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Simulation of Mortgage Installment Payments Using the Linear Congruent Method (LCM) at PT Rizky Agung Berkah

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Abstract − Home Ownership Credit (KPR) is a popular solution for home ownership through installment systems; however, the complexity of interest and tenor calculations often hinders prospective debtors from fully understanding their financial obligations. PT Rizky Agung Berkah, as a property company, requires a KPR installment simulation system that is efficient, accurate, and easy to understand. This study aims to implement the Linear Congruent Method (LCM) in a web-based KPR installment simulation to generate dynamic installment estimates based on Down Payment (DP) values, random interest rates, and loan tenors. The methodology includes needs analysis, system design using UML, application development with PHP and MySQL, and testing with real sample data. The results show that the system is capable of calculating interest and installments efficiently and displays the simulation results in a detailed installment table. The system also produces varied simulations based on the iteration of random numbers generated by LCM, providing flexibility in payment scenarios. In conclusion, the use of LCM in KPR simulation not only improves the accuracy of calculations but also helps prospective debtors better understand and plan their finances.

Keywords: KPR, Installment Simulation; Linear Congruent Method; Down Payment; Interest Rate

1. INTRODUCTION

Home Ownership Credit (KPR) has become the primary alternative for the public to gradually acquire a house. However, many prospective debtors find it difficult to understand the installment calculation scheme, which is influenced by the down payment (DP), interest rate, and loan tenure. Therefore, PT Rizky Agung Berkah requires a web-based simulation system capable of calculating installments using random variables, in order to produce estimates that closely reflect reality. Bankrate explains that a mortgage calculator helps users understand payment components such as principal, interest, and down payment, enabling prospective borrowers to assess their financial capability.

PT Rizky Agung Berkah, as one of the companies engaged in the property sector, has a need to develop an effective simulation system for KPR (Home Ownership Credit) installment payments. One method that can be used in this simulation is the Linear Congruent Method (LCM), which is a commonly used technique for generating pseudo-random numbers. This method is computationally fast and efficient. Research using the linear congruent method (LCM) [1] has been widely applied in various fields, including cryptography [2] [3].LCM calculations only require simple arithmetic operations (multiplication, addition, and modulo), making it well-suited for simulations that demand a large quantity of random numbers in a short time. [4]. The linear congruent method is also used in educational games for learning to read the Quran [5]

The use of LCM in KPR installment simulations aims to provide monthly installment calculations by taking into account interest rates, loan tenure, and loan amount. With this simulation, it is expected that both the company and prospective debtors can obtain clearer information regarding payment estimates, thereby assisting in financial decision-making processes.

This study will focus on the application of the LCM method in simulating KPR installment payments at PT Rizky Agung Berkah, with the expectation of contributing to increased efficiency in KPR simulation calculations and providing benefits for prospective debtors in planning their finances more accurately. It also aims to encourage greater public demand for Home Ownership Credit (KPR). As a major financing instrument, KPR plays a crucial role in enabling the public to achieve home ownership. However, the complexity of KPR installment calculations often becomes an obstacle for prospective debtors in understanding long-term payment schemes. On the other hand, financing companies like PT Rizky Agung Berkah are required to provide installment simulations that are accurate, transparent, and easy to understand in order to build customer trust and minimize the risk of calculation errors.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The research stages carried out in the Simulation of Mortgage Installment Payments Using the Linear Congruent Method (LCM) at PT Rizky Agung Berkah are as follows

1. Problem Identification
   Determine the main problems, namely: Many prospective borrowers have difficulty in understanding the calculation of mortgage installments due to the complexity of components such as DP, interest, and tenor.There is no interactive web-based simulation system that contains random interest variations.
2. Literature Study

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Conduct a literature review on:
Web-based installment simulation system.
The use of random number methods such as Linear Congruential Method (LCM).
Interest theory, fixed installments, and mortgage calculations.
References come from journals, scientific articles, academic books, and banking reports.

3. Formulation of Objectives and Benefits
   Objectives: To build a mortgage simulation system using LCM to generate random interest variations in installment calculations.
   Benefits: Provide a more realistic and flexible installment estimation for prospective debtors and property companies.
4. System Design
   System model: Using UML (Use Case Diagram, Activity Diagram, Sequence Diagram, and Class Diagram).
   Algorithm: Applying the LCM formula to generate random interest. Simulation logic: The resulting random numbers are used to determine the percentage of interest based on a set range according to the amount of DP.
5. System Development
   Programming language: PHP, HTML, JavaScript.
   Database: MySQL to store simulation data and user input.
   Feature implementation:
   Input: House price, down payment, tenor.
   Output: Installment table containing interest, principal installment, total installment, and remaining loan.
6. System Testing
   Blackbox Testing: Ensures that each input produces the appropriate output.
   Randomness Testing: Verifies that the random interest value from LCM varies according to the parameters and does not repeat in a short period of time.
7. Analysis and Evaluation
8. Evaluate whether the system:
   Provides varied and realistic simulation results.
   Can help users understand the installment scheme.
   Efficient in terms of time and system performance.

