \tag{14}$$

2.12 REAL RATE AND APPARENT RATE

The apparent rate is that which applies to current transactions (CRESPO, 1999). When there is no inflation, the apparent rate is equal to the real rate, but when there is inflation, the apparent rate is made up of a component corresponding to inflation and another component corresponding to real interest.

Where C the initial capital; r the real rate; i the apparent rate; I the inflation rate.

The following cases may occur:

- With zero inflation and an interest rate of $r$the initial capital will, at the end of a period, be transformed into:

$$C(1 + r)$$

- With an inflation rate of $I$the initial capital at the end of a period will be equivalent to:

$$C(1 + I)$$

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ISSN: 2764-9547

- With an interest rate r and an inflation rate Isimultaneously, the initial capital will be equivalent to:

$$C(1+r)(1+I)$$

- With an apparent rate $i$the initial capital will, at the end of a period, be transformed into:

$$C(1+i)$$

As (III) and (IV) are equivalent expressions, as they both reflect the amount actually received, you can do the same thing:

$$C(1+i) = C(1+r)(1+I)$$

This leads to formula (15), which is used to calculate the real rate and the apparent rate:

$$(1+i) = (1+r)(1+I) \tag{15}$$

2.13 COMPOUND CAPITALIZATION

In the compound capitalization system, the interest from each period is incorporated into the following period, generating a new calculation on the accumulated interest, so that it behaves like a geometric progression (PG), generating the so-called "interest on interest". Using the previous example, let's assume that an investment of R$1,000.00 brings a return of 1% at the end of each month at compound interest, the results of which are shown in Table 2.

Table 2- Representation of the calculation of the compound capitalization regime

Month	Balance at the beginning of each month ($)	Monthly interest ($)	Monthly growth ($)	Balance at the end of each month ($)
1	1.000,00	0,01 x 1.000,00 = 10,00	10,00	1.010,00
2	1.010,00	0,01 x 1.010,00 = 10,10	10,10	1.020,10
3	1.020,10	0,01 x 1.020,10 = 10,20	10,20	1.030,30
4	1.030,30	0,01 x 1.030,30 = 10,30	10,30	1.040,60
5	1.040,60	0,01 x 1.040,60 = 10,41	10,41	1.051,01

Source: Author's collection

You can see from the table that in the compound interest system, the interest produced at the end of each month is added to the capital that produced it, with both the capital and the interest earning interest the following month. It can also be concluded that the amount in the compound interest system is greater than in the simple interest system from the second period onwards.

3 AMORTIZATION SYSTEMS

3.1 LOAN AMORTIZATION SYSTEMS

This chapter will study the constant, French (Price) and mixed amortization systems and their different ways of repaying a debt. In addition, two examples of loans will be analyzed using each of these systems by constructing financial tables. Amortization systems, developed basically for long-term loans and financing operations, are the ways in which loans are repaid, in other words, these systems basically deal with the way in which the principal and financial charges are returned to the lender of the capital (NETO 2006; VERAS 2005).

3.3.1 Constant amortization system (SAC) and Amortization (AMORT)

According to Neto (2006), in SAC, as the name suggests, the principal repayments are always constant, i.e. they are the same throughout the term of the operation, because the repayment value is obtained by dividing the borrowed capital by the number of installments. In addition, interest, since it is charged on the outstanding balance, the amount of which decreases after each repayment, takes on decreasing values over the periods.

As a result of the behavior of amortization and interest, the periodic and successive installments of the constant amortization system are decreasing in arithmetic progression. The following are formulas to help with SAC calculations. The amortization values are always the same in all periods and are obtained from formula (19):

$$Amort = \frac{VP}{n} \tag{19}$$

Of which VP the principal value and n the total number of periods.

Then:

$$\frac{VP}{n} = Amort_1 = Amort_2 = Amort_3 = \cdots = Amort_n$$

$$VP = Amort_1 + Amort_2 + Amort_3 + \cdots + Amort_n$$

3.3.1.1 Balance due (SD), Interest and installment (PT)

The outstanding balance decreases in arithmetic progression (AP) by the constant value of the amortization. To calculate the debit balance, use (20).

$$SD_n = SD_{n-1} - Amort \tag{20}$$

Where SD_n the debit balance for the period; SD_{n-1} the debit balance for the previous period and $Amort$ the amount of the amortization. It can be seen from (20) that the debit balance of the following period will be equal to that of the previous period minus the amortization. Therefore $0 < n$ (considering period 0 only as the start of the debt), we have:

$$n = 1;\ SD_1 = SD_{1-1} - Amort \Rightarrow SD_1 = SD_0 - Amort$$
$$n = 2;\ SD_2 = SD_1 - Amort \Rightarrow SD_2 = SD_0 - 2Amort$$
$$n = 3;\ SD_3 = SD_2 - Amort \Rightarrow SD_3 = SD_0 - 3Amort$$

