

**Feasibility Study to Find Suitable Car Park
A Case Study of School of Engineering, KMITL**

BY

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A Case Study of School of Engineering, KMITL

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ABSTRACT

Nowadays, Personal cars have become one of the most important factors in daily life because it is convenient to go to another place. Based on the survey, School of Engineering has capacity of car park is 535 and in the future that will be decrease but the number of personal cars will be increased resulting in insufficient parking space for the number of private cars. This will be wasting, a lot of time to find a parking space.

This project is a feasibility study to establish a suitable carpark for students and staffs at School of engineering, KMITL. There are 4 scenarios purpose in this study 1.) Buy EV shuttle bus 2.) A building car park at in front of convention hall 3.) A building of car park at soccer field in faculty of architecture and 4.) Using smart card for entering carpark of school of engineering. This study will also a purpose the tools to help student and staff make decisions to choose the most suitable solution.

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Without all this, I might not be able to complete this research properly.

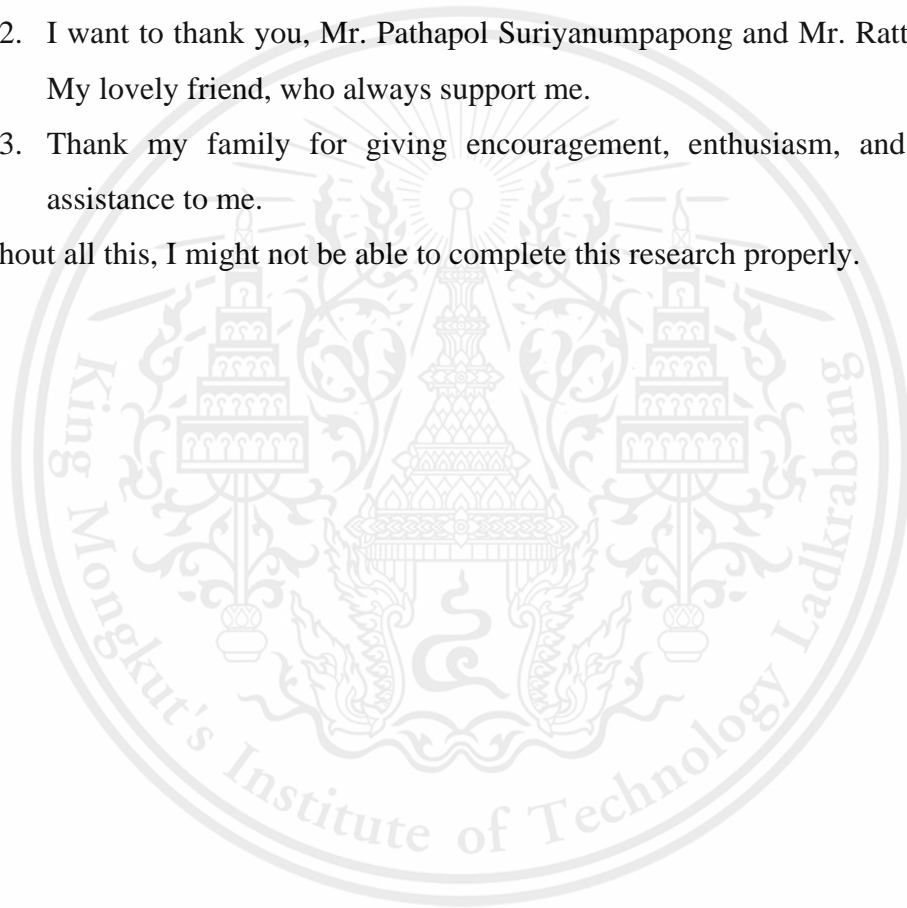


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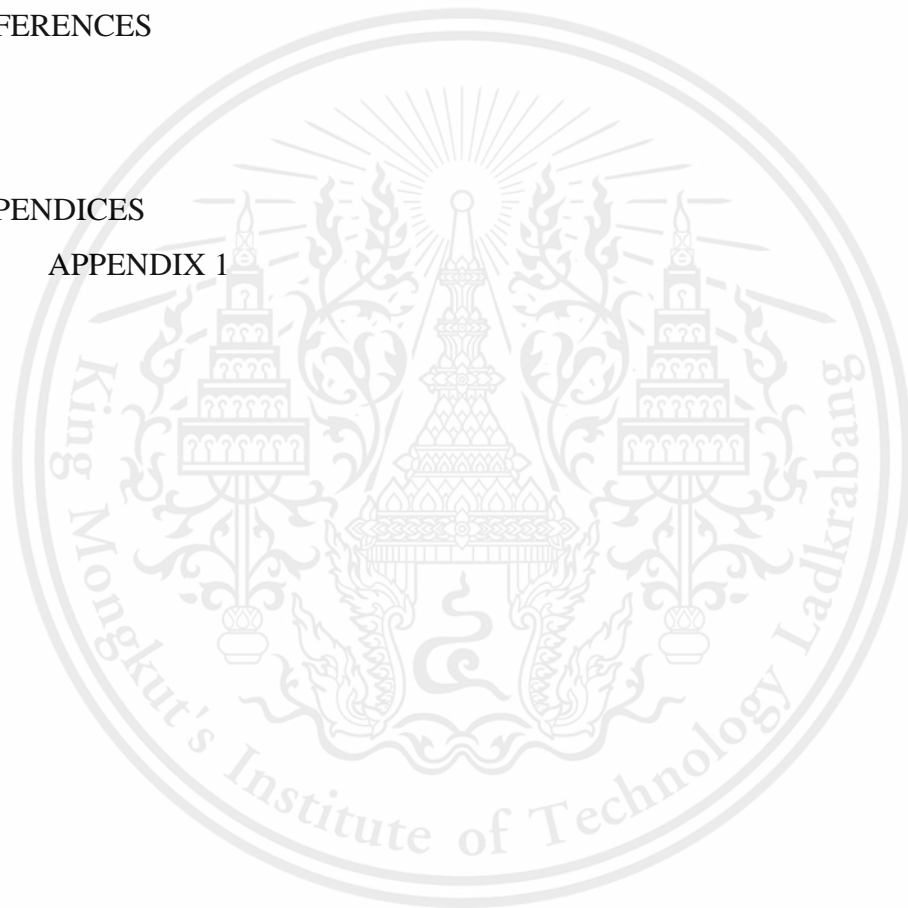
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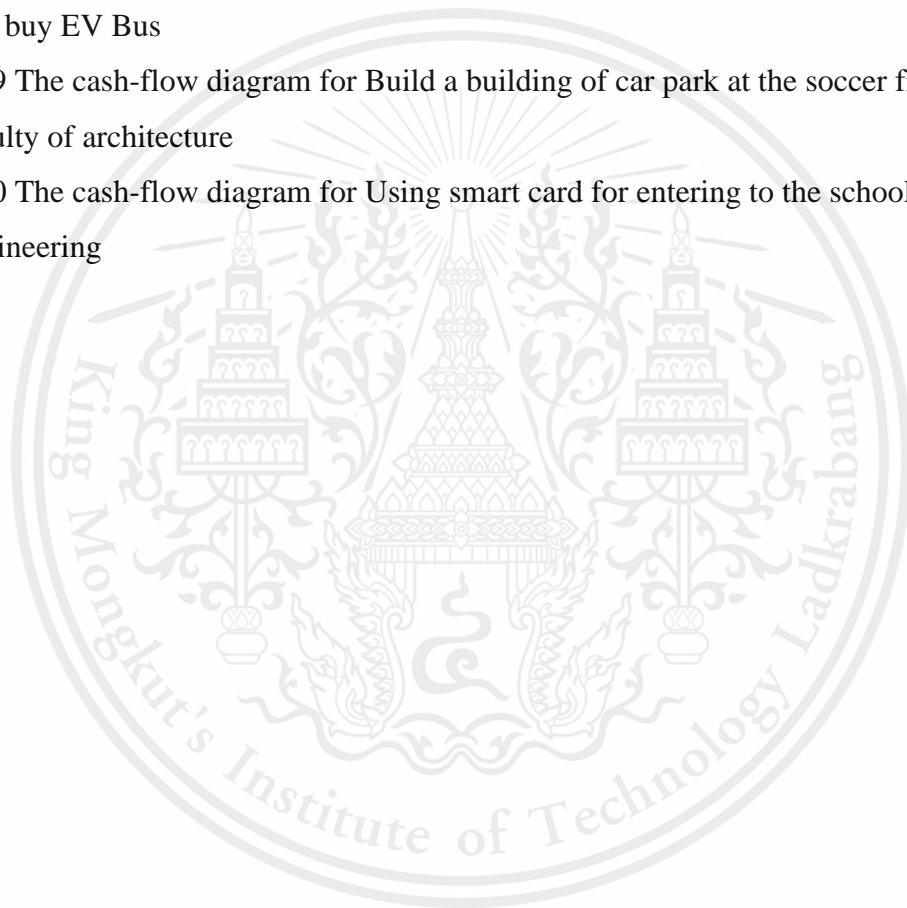
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LIST OF SYMBOLS/ABBREVIATIONS

Symbols/Abbreviations	Terms
KMITL	King Mongkut's Institute of Technology Ladkrabang
B/C	Benefit/Cost Analysis
PI	Profitability Index
PV	Present Value
IRR	Internal Rate of Return
ROI	Return on Investment
NPV	Net Present Value
AW	Annual Worth Analysis
EV	Electric vehicle
BOQ	Bill of Quantities
PB	Payback Analysis

CHAPTER 1

INTRODUCTION

This project is a feasibility study to purpose suitable car park “A case study of school of engineering, KMITL”. This chapter consists of detail of the state of the problems, objective, research scopes, research proposal, and report outline.