2.2 Linear Congruent Method (LCM)

The Linear Congruent Method (LCM) is a random number generator method that is widely used in computer programs. LCM utilizes a linear model to generate random numbers. [6]

$$X_{n+1} = (a \cdot X_n + c) \; mod \; m \qquad (1)$$

One notable feature of this method is that the generated values tend to repeat after a specific interval or number of iterations. To minimize this repetition, selecting appropriate LCM constants (a, c, and m) is crucial, as they play a significant role in ensuring the quality of the generated random numbers—making them appear non-repetitive by undergoing several evaluation tests [2] [7]

Figure 1. The Linear Congruent Method

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The following are the steps for working on the Linear Congruent Method.

1. Input Seed. In default the Seed value is 12345. This seed will be updated every time the program is run so that the results are different
2. Determine the Constant; a, c and m. LCM uses three constants: a →multiplier = 1664525, c →enhancer = 1013904223 dan m →modulus = 2^{32} or 4294967296. These values must be determined in advance for the LCM to work properly. These constants are already commonly used in random number generation.
3. Calculate the Next Random Numberusing the Linear Congruential Method (LCM).

Table 1. LCM Test Data Table

House price	DP	Tenor
Rp250.000.000	Rp50.000.000	20 years

4. Convert Random Numbers to Interest Rates
   After obtaining the random numbers, the program uses them to determine the interest rate based on the percentage of down payment paid. Interest determination rules:
   - DP ≥ 70% → interest between 4% - 5%
   - DP ≥ 60% → interest between 4% - 6%
   - DP ≥ 50% → interest between 5% - 7%
   - DP ≥ 40% → interest between 6% - 8%
   - DP ≥ 30% → interest between 7% - 9%
   - DP ≥ 20% → interest between 8% - 10%
   - DP ≥ 10% → interest between 9% - 11%
   - DP < 10% → interest between 10% - 12%

   The interest value is calculated using a formula; $bunga = bungaMin + \frac{X_n mod\ 1000}{1000} x(bungaMax - bungaMin)$
5. Calculate mortgage installments
   After the interest is determined, the program calculates the monthly installment amount:
   - Calculate the new price after DP:
     $new - price = unit - price - DP$ (2)
   - Calculate the number of months (tenor x 12):
     $tenor\ in\ months = Tenor(years)x12$ (3)
   - Calculate the principal installment:
     $principal\ installment = \frac{installment}{Tenor\ in\ months}$ (4)
   - Calculate the monthly interest:
     $Monthly\ Interest = (\frac{Price\ x\ interest}{100}) : 12$ (5)
   - Calculate the total installment per month:
     $Total\ Installment = Principal\ Installment + Monthly\ Interest$ (6)
   - Subtract principal installment:
     $new\ installment = old\ installment - total\ installment$ (7)
6. Show Simulation Results
   The program displays the results of the mortgage installment simulation in the form of a table containing:
   - Which year
   - What month
   - Interest rate used
   - Principal installment amount
   - Amount of interest installment
   - Total installments per month
   - Remaining loan after installment

3. RESULT AND DISCUSSION

he discussion of the research results reveals that the use of LCM in mortgage installment payment simulations provides advantages in terms of calculation speed and dynamic simulation results. In each iteration, the system generates new random numbers that affect interest rate calculations, thereby providing flexibility in modeling various payment scenarios. Additionally, the web-based system developed using PHP and MySQL allows users to access and perform simulations easily, without the need for complex manual calculations. The UML diagrams used in system design, such as use case diagrams, class diagrams, activity diagrams, and sequence diagrams, help describe the system's workflow in a structured manner.

The implementation of this application consists of several key features, including an admin login page, a dashboard for managing subsidized housing data, a mortgage simulation page for users, and a simulation results display

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showing estimated monthly installments. System validation shows that the calculations performed by the system align with the applied formulas and display accurate and easily understandable data for potential borrowers. However, during testing, it was found that simulation results may vary each time the page is refreshed, as the random numbers generated by the LCM always change. This can be a challenge in maintaining data consistency for users who want to compare multiple simulations simultaneously.