It follows that:

$$SD_n = SD_0 - n\,.Amort \tag{21}$$

Since interest is charged on the outstanding balance, it is constantly reduced over the periods, behaving like a decreasing AP. If $i$the interest rate, (22) is used to calculate the interest for each period. For any period t, we have:

$$J_t = \left(VP - \frac{VP}{n} - \frac{VP}{n} - \cdots - \frac{VP}{n}\right).i$$
$$J_t = \left(VP - \frac{(t-1)VP}{n}\right).i$$
$$J_t = \left(\frac{VP.n - (t-1)VP}{n}\right).i$$
$$J_t = \left(\frac{VP[n-(t-1)]}{n}\right).i$$

This results in

$$J_t = \tfrac{VP}{n}.(n - t + 1).i \tag{22}$$

The installment is the sum of the amortization and the interest. To calculate it, use (23).

$$PT = Amort + J$$
$$PT = \frac{VP}{n} + \left[\frac{VP}{n}.(n - t + 1).i\right]$$

Like this:

$$PT = \tfrac{VP}{n}[1 + (n - t + 1).i] \tag{23}$$

We will now use examples 1 and 2 as a basis for analyzing loans in the amortization systems discussed in this paper.

Example 1: The owner of a textile industry, with the aim of increasing his production, takes out a loan from the bank for R$400,000.00 to invest in new machinery. The interest rate assigned to this amount is 13.8% per semester, to be paid back in six-monthly installments over a period of 4 years using the constant amortization system.

Table (3) shows the values obtained in this operation by calculating the SAC.

Table 3: Constant amortization system with no grace period

Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	400.000,00	-	-	-
1	350.000,00	50.000,00	55.200,00	105.200,00
2	300.000,00	50.000,00	48.300,00	98.300,00
3	250.000,00	50.000,00	41.400,00	91.400,00
4	200.000,00	50.000,00	34.500,00	84.500,00
5	150.000,00	50.000,00	27.600,00	77.600,00
6	100.000,00	50.000,00	20.700,00	70.700,00
7	50.000,00	50.000,00	13.800,00	63.800,00
8	-	50.000,00	6.900,00	56.900,00
Total	-	400.000,00	248.400,00	648.400,00

Source: Author

Example 2: A couple, looking to start their married life, decide to take out a loan of R$160,000.00 to buy a property at an interest rate of 7.2% per year, to be paid off within 25 years. Their contract includes an agreement stating that the installment for each period (year) will be divided equally into 12 monthly installments using the constant amortization system. Table (4) shows the calculations and values for this loan.

Table 4 - Constant amortization system with no grace period

Period (Year)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Annual payment (R$)	Monthly payment
0	160.000,00	-	-	-	
1	153.600,00	6.400,00	11.520,00	17.920,00	1493,33
2	147.200,00	6.400,00	11.059,20	17.459,20	1454,93
3	140.800,00	6.400,00	10.598,40	16.998,40	1416,53
4	134.400,00	6.400,00	10.137,60	16.537,60	1378,13
5	128.800,00	6.400,00	9.676,80	16.076,80	1339,73
6	121.600,00	6.400,00	9.216,00	15.616,00	1301,33
7	115.200,00	6.400,00	8.755,20	15.155,20	1262,93
8	108.800,00	6.400,00	8.294,40	14.694,40	1224,53
9	102.400,00	6.400,00	7.833,60	14.233,60	1186,13
10	96.000,00	6.400,00	7.372,80	13.772,80	1147,73
11	89.600,00	6.400,00	6.912,00	13.312,00	1109,33
12	83.200,00	6.400,00	6.451,20	12.851,20	1070,93
13	76.800,00	6.400,00	5.990,40	12.390,40	1032,53
14	70.400,00	6.400,00	5.529,60	11.929,60	994,13
15	64.000,00	6.400,00	5.068,80	11.468,80	955,73
16	57.600,00	6.400,00	4.608,00	11.008,00	917,33
17	51.200,00	6.400,00	4.147,20	10.547,20	878,93

18	44.800,00	6.400,00	3.686,40	10.086,40	840,53
19	38.400,00	6.400,00	3.225,60	9.625,60	802,13
20	32.000,00	6.400,00	2.764,80	9.164,80	763,73
21	25.600,00	6.400,00	2.304,00	8.704,00	725,33
22	19.200,00	6.400,00	1.843,20	8.243,20	686,93
23	12.800,00	6.400,00	1.382,40	7.782,40	648,53
24	6.400,00	6.400,00	921,60	7.321,60	610,13
25	-	6.400,00	460,80	6.860,80	571,73
Total	-	160.000,00	149.760,00	309.760,00	

Source: Author

In fact, the repayments are the same in all periods, and are obtained by dividing the principal amount by the number of installments. The way your interest is calculated is just as simple as calculating your repayments. They are found by multiplying the outstanding balance by the interest rate. In the first period, you calculate the principal amount multiplied by the interest rate, thus finding the interest amount for this period.

