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Financial Mathematical Analysis in Applying Interest Rates, Installments, Amortization, Present and Future Values to Home Ownership Loans

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Abstract

Home ownership credit has become a choice for many people to own a home, so that credit repayment runs smoothly, there needs to be an analysis from a financial perspective and a strategy for repayment. This paper aims to analyze and calculate the application of financial mathematical concepts in the context of home ownership credit. The main focus involves interest rates, installments, amortization, present and future value. Through a quantitative approach, we investigate the impact of changes in interest rates on monthly payments, explain the amortization mechanism, and evaluate the implications of payment policies on loan repayment times. The result is that by using the application of financial mathematics you can calculate monthly payments, analyze amortization, calculate present value and so on. So this paper can be useful for planning home ownership loans.

Keywords: Home ownership credit, interest rates, credit, amortization, present and future value.

1. Introduction

As time goes by, the human population on this earth also increases. Based on data from the Central Statistics Agency (BPS), in 2023 Indonesia's population will reach 278.8 million people. The increase in population has an impact on increasing people's needs for clothing, food and shelter. Owning a house is one of every human's desires, in fact it is a top priority that must be realized. However, as the population becomes increasingly dense, it becomes increasingly difficult to obtain available land. Limited land has an impact on increasing land prices every year. This also has an impact on increasing the price of existing houses. To own a house requires quite a large amount of funds. It is still difficult for people who do not have sufficient financial means to fulfill their need for a decent home if they have to buy in cash. To overcome this, the Bank, which is one of the financial institutions overseen by the Financial Services Authority (OJK), created a national housing program by distributing funds in the form of Home Ownership Credit (KPR).

Home Ownership Credit (KPR) is a credit facility provided by banks to individual customers who want to buy or repair a house. Through this Home Ownership Credit (KPR) system, debtors obtain a house, along with rights to the land on which the house stands, by payment in installments (Elisa, 2024). In this way, buyers do not have to wait until they have sufficient financial conditions to be able to obtain housing. Mortgages are in great demand among people who want to immediately own a residence, but don't have the money or not enough to buy it in cash. The safest investment currently is home ownership investment, because house prices will not decrease, on the contrary, housing prices increase every year.

Even though this home ownership credit (KPR) can ease someone's payments when buying a house, they must still consider the interest calculation system provided by the bank. Someone should understand the interest calculation system used by the bank before joining this mortgage program. The importance of a deep understanding of the interest calculation system is very necessary so that prospective homeowners can make smart financial decisions and plan credit payments wisely. Therefore, this research aims to provide a comprehensive analysis regarding the application of interest rates, installments, amortization, present and future value to home ownership loans.

2. Literature Review

2.1. The "Mathematics for Economics and Finance" by Martin Anthony dan Norman Biggs:

This book provides an in-depth guide to the application of financial mathematics in an economic and financial context. Concepts such as interest rates, annuities, and present value assessment are explained in detail with examples applicable to mortgage loans (Martin, 1996).

2.2. "The Mortgage Encyclopedia" by Jack Guttentag:

This book comprehensively discusses the various aspects of home loans. There are explanations of interest rates, amortization, and payment strategies that can provide practical insights for prospective homeowners.

2.3. "Mortgages For Dummies" by Eric Tyson dan Ray Brown:

This book presents information in simple and understandable language. With a focus on a basic understanding of mortgages, interest rates, and repayment strategies, this book can help readers understand the important concepts involved in home loans.

3. Materials and Methods

3.1. Materials

3.1.1. Interest and Interest Rates

Interest is a return of capital in the form of a sum of money received or obtained by an investor or providing capital for the use of the money outside of the initial capital. The interest rate is the price of the loan expressed as a percentage of the principal per unit of time. "Interest is a measure of the price of resources used by debtors that must be paid to creditors (Caballero, 2008). There are five types of credit interest rate charging methods, namely:

a. Fixed Interest (Fixed Rate) is an interest calculation that is fixed and will not change until the term or until the maturity date (during the credit period).

b. Floating Interest (Floating Rate) is an interest policy carried out by banks with a floating interest model. This means that banks can change interest rates without notification to debtors.

c. Flat Interest (Flat Rate) is a method of charging credit interest rates whose calculation refers to the principal amount of the loan at the beginning for each installment period. Flat interest calculations are usually intended for short-term credit.

d. Effective Interest (Sliding Rate) is the interest rate calculated from the remaining principal amount of the loan each month as the debt that has been paid decreases.

e. Annuity Interest Calculation of credit interest using this method determines the amount of principal installments plus interest installments paid to be the same every month.

3.1.2. Credit

Credit comes from the Greek "credere" which means trust and the Latin "creditum" which means belief in truth. According to Banking Law Number 10 of 1998, "credit is the provision of money or bills that can be equated with it, based on an agreement or loan agreement between the bank and another party which requires the borrower to pay off the debt after a certain period of time with interest." Muliadi, (2020) states that "credit can be interpreted as obtaining goods by paying in installments at a later date or obtaining a loan for which payment is made at a later date in installments or installments in accordance with the agreement Home Ownership Credit (KPR) is categorized as consumer credit because the object of financing in KPR is a house (property) which is not intended as capital goods or the customer's business.

3.1.3. Amortization

According to the Income Tax Law, amortization is the concept of allocating the acquisition price of intangible fixed assets and the acquisition price of natural resource assets.