1.1 State of the problems

In this decade, the personal car is popular because it is convenient for travelling. A lot of people use the personal car in daily life. But some problems are caused by too many personal cars. One of these problems is the insufficient car park. The insufficient car park is a problem that people can face everywhere, especially in big cities. At the school of engineering KMITL, the number of students and staff have been rising every year. Many students and staff drive cars to the school of engineering, and the number of students is already more than the number of car parking spaces. The school of engineering is facing the problem of the insufficient car parking. The insufficient car park problem in the school of engineering affects to students and staff in many terms such as losing time for finding an available car park, many people drive fast because they are hurry to find available car park it could make vehicle accident.

From the survey, the number of students car is 628 cars, and the number of staff cars is 500 cars, but there are 535 car parks in the school of engineering. The school of engineering has decided in the new policy that some areas in the school of engineering will be take up to be flea market. This policy will decrease the number of car parks remains at 433 car parks. Students and staffs go to the school of engineering almost every day if they must face the insufficient car park problem every day it is not good.

1.2 Objectives

1. To study the feasibility for propose a suitable car park for students and staff at the school of engineering, KMITL.
2. To design and evaluate scenarios to propose new car park for students and staffs at the school of engineering, KMITL.

1.3. Project Scopes

1. Design of scenarios to propose new car park is only for the school of engineering, KMITL.
2. Evaluation of each scenario based on economics theory.

1.4 Report Outline

The rest of this report is organized as follows: Chapter 2 reviews of the economics theory to analyze the 4 scenarios. Chapter 3 describes the design and implementation of collecting data of the number of the car park, collecting the number of student's car and staff's car, plan the four scenarios to purpose new car park, cash-flow diagram of each scenario, and using economic theory to find the suitable scenarios for proposing a new car park in the different financial situation at school of engineering, KMITL. Chapter 4 described details of the research operations from calculating the data to assist in investment decisions in each method. Chapter 5 present tools to help you make decisions to choose the most suitable solution and conclude which method is the most suitable.

CHAPTER 2

REVIEW OF THE ECONOMICS THEORY TO ANALYZE THE 4 SCENARIOS.

This chapter discusses the concept and meaning of the economics theory that use to analyze the 4 scenarios considered during the analysis and design phase of this project. This chapter consists of economics theory, literature review, and chapter summary.

2.1 Relationship between interest rate or yield, time, and value of money

In the calculation of the value of money over time, the principle of the cash flow diagram is the basis for further analysis of the value of money. The variable used to analyze the value of money and charting the cash flow are:

- P** = The value or sum of money for a given period of time or at time $t=0$ may be used to represent the value of Present worth (PW), Present value (PV), Net present value (NPV).
- F** = Value or sum of future money may be substituted for Future Worth (FW) and Future Value (FV).
- A** = The monthly or annual payment value with the same amount of anchor may is used in place of Annual worth(AW) and Equivalent uniform annual worth (EUAW) unit per year or per month.
- n** = Number of periods for the analysis of year, month, or day unit.
- i** = The interest rate or the rate of return per period percentage units per year, per month or percentage per day.

2.2 Cash - flow diagram

Cash flow diagrams represent income and expenses over some time interval. The diagram consists of a horizontal line with markers at a series of time intervals. At appropriate times, expenses and costs are shown.

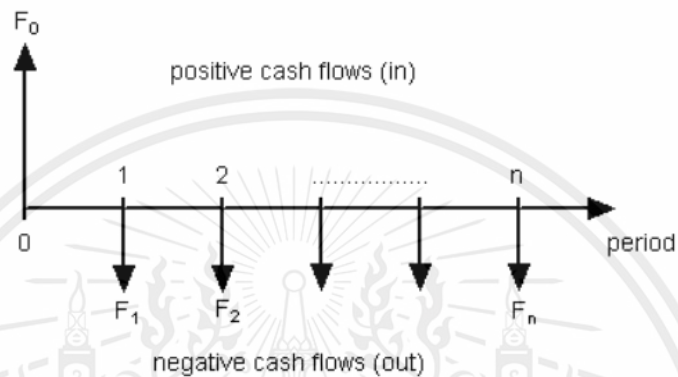


Figure 2.1: Cash flow diagram.

2.3 Benefit/cost analysis

Benefit/cost analysis or Benefit/cost ratio or B / C ratio is a popular method of evaluating the investment suitability of government projects because most government projects are not in the process of showing any benefit but still, they are intended for public benefits, such benefits may not be in the form of the money the state receives. It is still in the form of benefits that the community has received such as, the good quality of life expenditure on the travelling, increase income or productivity, safety, or mental health of people in the community. It is essential to analyze the control of the stakeholders which will be converted in the figure of value to compare the money invested in the project. There are two essential variables for the Benefit/cost analysis.

The benefit is a benefit that has been increased both in terms of money and welfare from the project compared to the situation that has not yet been operating under the project. The public benefits arising from the project can be divided into two categories. First, the benefits received in the form of increasing income or increasing productivity, such as increased income from toll collection, etc. Second, received in the form of cost savings and damage reduction.