As your installments are obtained by adding the amortization plus the interest, you get the first installment to be paid. In the second period, the same reasoning is followed, calculating the outstanding balance for this period multiplied by the interest rate and adding this to the amortization, giving the installment for the second period and continuing with the remaining periods.

You can see that because your amortizations are constant, your debit balance will decrease arithmetically in every period. In the same way, interest is charged on the debit balance, since it directly affects the value of each installment, as it is the difference in value from the first installment to the second, from the second to the third and so on. Therefore, the payment method is decreasing.

3.3.1.2 Constant amortization system with grace period

To show how this system is calculated with a grace period, we will use o Example 1.

Table (5) shows the SAC with a 2-year grace period and interest payments.

Table 5 - Constant Amortization System with 2-year grace period and interest payments

Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	400.000,00	-	-	-
1	400.000,00	-	55.200,00	55.200,00
2	400.000,00	-	55.200,00	55.200,00
3	400.000,00	-	55.200,00	55.200,00
4	400.000,00	-	55.200,00	55.200,00
5	350.000,00	50.000,00	55.200,00	105.200,00
6	300.000,00	50.000,00	48.300,00	98.300,00
7	250.000,00	50.000,00	41.400,00	91.400,00

8	200.000,00	50.000,00	34.500,00	84.500,00
9	150.000,00	50.000,00	27.600,00	77.600,00
10	100.000,00	50.000,00	20.700,00	70.700,00
11	50.000,00	50.000,00	13.800,00	63.800,00
12	-	50.000,00	6.900,00	56.900,00
Total	-	400.000,00	469.200,00	869.200,00

Source: Author

In table (5), interest is paid during the grace period. Therefore, in the first four periods corresponding to the 2-year grace period, the installments to be paid will be the interest recurring to the principal amount.

After the end of the grace period, the amortization payment plus interest begins, so the debt is extinguished in the same way as with SAC without a grace period.

Table (6) shows the SAC with grace period and interest capitalization.

Table 6 - Constant Amortization System with 2-year grace period and interest capitalization

Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	400.000,00	-	-	-
1	455.200,00	-	-	-
2	518.017,60	-	-	-
3	589.504,03	-	-	-
4	670.855,59	-	-	-
5	350.000,00	50.000,00	363.433,65	413.433,65
6	300.000,00	50.000,00	48.300,00	98.300,00
7	250.000,00	50.000,00	41.400,00	91.400,00
8	200.000,00	50.000,00	34.500,00	84.500,00
9	150.000,00	50.000,00	27.600,00	77.600,00
10	100.000,00	50.000,00	20.700,00	70.700,00
11	50.000,00	50.000,00	13.800,00	63.800,00
12	-	50.000,00	6.900,00	56.900,00
Total	-	400.000,00	469.110,59	956.633,65

This table shows the amortization of the debt without the payment of interest, with interest being added to the outstanding balance, capitalizing it using compound interest criteria. Therefore, at the end of the first semester, the rate of 13.8% is added to the debit balance, giving the debit balance for the following semester and so on for the rest of the periods.

In the fifth semester, the outstanding balance is calculated again using the interest rate, so that the final amount of interest is found after the grace period, so that in this period the periodic repayments begin with the payment of all the interest capitalized during the grace period. From this period onwards, the debt will be paid off in the same way as the SAC with no grace period. Table 7 shows the SAC with a 2-year grace period and capitalization of the interest added to the outstanding balance.

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Table 7 - Constant Amortization System with a 2-year grace period and capitalization of the interest added to the outstanding balance.

Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	400.000,00	-	-	-
1	455.200,00	-	-	-
2	518.017,60	-	-	-
3	589.504,03	-	-	-
4	670.855,59	-	-	-
5	586.998,65	83.856,95	92.578,07	176.435,02
6	503.141,70	83.856,95	81.005,81	164.862,76
7	419.284,75	83.856,95	69.433,55	153.290,50
8	335.427,80	83.856,95	57.861,29	141.718,24
9	251.570,85	83.856,95	46.289,04	130.145,99
10	167.713,90	83.856,95	34.714,78	118.573,73
11	83.856,95	83.856,95	23.144,52	107.001,47
12	-	83.856,94	11.572,26	95.429,20
Total	-	670.855,59	416.599,32	1.087.454,91

Source: Author

In table (7) the interest is capitalized in the same way as in table (6), but in table (7) from the fifth semester onwards the interest is distributed equally in the amortization flow, after which the debt acts in the same way as the SAC with no grace period, with constant amortization.