3.1 Application Implementation

3.1.1 Mortgage Simulation Results Page Display

Hasil Simulasi Cicilan KPR

Harga Unit Properti: Rp 270.000.000
DP Awal: Rp 70.000.000
Harga Setelah DP: Rp 200.000.000
Suku Bunga Berdasarkan DP & Tenor: 9.74%
Jangka Waktu: 15 tahun (180 bulan)

kembali

Tahun	Bulan	Bunga (%)	Angsuran Pokok	Angsuran Bunga	Total Angsuran	Sisa Angsuran
Tahun 1	Ke-1	9.74%	Rp 1.111.111	Rp 1.623.333	Rp 2.734.444	Rp 198.888.889
	Ke-2	9.74%	Rp 1.111.111	Rp 1.614.315	Rp 2.725.426	Rp 197.777.778
	Ke-3	9.74%	Rp 1.111.111	Rp 1.605.296	Rp 2.716.407	Rp 196.666.667
	Ke-4	9.74%	Rp 1.111.111	Rp 1.596.278	Rp 2.707.389	Rp 195.555.556
	Ke-5	9.74%	Rp 1.111.111	Rp 1.587.259	Rp 2.698.370	Rp 194.444.444
	Ke-6	9.74%	Rp 1.111.111	Rp 1.578.241	Rp 2.689.352	Rp 193.333.333
	Ke-7	9.74%	Rp 1.111.111	Rp 1.569.222	Rp 2.680.333	Rp 192.222.222
	Ke-8	9.74%	Rp 1.111.111	Rp 1.560.204	Rp 2.671.315	Rp 191.111.111
	Ke-9	9.74%	Rp 1.111.111	Rp 1.551.185	Rp 2.662.296	Rp 190.000.000
	Ke-10	9.74%	Rp 1.111.111	Rp 1.542.167	Rp 2.653.278	Rp 188.888.889

Figure 2. Mortgage Simulation Results Page Display

Figure 2 above shows the simulation results page for a mortgage loan. This figure displays the simulation results for mortgage loan installments based on the previously entered inputs. At the top, there are details regarding the property unit price of IDR 270,000,000 with a down payment (DP) of IDR 70,000,000, resulting in a price after the down payment of IDR 200,000,000. The interest rate applied based on the down payment and loan term is 9.74%, with a loan repayment period of 15 years or equivalent to 180 months.

There is a table showing the monthly installment calculations. The columns in the table include the year and month of the installment, the interest rate applied, the principal installment, the interest installment, the total installment to be paid each month, and the remaining installment to be paid after each installment. For example, in the first month, the principal installment is Rp 1,111,111 with an interest installment of Rp 1,623,333, resulting in a total installment of Rp 2,734,444, with a remaining installment after the first payment of Rp 198,888,889. This table provides users with an overview of how mortgage installments will develop over the selected period. With this information, prospective borrowers can better plan their finances before applying for a mortgage loan. On the right side of the page, there is a "back" button that allows users to return to the previous page if they wish to run the simulation again or change the calculation parameters.

4. CONCLUSION

Linear Congruent Method (LCM) is an easy, fast, and deterministic method, making it a practical choice for simulating installment payments such as mortgages, especially in small to medium-sized applications. However, it has serious limitations in terms of randomness quality, random periods, and pattern regularity, which can have a negative impact on simulation results if used extensively or in complex multi-dimensional statistics.

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REFERENCES

[1]. D. H. Lehmer, "Random number generation on the BRL high speed computing machines," by M. L. Juncosa. Math. Rev. 15 (1954), 559.

[2]. Aswathy, R. H., & Malarvizhi, N. (2021). A design of lightweight ECC based cryptographic algorithm coupled with linear congruential method for resource constraint area in IoT.Journal of Ambient Intelligence and Humanized Computing, 1-10.

[3]. Cuarto, P. M. (2014). Algebraic Algorithm for Solving Linear Congruences: Its Application to Cryptography. Asia Pacific Journal of Education, Arts and Sciences, 1(1), 1-1.

[4]. K. Park, and K. W. Miller, "Random number generators: good ones are hard to finnd," Association for Computing Machinery,31 (10), pp:1192-2001, 1988.

[5]. L. S. S. G. R. Muchlis, "Game Edukasi Belajar Mengaji Menggunakan Metode Linear Congruent Method (LCM) Berbasis Android," Jurnal Informatika Universitas Pamulang, vol. 5, pp. 1-9, 2020

[6]. Harsandi, P. 2022. Implementasi Linear Congruent Method Pada Game Jigsaw Puzzle Tokoh Pewayangan. JURNAL SISTEM & TEKNOLOGI INFORMASI KOMUNIKASI, 6(1), 23-27

[7]. Marwan, A. (2017). Penerapan Metode Linear Congruent Method (Lcm) Dalam Perancangan Dan Pembuatan Game Monopoli Edukasi Untuk Tokoh Pahlawan Nasional. semanTIK, 3(1), 1-8.