Cost is the total cost owed throughout the implementation of the project. Thus, it is the sum of the initial cost of the project and the operating expenses, among others, due to environmental and community impacts in the project area, such as expenses for compensation for land expropriation, costs of adjusting the community's environment after construction, etc. The subtleties of the investment details and returns will vary from project to project. The following equation can analyze the Benefit/cost ratio.

The projects with the B / C ratio greater than 1 is a project to invest if BC ratio less than 1 is a project that is not suitable for investment and if B / C ratio of 1 means that the project will not profit and not profit loss.

2.4 Profitability Index (PI)

The profitability index (PI), also known as the value investment ratio (VIR) or profit investment ratio (PIR), is an index that depicts the relationship between a planned project's costs and benefits. It was measured as the percentage of the current value of potential projected cash flows to the project's original investment. A higher PI means that a project will be considered more attractive. The profitability index is a metric for determining the attractiveness of a project or investment. The PI is determined by calculating the current value of projected potential cash flows by the project's initial investment level. A PI greater than 1.0 is deemed as a good investment, with higher values corresponding to more attractive projects. Only the projects with the highest PIs can be performed under capital restrictions and mutually exclusive projects. [3]

The PI aids in project ranking because it allows investors to measure the value generated per investment unit. Any value smaller than 1.0 indicates that the project's present value (PV) is less than the original investment, so a profitability index of 1.0 is technically the lowest suitable metric on the index. The financial attractiveness of the planned project increases as the value of the profitability index rises. [4]

The profitability index is a method of evaluating future capital expenditures. To assess a project's feasibility, split the estimated capital inflow by the projected capital outflow. The profitability index, as shown by the formula, represents the above factors using the current value of potential cash flows and the initial investment. When comparing the desirability of projects using the profitability metric, it is important to

remember that the method ignores project scale. As a result, ventures with higher cash inflows will have lower profitability index calculations due to lower profit margins.

2.4.1 PV of future cash flows

The time value of money equations is used to determine the current value of potential cash flows. To compare potential cash flows to existing monetary values, cash flows are discounted for the required number of years. Discounting is the concept that the worth of a dollar now does not equal the value of a dollar earned in a year because the money available now has greater income power in the form of interest-bearing savings accounts than money that is now scarce. As a result, cash flows obtained later in the future are thought to have a better current value than capital received sooner.

2.4.2 Investment required.

The initial capital outlay of a project is represented by discounted estimated cash outflows. Only the cash flow needed at the outset of the project is required as an initial investment. All such outlays occur at any time during the project's life cycle, and they are factored into the equation through the numerator's discounting. These extra capital expenditures could have tax or depreciation gains. [3]

Although profitability index equations cannot be negative, they must be converted to positive numbers before being considered useful. If the calculation is greater than 1.0, the project's future discounted cash inflows are expected to be greater than its expected discounted cash outflows. Whereas if the result is less than 1.0, the outflows shortfall is higher than the discounted inflows, and the project can be rejected. Calculations that equal 1.0 result in conditions of ignorance, in which all project benefits or losses are minor.

Calculations higher than 1.0 are ranked based on the largest estimate by using the profitability metric solely. When money is scarce and projects are mutually exclusive, the project with the highest feasibility index should be chosen because it represents the most efficient use of scarce resources. Because of this, the profitability index is also known as the benefit-cost ratio. Even though certain ventures have better net present values, they might be picked over because they do not have the best

profitability ranking and may not reflect the most advantageous use of business properties. [3]

2.5 Rate of return analysis

When investing in engineering projects is often a significant investment and requires much capital, it is necessary for investors to calculate the rate of return that is worth their investment when comparing with MARR (Minimum acceptable rate of return). MARR is mostly determined by the interest rate on the loan or the deposit rate in case the investor borrows from the loan source the selected project's rate of return must be higher than the loan rate to have sufficient funds to be paid to the loan source and in the future. In the case of the agency's private investment, the rate of return of the selected project must be higher than the deposit rate to achieve a cost-effective basis for withdrawing the inventory from the bank to invest in the project. If the calculation rate of return of the project is greater than the MARR, it can be concluded that the project is suitable for investment. In the case of multiple projects, the project that has highest of the rate of return will be the project that will be considered. The rate of return from the calculation is the lowest rate of return that brings the present value or annual equivalent value of the investment (PW_D) equal to the present value or the annual equivalent value of the benefit received (PW_B).

2.6 Return on Investment (ROI)

Return on investment (ROI) is a measure of performance used to assess an investment's productivity or profitability, as well as to analyze the efficiency of several investments. The return on investment (ROI) attempts to explicitly calculate the amount of profit made on a given investment concerning its expense.

ROI and other cash flow indices, such as internal rate of return (IRR) and net present value (NPV), are primary metrics used in market valuation to assess and rank the attractiveness of various investment options. Even though ROI is a ratio, it is usually expressed as a percentage rather than a ratio. ROI is determined by subtracting the original investment value from the final investment value (which equals the net return), dividing the new amount (the net return) by the investment cost, and then multiplying it by 100. One limitation of ROI is that it does not consider the length of time that an

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investment has been carried as a result, for an investor looking to compare possible investments, a profitability metric that includes the retention period could be more useful. Because of its flexibility and simplicity, ROI is a common metric. Essentially, the return on investment (ROI) may be used as a crude indicator of an investment's profitability.