3.1.4. Present and future value

Keown (2001) states that future value is the value at some time in the future of a sum of money in the present or a series of payments which is evaluated using a certain interest rate. The value of money in the future (future

value) is determined by certain interest rates that apply in the financial markets. The higher the interest rate, the higher the value of money in the future.

Present Value is the current value of the projected net cash inflow (net cash flow) in the future. Future net cash inflows are projected investment returns. Present value is also called "discounted". The discount rate (capitalization rate) is the interest rate used to convert future value into present value. The higher the interest rate, the smaller the value of money now in the planned future receipt of money. The difference between the present value of receipts and the present value of investment is referred to as Net Present Value (Van Horne, 2000).

3.1.5. Home Ownership Credit (KPR)

Home Ownership Credit (KPR) is one type of credit service provided by banks to customers who want special loans to meet their needs in house construction or home renovation. KPR itself arises because of the need to own a house which is getting higher and higher without being matched by adequate purchasing power by the community (Muliadi, 2020).

3.2. Methods

The steps for applying financial math concepts to mortgage loans can be divided into several stages. Here are the steps that can be taken:

1. Identify Credit Information:
   Get complete information about the mortgage, including the interest rate, loan amount, loan term, and additional costs such as insurance and administration fees.
2. Calculate Monthly Payments:
   Use a financial math formula to calculate the monthly payment of the loan. This involves the interest rate, loan amount, and loan term. Fixed and variable interest rates can affect this calculation.
3. Amortization Analysis:
   Build an amortization schedule to see how the monthly payments are divided between interest payments and principal payments. This analysis provides an understanding of the progression of payments over the life of the loan.
4. Calculate Present Value:
   Use the concept of present value to assess the present value of future cash flows associated with loan repayments. This can help in decision-making regarding the present value of the home investment.

3.2.1. Formula / Equation

1. Monthly Payment (PMT)

$$PMT = P \times \frac{r(1+r)^n}{(1+r)^n - 1}$$

Where,

- PMT is the monthly payment,
- P is the loan amount
- r is the interest rate per payment period
- n is the total number of payments

2. Amortization Analysis

Principal Payment = PMT - Interest Payment
Remaining Loan = Remaining Loan - Principal Payment
Interest Payment = Remaining Loan x Interest Rate
Principal Payment = Monthly Payment - Interest Payment
Remaining Loan = Remaining Loan - Principal Payment

3. Present Value

$$PresentValue = \sum_{t=1}^{n} \frac{CF}{(1+r)\text{^}t}$$

Where,

- CF_t is the cash flow in period t.

- r is the discount rate
- n is the total number of periods

3.2.2. Study Case Scenario

First, it is necessary to identify the problem to find out the influencing variables. Suppose someone decides to apply for a home loan of $250,000 with an annual interest rate of 5% over a 20 year loan term. By following the method that has been presented, we can find out the monthly payments, amortization analysis, the present value of future cash flows.

4. Results and Discussion

From the above case study, it is known.

- Loan Amount: $250,000
- Annual Interest Rate: 5%
- Loan Term: 20 Years

Using these formulas, we can calculate:

1. Calculate Monthly Payment

$$PMT = P \times \frac{r(1+r)^n}{(1+r)^n - 1}$$

$$PMT = 250{,}000 \times \frac{\frac{5}{12}\left(1+\frac{5}{12}\right)^n}{\left(1+\frac{5}{12}\right)^n - 1}$$

$$PMT = 250{,}000 \times \frac{0.00416667(1+0.00416667)^{240}}{(1+0.00416667)^{240} - 1}$$

$$PMT \approx 1{,}719.43$$

Thus, the monthy payment is about $1,719.43.

2. Amortization Analysis (first six-month example)

Month	Remaining Loan	Interest Payment	Principal Payment	Monthy Payment
1	$250,000	$1,041.67	$677.76	$1,719.43
2	$249,322.24	$1,038.84	$680.59	$1,719.43
3	$248,641.65	$1,035.84	683.59	$1,719.43
4	$247,958.06	$1,032.32	$687.11	$1,719.43
5	$247,271.95	$1,028.63	$690.80	$1,719.43
6	$246,583.15	$1,025.70	$693.73	$1,719.43

3. Calculate Present Value of Future Cash Flows

$$PresentValue = \sum_{t=1}^{240} \frac{1{,}719.43}{(1+0.00416667)^t}$$

$$PresentValue = \frac{1{,}719.43}{(1+0.00416667)^1} + \frac{1{,}719.43}{(1+0.00416667)^2} + \cdots + \frac{1{,}719.43}{(1+0.00416667)^{240}}$$

$$PresentValue = 260{,}537.082$$

5. Conclussion

This paper provides an understanding of the application of financial concepts to mortgage loans. Some of the important aspects analyzed include monthly payments, amortization schedule and present value. In addition, it can also calculate or determine the nature of the payment if the monthly payment is increased, or the interest rate is increased. The monthly payment on a mortgage can be calculated using an annuity formula, which considers the

interest rate, loan amount and loan term. The amortization schedule gives an idea of how the monthly payment is divided between interest payments and principal payments over the life of the loan. Through the amortization schedule, homeowners can see the changes in the proportion of interest and principal payments over time. Present value measures the present value of future cash flows associated with mortgage payments. Understanding present value helps in making wise financial decisions and planning effective repayment strategies.

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