3.1.2 French amortization system (FAS) - Price

According to Neto (2006), in SAF, unlike SAC, the installments must be equal, periodic and successive from the beginning to the end of the contract. In this system, interest, since it is levied on the outstanding balance, is decreasing and amortization is increasing, so the sum of amortization and interest always remains the same.

The following are the basic formulas that will make the SAF calculations easier.

3.1.2.1 Installment (PT); interest (J) and amortization (AMORT) and outstanding balance (SD)

The benefits of this system are obtained from formula (24).

$$PT = VP\,.\left(\frac{i\,.(1+i)^n}{(1+i)^n-1}\right) \tag{24}$$

Interest is charged on the outstanding balance for each period. The expression for calculating interest can be illustrated as follows:

$$J_1 = SD_0\,.i = VP\,.i$$
$$J_2 = SD_1\,.i = (VP - Amort_1).i$$
$$J_3 = SD_2\,.i = (VP - Amort_1 - Amort_2).i$$

Thus, for any period n any period, *we* obtain the formula (25) used to calculate the interest.

$$J_n = SD_{n-1} \,.\, i \tag{25}$$

The amortization of this system takes an increasing form, as it is obtained by the difference between the value of the installment and that of the interest. Thus, we have

$$Amort = PT - J$$

Where PT the amount of the installment and J the amount of interest.

The amortization of the first and second periods is expressed as:

$$Amort_1 = PT - J_1$$
$$Amort_2 = PT - J_2$$

Thus, the value of the amortization in any given period $n$is calculated using formula (26).

$$A_n = PT - J_n \tag{26}$$

The outstanding balance is calculated for each period by the difference between the amount owed at the start of the period and the amortization for the period. This gives us

$$SD_1 = VP - Amort_1$$
$$SD_2 = SD_1 - Amort_2$$

So, to calculate the debit balance in any given period $n$the formula (27) is used.

$$SD_n = SD_{n-1} - Amort_n \tag{27}$$

Now we'll use Example 1 to show the FAS calculation. Table (8) shows the values obtained in this operation by calculating the SAF.

Table 8 - French Amortization System with no grace period

Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	400.000,00	-	-	-
1	369.549,78	30.450,22	55.200,00	85.650,22
2	334.897,43	34.652,35	50.997,87	85.650,22
3	295.463,06	39.434,37	46.215,85	85.650,22
4	250.586,74	44.876,32	40.773,90	85.650,22
5	199.517,49	51.069,25	34.580,97	85.650,22
6	141.400,68	58.116,81	27.533,41	85.650,22
7	75.263,75	66.136,93	19.513,29	85.650,22
8	-	75.263,75	10.386,40	85.650,15
Total	-	400.000,00	285.201,69	685.201,69

Source: Author

Example 2 will be used below to show the SAF calculation. Table (9) shows the values acquired on this loan through the SAF calculation.

Table 9 - French Amortization System with no grace period

Period (Year)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	160.000,00	-	-	-
1	157.542,04	2.457,96	11.520,00	13.977,96
2	154.907,11	2.634,93	11.343,03	13.977,96
3	152.082,46	2.824,65	11.153,31	13.977,96
4	149.054,44	3.028,02	10.949,94	13.977,96
5	145.808,40	3.246,04	10.731,92	13.977,96
6	142.328,65	3.479,75	10.498,21	13.977,96
7	138.598,35	3.730,30	10.247,66	13.977,96
8	134.599,47	3.998,88	9.979,08	13.977,96
9	130.312,67	4.286,80	9.691,16	13.977,96
10	125.717,22	4.595,45	9.382,51	13.977,96
11	120.790,90	4.926,32	9.051,64	13.977,96
12	115.509,89	5.281,01	8.696,95	13.977,96
13	109.848,64	5.661,25	8.316,71	13.977,96
14	103.779,78	6.068,86	7.909,10	13.977,96
15	97.273.96	6.505,82	7.472,14	13.977,96
16	90.299,73	6.974,23	7.003,73	13.977,96
17	82.823,35	7.476,38	6.501,58	13.977,96
18	74.808,67	8.014,68	5.963,28	13.977,96
19	66.216,96	8.591,71	5.386,22	13.977,96
20	57.006,62	9.210,34	4.767,62	13.977,96
21	47.133,14	9.873,48	4.104,48	13.977,96
22	36.548,77	10.584,37	3.393,59	13.977,96
23	25.202,32	11.346,45	2.631,51	13.977,96
24	13.038,93	12.163,39	1.814,57	13.977,96
25	-	13.038,93	938,80	13.977,73
Total	-	160.000,00	189.448,74	349.448,77

Source: Author

The characteristic of this system is that the installments are identical in every period, and it is first necessary to find their value in order to calculate their amortization. The debit balance decreases as a result of the elimination of the amortization of each period as they are paid off, and likewise the interest decreases as it is calculated on the debit balance, becoming inversely proportional to the amortization, i.e. while the interest decreases, the amortization increases, so that both add up to equal installments.