As ROI equations produce a positive result, it indicates that net returns are positive (because total returns exceed total costs). If ROI equations produce a negative result, it means that total costs outweigh total returns, resulting in negative net returns. (In other words, this investment produces a loss.) Finally, net returns and total costs should be weighed when calculating ROI with the greatest precision. Annualized ROI can be used to make an apples-to-apples distinction of rival investments. [5]

2.6.1 Advantages of Return on Investment (ROI)

First, Better Measure of Profitability: It compares net profits to divisional investments, providing a more accurate measure of divisional profitability. All divisional managers understand that their success will be measured by how they used assets to generate benefits, which will motivate them to use assets to their full potential. It also guarantees that investments are only purchased when they are certain to have dividends by the organization's policies. As a result, the necessary amount of investment is the primary target of ROI. There is an optimal amount of investment in each commodity for a particular business unit at a given point in time that helps maximize earnings. This form of cost-benefit analysis aids managers in determining the rate of return that can be expected from various investment proposals. This enables them to choose an investment that would improve both divisional and organizational benefit efficiency while also allowing them to make more use of current investments. Second, Achieving Goal Congruence: ROI guarantees that the goals of the various departments and the company. Third, Comparative Analysis: In terms of profitability and asset use, ROI aids in comparisons between various business units. It may be used for inter-firm comparisons if the companies whose results are compared are of a similar scale and in the same sector. The return on investment (ROI) is a useful metric because it can be conveniently compared to the associated cost of capital when deciding the investment prospects to pursue. Fourth, Performance of Investment Division: ROI is

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essential in evaluating the investment division's performance, which focuses on maximizing benefit and making informed decisions on the purchase and disposition of capital assets. The ROI can also be used to evaluate the performance of the investment center manager. Fifth, ROI as Indicator of Other Performance Ingredients: ROI is the single most significant indicator of an investment division's efficiency, and it covers other elements of a business unit's performance. A higher ROI indicates that an investment center is doing well in other areas, such as expense control, asset efficiency, sale price planning, marketing, and advertising policy, and so on. Lastly, Matching with Accounting Measurements: Standard accounting measures in financial accounting are used to calculate ROI. The details used to calculate ROI do not require a new accounting calculation. Many of the numbers used to calculate ROI can be found in financial statements compiled using a traditional accounting scheme. It might be appropriate to make any corrections to current accounting figures to calculate ROI, but this is not a concern. [6]

2.6.2 Disadvantages of Return on Investment (ROI)

There are several drawbacks to using ROI as a metric. First, it ignores an investor's retention time, which may be problematic when comparing investment options. Assume that investment X yields a 25% ROI, while investment Y yields a 15% ROI. Unless the period of each investment is already known, it is impossible to conclude that X is the superior investment. The 25% ROI from investment X was likely achieved over a five-year cycle, but the 15% ROI from investment Y was achieved in only one year. Second, ROI should not take risk into account. It is well understood that investment returns are directly proportional to risk: the higher the future returns, the higher the risk. This is something that can be used firsthand in the investment community. Third, if all projected expenses are not included in the estimate, ROI numbers may be underestimated. This can happen on purpose or unintentionally. When calculating the return on investment on a piece of real estate, for example, all related costs should be considered. Mortgage interest, property taxes, insurance, and other maintenance expenses are included. These costs will exclude a significant amount from the estimated ROI; if they are not factored into the equation, the ROI can be greatly exaggerated. Finally, when assessing the returns on investment, ROI, like many other

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profitability indices, just stresses financial benefits. Auxiliary incentives, such as socioeconomic or environmental advantages, are not considered. The Social Return on Investment (SROI), a comparatively recent ROI index, aids in quantifying some of these gains for investors. [5]

2.7 Payback analysis

Payback analysis is a mathematical methodology to determine the payback period for an investment. The payback period (n_p) is how long it will take to pay off the investment with the cash flow derived from the asset or project. In colloquial terms, it calculates the 'breakeven point.' The payback period is usually measured in fractions of years.

2.8 Net present value method (NPV)

The disparity between the current value of currency inflows and outflows over some time is known as net present value (NPV). The net present value (NPV) is a calculation used in capital budgeting and investment planning to determine the feasibility of a proposed investment or project.

The net present value (NPV) is the product of equations used to determine the current value of a potential stream of payments. It takes the time value of capital into account and can be used to compare related investing options. Any proposal or investment with a negative NPV can be excluded because it is based on a discount rate that can be extracted from the cost of money used to make the investment. A major disadvantage of using an NPV analysis is that it makes unreliable predictions about future events. If a project's or investment's net present value (NPV) is positive, it means that the discounted present value of all possible cash flows associated with the project or investment is positive, and therefore appealing. A positive net present value means that a project's or investment's expected earnings (in present dollars) outweigh its estimated costs (also in present dollars). An investment with a positive net present value (NPV) is productive. A negative NPV investment would result in a net loss. The Net Present Value Rule, which states that only investments with positive NPV values can be considered, is based on this principle. [7]

The NPV is calculated using a discount rate that can be calculated using the cost of capital needed to invest, and any project or investment with a negative NPV should be avoided [8].

2.8.1 Advantages of Net Present Value

Firstly, NPV is a straightforward metric. Provided the discount rate used, it calculates the asset creation from a future transaction in today's dollars. Secondly, the scale of the investment is factored into the NPV. It can be used to compare small forestry ventures to multibillion-dollar developments or acquisitions. Thirdly, Calculating the net present value (NPV) is easy (especially with a spreadsheet). Fourthly, instead of using net profits, NPV considers cash flows (which include non-cash items such as depreciation). Fifthly, the time value of money is recognized by NPV (unlike cash-on-cash returns or simple payback period). This is important and completely necessary for forestry investments, which appear to be long-term. Lastly, The NPVs are added together. You should add up projects to get a sense of net asset generation from all investable projects if you have several projects and surplus money.

2.8.2 Disadvantages of Net Present Value

The first one, it is important to choose a discount rate. NPV also maintains that the interest rate remains constant during the investment or project's duration. Discount rates fluctuate from year to year, much like interest rates. Consider commercial real estate capitalization (“cap”) prices. Benchmarks change over time. Investors' opportunity costs adjust and vary. The second one, NPV assumes that you can correctly measure and forecast future cash flows. Although your crystal ball may be infallible, mine has sometimes shown cracks. And the third one, for some, is an intuitively difficult concept to grasp. [9]

2.9 Annual Worth analysis

Annual Worth (AW) is economically implied as to the annual value of the Present Worth (PW) and Future Worth (FW) monetary values that occur at different periods throughout a project, calculated from the MARR (Minimum acceptable rate of return) over n year period.

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2.10 Literature Review

2.10.1 According to the research “Empirical study of parking problem on university campus” [11].

This paper aims to present a case study of the campus parking problem, taking the Beijing University of Aeronautics and Astronautics as an example. The inflow and outflow of vehicles on campus, as well as the location and usage of parking lots and the parking activity of drivers, are both surveyed and analyzed. The survey data were used to calculate the average parking time and parking lot usage turnovers. In conclusion, the BUAA campus parking facility has the following features and issues. In conclusion, the BUAA campus parking facility has the following features and issues:

- 1.Many cars are parked in the public activity zone. The number is higher during the day and lower at night; it is higher when on duty and lower when off duty. The number of cars parking on this campus are those that are parked for more than four hours.
- 2.There are not enough parking spaces on this campus. Meanwhile, new parking lots have poor vacancy rates.
- 3.Ground areas surrounding buildings are currently used as parking lots. A newly built underground parking lot under the New Main Building is now open for business. It is anticipated that it will resolve the parking issue in the southeast corner of campus.
- 4.On-street parking has resulted in several issues, including traffic congestion, which is thus hazardous to pedestrians.
- 5.Every day, many cars that are not owned by university workers drive across campus, adding to the traffic congestion.
- 6.Parking tolls only affect vehicles without entrance permits, and university workers park their cars on campus for extended periods with no restrictions. As a result, the use turnovers of parking lots are very low, less than two on average.

2.10.2 According to the research “Problems with parking places and traffic in Burapha University project” [12]

This paper aims to solve the problem of the number of parking places of students and staff in Burapha University with insufficient parking lots and traffic jams, traffic problems. From the survey of the faculty, the organization made a questionnaire for those in the study area to express their opinions by answering questionnaires. The

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sample group consisted of 35 people, consisting of 10 students, 10 staff members, 10 motorbikes, and 5 others. And concluded the solution to solve the problem as follows:

1. There should be an increase in the number of parking places to more accommodate.
2. To reduce competition and traffic congestion, a tram service should be added.
3. To avoid accidents, each point should have a road crossing area.
4. Should have a new bus system.
5. Should enact a policy that penalizes those who break the university's traffic laws.

2.10.3 According to the research “Solution to Parking Space Problem on Campus Essay”. [13]

This paper aims to address the inefficiency of the current parking infrastructure, expand student parking opportunities, reduce existing parking rates, and present alternative modes of transportation. To resolve the current issue, the campus administration must have alternative parking spaces and lower parking rates. This paper has shown that by taking these steps, the administration can improve student efficiency while still lowering student financial burdens. As a result, students will be able to devote more time to the institution's main goal of obtaining a decent education.

2.10.4 According to the research “Example of report on parking issues on the College Campus” [14].

This paper aims to ensure that members of the college fraternity and the surrounding community will live in harmony. Without the peaceful coexistence of the citizens in that community, the college would not be able to make any progress. To summarize, the parking issue has had a significant impact on the college campus, and the college administration should take decisive action. It has harmed students' academic success due to time waste and other factors such as suspension and expulsion. Another problem that has arisen is environmental pollution, which is caused by the noise and exhaust emissions of congested cars. Because of the competition for parking spaces and the congestion of traffic, there has been a rise in car accidents in parking lots. Individual disputes have caused havoc on the relationships of the participants. Because of the illegal parking of students outside their premises, the owners of the properties surrounding the college seem to have lost faith in the college. The situation would only

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add to the tension of the college's students, lecturers, and other stakeholders. This will divert their attention away from the college's core business.