Therefore, it can be seen that once the value of the installments has been found, the other values are obtained sequentially in each period.

3.3.2.2 French amortization system with grace period

The following shows how the SAF is calculated with a shortfall, using example 1.

(10) shows the SAF with a 2-year grace period and interest payments.

Table 10 - French Amortization System with 2-year grace period and interest payments

Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	400.000,00	-	-	-
1	400.000,00	-	55.200,00	55.200,00
2	400.000,00	-	55.200,00	55.200,00
3	400.000,00	-	55.200,00	55.200,00
4	400.000,00	-	55.200,00	55.200,00
5	369.549,78	30.450,22	55.200,00	85.650,22
6	334.897,43	34.652,35	50.997,87	85.650,22
7	295.463,06	39.434,37	46.215,85	85.650,22
8	250.586,74	44.876,32	40.773,90	85.650,22
9	199.517,49	51.069,25	34.580,97	85.650,22
10	141.400,68	58.116,81	27.533,41	85.650,22
11	75.263,75	66.136,93	19.513,29	85.650,22
12	-	75.263,75	10.386,40	85.650,15
Total	-	400.000,00		

Source: Author

Table (10) is similar to the SAF table with no grace period, the only difference being the interest payments, which are obtained by multiplying the rate by the outstanding balance during the grace periods. The sequence of semesters follows the same reasoning as the system without a grace period, with equal installments, decreasing interest and increasing repayments.

Table (11) shows the SAF with a grace period and interest capitalization.

Table 11 - French Amortization System with 2-year grace period and interest capitalization

Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	400.000,00	-	-	-
1	455.200,00	-	-	-
2	518.017,60	-	-	-
3	589.504,03	-	-	-
4	670.855,59	-	-	-
5	619.786,35	51.069,24	92.578,07	143.647,31
6	561.669,56	58.116,79	85.530,52	143.647,31
7	495.532,65	66.136,91	77.510,40	143.647,31
8	420.268,85	75.263,80	68.383,51	143.647,31
9	334.618,64	85.650,21	57.997,10	143.647,31
10	237.148,70	97.469,94	46.177,37	143.647,31
11	126.227,91	110.920,79	32.726,52	143.647,31
12	-	126.227,91	17.419,45	143.647,36
Total	-	670.855,59	478.322,94	1.149.178,53

Source: Author

Table (11) shows the capitalization of interest during the grace period. Instead of being paid during the grace period, the interest is added to the outstanding balance during the four

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semesters. In the fifth semester, the debt begins to be paid off, so new calculations are made to obtain the installment values, and consequently the interest and amortization.

In this way, the system shown here takes the form of calculations identical to the SAF without a grace period.

3.1.3 Analysis between SAC and SAF

Table (12) shows the results obtained in the SAC and SAF used in example 1.

Table 12- Results obtained with the SAC and SAF amortization systems

SAC					SAF				
Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)	Period (Semester)	Balance owed (R$)	Amortization (R$)	Interest (R$)	Rendering (R$)
0	400.000,00	-	-	-	0	400.000,00	-	-	-
1	350.000,00	50.000,00	55.200,00	105.200,00	1	369.549,78	30.450,22	55.200,00	85.650,22
2	300.000,00	50.000,00	48.300,00	98.300,00	2	334.897,43	34.652,35	50.997,87	85.650,22
3	250.000,00	50.000,00	41.400,00	91.400,00	3	295.463,06	39.434,37	46.215,85	85.650,22
4	200.000,00	50.000,00	34.500,00	84.500,00	4	250.586,74	44.876,32	40.773,90	85.650,22
5	150.000,00	50.000,00	27.600,00	77.600,00	5	199.517,49	51.069,25	34.580,97	85.650,22
6	100.000,00	50.000,00	20.700,00	70.700,00	6	141.400,68	58.116,81	27.533,41	85.650,22
7	50.000,00	50.000,00	13.800,00	63.800,00	7	75.263,75	66.136,93	19.513,29	85.650,22
8	-	50.000,00	6.900,00	56.900,00	8	-	75.263,75	10.386,40	85.650,15
Total	-	400.000,00	248.400,00	648.400,00	Total	-	400.000,00	285.201,69	685.201,69

In Table 12 above, it can be seen that for the same loan, with SAC the installments are initially larger and decreasing, so that at the end of the contract you pay less interest than with SAF, which unlike SAC, starts with smaller, fixed installments that end up increasing the total amount of interest paid at the end of the loan.

4 COMPARISON BETWEEN THE AMORTIZATION SYSTEMS USED IN LOAN SIMULATIONS

This chapter will present two loan simulations at different banks that will be calculated in tables using the French amortization systems (SAF), which will then be calculated using the constant amortization system (SAC), comparing the total amount of interest and installments paid on each of the loans according to the amortization system offered by the bank. ending with an analysis of the advantages and disadvantages of these three amortization systems.

4.1 CREDIT SIMULATIONS

This section will present two simulations related to amortization systems, as well as the use of graphs that will make it easier to understand the comparison between SAF and SAC.

4.1.1 Personal loan simulation at Bradesco bank

At this bank, we simulated a loan of $R\$10.000,00$. Table 14 shows the conditions required by Bradesco to take out this loan.

Table 14- Loan contract data

Amortization system	Amount lent	Amount of the installment	Interest rate (p.a.) %	Interest rate (a.m) %	Term (months)	CET (p.a.) %	CET (a.m) %	Value (IOF)
SAF	10000,00	856,68	145,46	7,77	36	157,60	8,20	330,82

Source: Author

From the data in table 14, calculations are made using the SAF to obtain the monthly amounts to be paid on the loan in question, as shown in table 15.

This bank simulated a loan of $R\$10000,00$ Bradesco uses the French amortization system (SAF) to amortize the debt. Table (15) shows the amounts obtained each month using the FAS:

Table 15- Simulation of loan repayment using SAF

PERIOD (MONTH)	BALANCE OWED (R$)	AMORTIZATION (R$)	INTEREST (R$)	GIFT (R$)
0	10.000,00	-	-	-
1	9.948,97	51,03	820,00	871,03
2	9.893,76	55,21	815,82	871,03
3	9.834,02	59,74	811,29	871,03
4	9.769,38	64,64	806,39	871,03
5	9.699,44	69,94	801,09	871,03
6	9.623,76	75,68	795,35	871,03
7	9.541,88	81,88	789,15	871,03
8	9.453,28	88,60	782,43	871,03
9	9.357,42	95,86	775,17	871,03
10	9.253,70	103,72	767,31	871,03
11	9.141,47	112,23	758,80	871,03
12	9.020,04	121,43	749,60	871,03
13	8.888,65	131,39	739,64	871,03
14	8.746,49	142,16	728,87	871,03
15	8.592,67	153,82	717,21	871,03

16	8.426,24	166,43	704,60	871,03
17	8.246,16	180,08	690,95	871,03
18	8.051,32	194,84	676,19	871,03
19	7.840,50	210,82	660,21	871,03
20	7.612,39	228,11	642,92	871,03
21	7.365,58	246,81	624,22	871,03
22	7.098,53	267,05	603,98	871,03
23	6.809,58	288,95	582,08	871,03
24	6.496,94	312,64	558,39	871,03
25	6.158,66	338,28	532,75	871,03
26	5.792,64	366,02	505,01	871,03
27	5.396,61	396,03	475,00	871,03
28	4.968,10	428,51	442,52	871,03
29	4.504,45	463,65	407,38	871,03
30	4.002,79	501,66	369,37	871,03
31	3.459,99	542,80	328,23	871,03
32	2.872,68	587,31	283,72	871,03
33	2.237,21	635,47	235,56	871,03
34	1.549,63	687,58	183,45	871,03
35	805,67	743,96	127,07	871,03
36	-	805,67	66,06	871,73
TOTAL	-	10.000,00	21.357,78	31.357,78

Source: Author

Now, in order to compare the most viable amortization system to be used for this loan, the debt amortization using SAC will be analyzed in table (16).

Table 16- Simulation of loan repayment using SAC

PERIOD (MONTH)	BALANCE OWED (R$)	AMORTIZATION (R$)	INTEREST (R$)	GIFT (R$)
0	10.000,00	-	-	-
1	9722,23	277,77	820,00	1.097,77
2	9444,46	277,77	797,22	1.074,99
3	9166,69	277,77	774,45	1.052,22
4	8888,92	277,77	751,67	1.029,44
5	8611,15	277,77	728,89	1.006,66
6	8333,38	277,77	706,11	983,88
7	8055,61	277,77	683,34	961,11
8	7777,84	277,77	660,56	938,33
9	7500,07	277,77	637,78	915,55
10	7222,30	277,77	615,01	892,78
11	6944,53	277,77	592,23	870,00
12	6666,76	277,77	569,45	847,22
13	6388,99	277,77	546,67	824,44
14	6111,22	277,77	523,90	801,67
15	5833,45	277,77	501,12	778,89
16	5555,68	277,77	478,34	756,11
17	5277,91	277,77	455,57	733,34
18	5000,14	277,77	432,79	710,56
19	4722,37	277,77	410.01	687,78
20	4444,60	277,77	387,23	665,00
21	4166,83	277,77	364,46	642,23
22	3889,06	277,77	341,68	619,45