2.10.5 According to the research “Determining On-Street Parking Places in Urban Road Networks Using Meta-Heuristic Harmony Search Algorithm” [15].

This paper aims to develop a simulation/optimization model for determining on-street parking spaces in urban road networks. Due to the binary decision variables, the problem is dealt with in the sense of Discrete Network Design (DND), and the problem is solved using the bi-level programming technique. The determination of on-street parking spaces is handled at the upper level, while the reaction of drivers to the design is handled at the lower level in a user-equilibrium manner. The upper-level problem is formulated as a non-linear mixed integer programming problem, and the solution is found using the meta-heuristic Harmony Search (HS) optimization technique. The lower-level problem in the proposed model is solved using the VISUM traffic analysis program as a simulation tool. The proposed model's efficiency is evaluated using the Sioux-Falls Road network, which has been extensively used in previous DND studies. The proposed model can be used to determine optimal or near-optimal on-street parking spots, according to the results.

2.11 Chapter Summary

In Chapter 1 we proposed the 4 scenarios to find the suitable new car park.

In this chapter explain the economics theory that use to analyze the 4 scenarios (Section 2.1 – Section 2.9), literature Review (Section 2.10) to support the state of the problem.

The next chapter presents the design of procedures of research operation.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the procedures of research operation from the collecting data of the number of the car park, collecting the number of students cars and staff cars, planning the 4 scenarios to purpose new car park, cash-flow diagram of each scenarios, and using economic theory to find the suitable scenarios for proposing a new car park in the different financial situation at school of engineering, KMITL.

3.2 Design Methodology

The school of engineering KMITL has more numbers of cars from students and staff than the numbers of parking spots. The 4 scenarios to purpose new car park are the method that can help in making the decision to solve the problem of the insufficient car parking spaces.

3.2.1 Collecting data of number of car park in school of engineering, KMITL.

3.2.1.1 In front of mechanical engineering building - 21 car parks



Figure 3.1: The location of the car parking at in front of mechanical engineering building.

3.2.1.2 In front of industrial engineering building - 16 car parks



Figure 3.2: The location of the car parking at in front of industrial engineering building.

3.2.1.3 In front of Instrumentation engineering building - 6 car parks



Figure 3.3: The location of the car parking at in front of Instrumentation engineering building.

3.2.1.4 In front of B canteen 47 car parks for student 14 car parks for teacher



Figure 3.4: The location of the car parking at in front of B canteen.

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3.2.1.5 In front of Telecommunications Engineering building - 35 car parks



Figure 3.5: The location of the car parking at in front of Telecommunications Engineering building.

3.2.1.6 In front of A building - 14 car parks for staff



Figure 3.6: The location of the car parking at in front of A building.

3.2.1.7 In front of auditorium of school of engineering - 58 car parks



Figure 3.7: The location of the car parking at in front of auditorium of school of engineering.

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3.2.1.8 Basement of HM building - 47 car parks

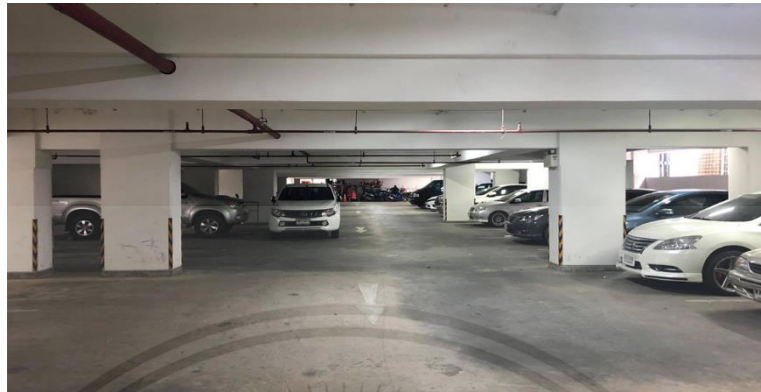


Figure 3.8: The location of the car parking at basement of HM building.

3.2.1.9 Backside of civil engineering building - 63 car parks



Figure 3.9: The location of the car parking at backside of civil engineering building.

3.2.1.10 HM building civil engineering side - 10 car parks



Figure 3.10: The location of the car parking at HM building civil engineering side.
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3.2.1.11 In front of CCA building 16 car parks for teacher 21 car parks for student



Figure 3.11: The location of the car parking at in front of CCA building.

3.2.1.12 Roadside in front of architecture faculty - 33 car parks



Figure 3.12: The location of the car parking at roadside in front of architecture faculty.

3.2.1.13 In front of Agricultural engineering building - 12 car parks for teacher



Figure 3.13: The location of the car parking at in front of Agricultural engineering building.