23	3611,29	277,77	318,90	596,67
24	3333,52	277,77	296,13	573,90
25	3055,75	277,77	273,35	551,12
26	2777,98	277,77	250,57	528,34
27	2500,21	277,77	227,79	505,56
28	2222,44	277,77	205,02	482,79
29	1944,64	277,77	182,24	460,01
30	1666,90	277,77	159,46	437,23
31	1389,13	277,77	136,69	414,46
32	1111,36	277,77	113,91	391,68
33	833,59	277,77	91,13	368,90
34	555,82	277,77	68,35	346,12
35	278,05	277,77	45,58	323,35
36	-	278,05	22,80	300,85
TOTAL	-	**10.000,00**	**15.170,40**	**25.170,40**

Source: Author

To make it easier to understand the total amount of interest and installments paid on this loan using the SAF and the SAC, we will show the table (17) and then the graph involving the two amortization systems which will serve as a tool for comparing and indicating the best amortization system for paying off the loan of $R\$10.000,00$.

Table 17- Representation of the total amounts of interest and installments paid with SAF and SAC

AMORTIZATION SYSTEM	TOTAL AMORTIZATION PAID	TOTAL INTEREST PAID (R$)	TOTAL INSTALLMENTS PAID (R$)
SAF	10.000,00	21.357,78	31.357,78
SAC	10.000,00	15.170,40	25.170,40

Source: Author

4.1.2 Personal loan simulation at itaú bank

At this bank, we simulated a loan of $R\$10.000,00$. Table 18 shows the conditions required by Itaú to take out this loan.

Table 18- Loan contract data

Amortization system	Amount borrowed	Amount of the installment	Interest rate (p.a.) %	Interest rate (a.m) %	Term (months)	CET (p.a.) %	CET (a.m) %	Value (IOF)
SAF	10000,00	1.003,16		7,77%	36	202,77 %	9,67%	

Source: Author

Based on the data in table 18, calculations are made using the SAF to obtain the monthly amounts to be paid on the loan in question, as shown in table 19.

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ISSN: 2764-9547

Table 19- Simulation of loan repayment using SAF

PERIOD (MONTH)	BALANCE OWED (R$)	AMORTIZATION (R$)	INTEREST (R$)	GIFT (R$)
0	10.000,00	-	9,67%	-
1	9.963,84	36,16	967,00	1.003,16
2	9.924,18	39,66	963,50	1.003,16
3	9.880,69	43,49	959,67	1.003,16
4	9.832,99	47,70	955,46	1.003,16
5	9.780,68	52,31	950,85	1.003,16
6	9.723,31	57,37	945,79	1.003,16
7	9.660,39	62,92	940,24	1.003,16
8	9.591,39	69,00	934,16	1.003,16
9	9.515,72	75,67	927,49	1.003,16
10	9.432,73	82,99	920,17	1.003,16
11	9.341,71	91,02	912,14	1.003,16
12	9.241,89	99,82	903,34	1.003,16
13	9.132,42	109,47	893,69	1.003,16
14	9.012,37	120,05	883,11	1.003,16
15	8.880,71	131,66	871,50	1.003,16
16	8.736,31	144,40	858,76	1.003,16
17	8.577,95	158,36	844,80	1.003,16
18	8.404,28	173,67	829,49	1.003,16
19	8.213,81	190,47	812,69	1.003,16
20	8.004,93	208,88	794,28	1.003,16
21	7.775,85	229,08	774,08	1.003,16
22	7.524,61	251,24	751,92	1.003,16
23	7.249,08	275,53	727,63	1.003,16
24	6.946,91	302,17	700,99	1.003,16
25	6.615,52	331,39	671,77	1.003,16
26	6.252,08	363,44	639,72	1.003,16
27	5.853,50	398,58	604,58	1.003,16
28	5.416,37	437,13	566,03	1.003,16
29	4.936,97	479,40	523,76	1.003,16
30	4.411,21	525,76	477,40	1.003,16
31	3.834,61	576,60	426,56	1.003,16
32	3.202,26	632,35	370,81	1.003,16
33	2.508,76	693,50	309,66	1.003,16
34	1.748,20	760,56	242,60	1.003,16
35	914,09	834,11	169,05	1.003,16
36	-	914,09	88,39	1.002,48
TOTAL	-	10.000,00	26.113,08	36.113,08

Source: Author

Table (20) now shows the amortization of the debt using SAC, in order to compare the most viable amortization system to be used for this loan.

Table 20- Simulation of loan repayment using SAC

PERIOD (MONTH)	BALANCE OWED (R$)	AMORTIZATION (R$)	INTEREST (R$)	GIFT (R$)
0	10.000,00	-	9,67%	-
1	9.722,23	277,77	967,00	1.244,77
2	9.444,46	277,77	940,14	1.217,91
3	9.166,69	277,77	913,28	1.191,05

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ISSN: 2764-9547

4	8.888,92	277,77	886,42	1.164,19
5	8.611,15	277,77	859,56	1.137,33
6	8.333,38	277,77	832,70	1.110,47
7	8.055,61	277,77	805,84	1.083,61
8	7.777,84	277,77	778,98	1.056,75
9	7.500,07	277,77	752,12	1.029,89
10	7.222,30	277,77	725,26	1.003,03
11	6.944,53	277,77	698,40	976,17
12	6.666,76	277,77	671,54	949,31
13	6.388,99	277,77	644,68	922,45
14	6.111,22	277,77	617,82	895,59
15	5.833,45	277,77	590,96	868,73
16	5.555,68	277,77	564,10	841,87
17	5.277,91	277,77	537,24	815,01
18	5.000,14	277,77	510,38	788,15
19	4.722,37	277,77	483,52	761,29
20	4.444,60	277,77	456,66	734,43
21	4.166,83	277,77	429,80	707,57
22	3.889,06	277,77	402,94	680,71
23	3.611,29	277,77	376,08	653,85
24	3.333,52	277,77	349,22	626,99
25	3.055,75	277,77	322,36	600,13
26	2.777,98	277,77	295,50	573,27
27	2.500,21	277,77	268,64	546,41
28	2.222,44	277,77	241,78	519,55
29	1.944,64	277,77	214,92	492,69
30	1.666,90	277,77	188,06	465,83
31	1.389,13	277,77	161,20	438,97
32	1.111,36	277,77	134,34	412,11
33	833,59	277,77	107,48	385,25
34	555,82	277,77	80,62	358,39
35	278,05	277,77	53,76	331,53
36	-	278,05	26,90	304,95
TOTAL	-	10.000,00	17.890,20	27.890,20

Source: Author

In order to make it easier to understand the total amount of interest and installments paid on this loan using the SAF and the SAC, we will show the table (21) and then the graph involving the two amortization systems which will serve as a tool for comparing and indicating the best amortization system for paying off the loan of $R\$10.000,00$.

Table 21- Representation of the total amounts of interest and installments paid in SAF and SAC

AMORTIZATION SYSTEM	TOTAL AMORTIZATION PAID	TOTAL INTEREST PAID (R$)	TOTAL INSTALLMENTS PAID (R$)
SAF	10.000,00	26.113,08	36.113,08
SAC	10.000,00	17.890,20	27.890,20

Source: Author

A comparison will now be made between the data from Bradesco and Itaú banks, as shown in (22), to indicate the best choice of bank for the client when taking out a loan of 10,000.00.

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ISSN: 2764-9547

Table 22- Comparison between Bradesco and Itaú loan contract data

BANKS	LOAN AMOUNT	MONTHLY PAYMENT	A.M. INTEREST RATE	CET A.A	CET A.M	TOTAL INTEREST PAID (R$)	TOTAL INSTALLMENTS PAID (R$)
Bradesco (SAF)	10.000,00	871,03	7,77%	157,60%	8,20%	21.357,78	31.357,78
Itaú (SAF)	10.000,00	1003,06	7,77%	202,77%	9,67%	26.113,08	36.113,08

It can be seen from table (22) that both Bradesco and Itaú use the SAF and the same interest rates of 7.77% per month, but it is worth noting that these rates are not the only ones used to calculate interest, but rather the Total Effective Cost (CET)[1] which, as can be seen in (21), is equivalent to 8.20% per month at Bradesco and 9.67% per month at Itaú. As a result, Itaú's monthly installments are higher than Bradesco's, meaning that the debt paid by the customer will be higher if they opt for the Itaú loan. Therefore, in these loan simulations between the Bradesco and Itaú banks, it would be better to take out a loan with Bradesco.

5 CONCLUSION

According to the context covered, it was found that the amortization systems, more specifically the constant and French amortization systems, represented much more viable systems for the client when taking out a loan, bearing in mind that the calculations presented can help the reader to have a better idea by means of simulations of the two loans to the point of comparing them.

The topics covered how financial mathematics can be applied and solved, and it is essential knowledge for those who wish to take out a loan, because it is necessary to know the interest rates and, above all, which is the most viable way and with the least amount at the end of the loan, because as it turned out, the study of the main repayment systems used in financial institutions; The study of the main amortization systems used by financial institutions, in order to highlight the most viable to customers and banks, can bring greater clarity to those dealing with these financial situations and financial mathematics can offer the best way with the lowest interest rate, as long as it is possible to evaluate, analyze and equate the rates before settling the installments.

In this way, the work was able to lead the reader to the methods used to situate the reader in the best loan conditions for amortization systems. Therefore, as mentioned throughout the text, financial mathematics as a field in applications in amortization systems in the matter of compound interest, contributes as one of the great aids for banking companies that aim only at profits, and profit billions due to the capitalization regime and application of rates, which must be carefully evaluated by those who seek these companies in search of loans.

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