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3.2.1.14 Roadside In front of Agricultural engineering building - 16 car parks



Figure 3.14: The location of the car parking at Roadside In front of Agricultural engineering building.

3.2.1.15 In front of C canteen - 50 car parks



Figure 3.15: The location of the car parking at in front of C canteen.

3.2.1.16 Backside of 12 floors building - 11 car parks



Figure 3.16: The location of the car parking at backside of 12 floors building.

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3.2.1.17 Backside of industrial engineering building - 16 car parks



Figure 3.17: The location of the car parking at backside of industrial engineering building.

3.2.1.18 12 floors building industrial engineering side - 11 car parks



Figure 3.18: The location of the car parking at 12 floors building industrial engineering side.

3.2.1.19 Under 12 floors building - 12 car parks



Figure 3.19: The location of the car parking at under 12 floors building.

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The number of car park at the school of engineering KMITL is 535 car parks.

3.2.1.20 New policy of school of engineering KMITL.

The school of engineering KMITL has decided to use some areas in the school of engineering to become a flea market in the future, and the flea market will take up area from the road in front of the department of Telecommunication's building to the road in front of the department of Instrumentation's building. This policy will decrease the number of car parks by 102 car parks. The number of car park will remain at 433 car parking spots.



Figure 3.20: The area of flea market in the new policy.

3.2.2 Collecting the number of student's car and staff's car in school of engineering, KMITL.

The number of students at the school of engineering KMITL in the academic year 2020 in bachelor's degree is 5,586 students [16]. We collect the number of students' car data by interviewing students in each section and each year and asking for the number of their friend who has a car. Collecting the number of staff's car by interview staff and found that there are 500 staffs who has a car. The total number of student's car and staff's car is 1,128 cars.

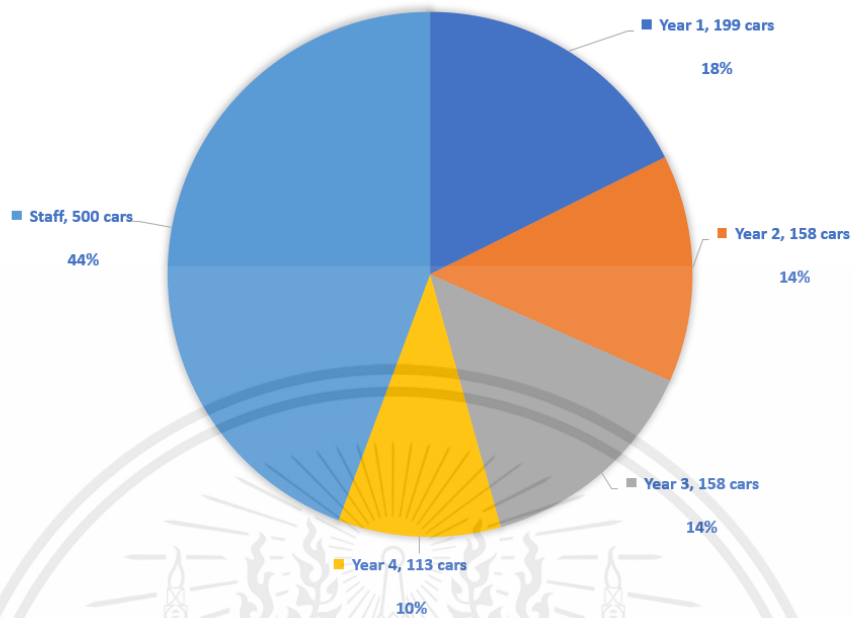


Figure 3.21: The number of student's cars and staff's cars in school of engineering.

3.2.3 four scenarios to purpose new suitable car park.

3.2.3.1 To buy EV Bus (Electric vehicle Bus).

This scenario uses the area in front of the convention hall to be the car parking spots and uses Electric Vehicle Bus to pick up students and staff to drop off at the school of engineering. There are 1,000 parking slots and two EV Buses for transportation. Collecting fees for students and staffs are first 4 hours free and after 4 hours 10 baht per hour after 12 hours 100 baht per hour. Collecting fees for the outsider is 15 baht per hour after 12 hours 150 baht per hour.



Figure 3.22: The example of EV Bus.(17)

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Table 3.1: The detail of the EV Bus.(17)

Items	Contents
Exterior Dimensions (mm)	65300*2230*2800
Number of Seats	20 Seats (35 passengers)
Max. gross weight (T)	8.2
Max. Speed (km/h)	60
Charging Time	20 Minutes
Operations Distance	Around 60 kilometres
Price	3,000,000 Baht

3.2.3.2 Build car park in front of convention hall and buy EV Bus.

This scenario will use the area in front of the convention hall and build car park with the roof. It will use two EV Buses for transportation from the convention hall to the school of engineering. There will be 720 car parking slots with the roof. Collecting fees for students and staffs are first 4 hours free and after 4 hours 20 baht per hour after 12 hours 100 baht per hour. Collecting fees for the outsider is 20 baht per hour after 12 hours 150 baht per hour.

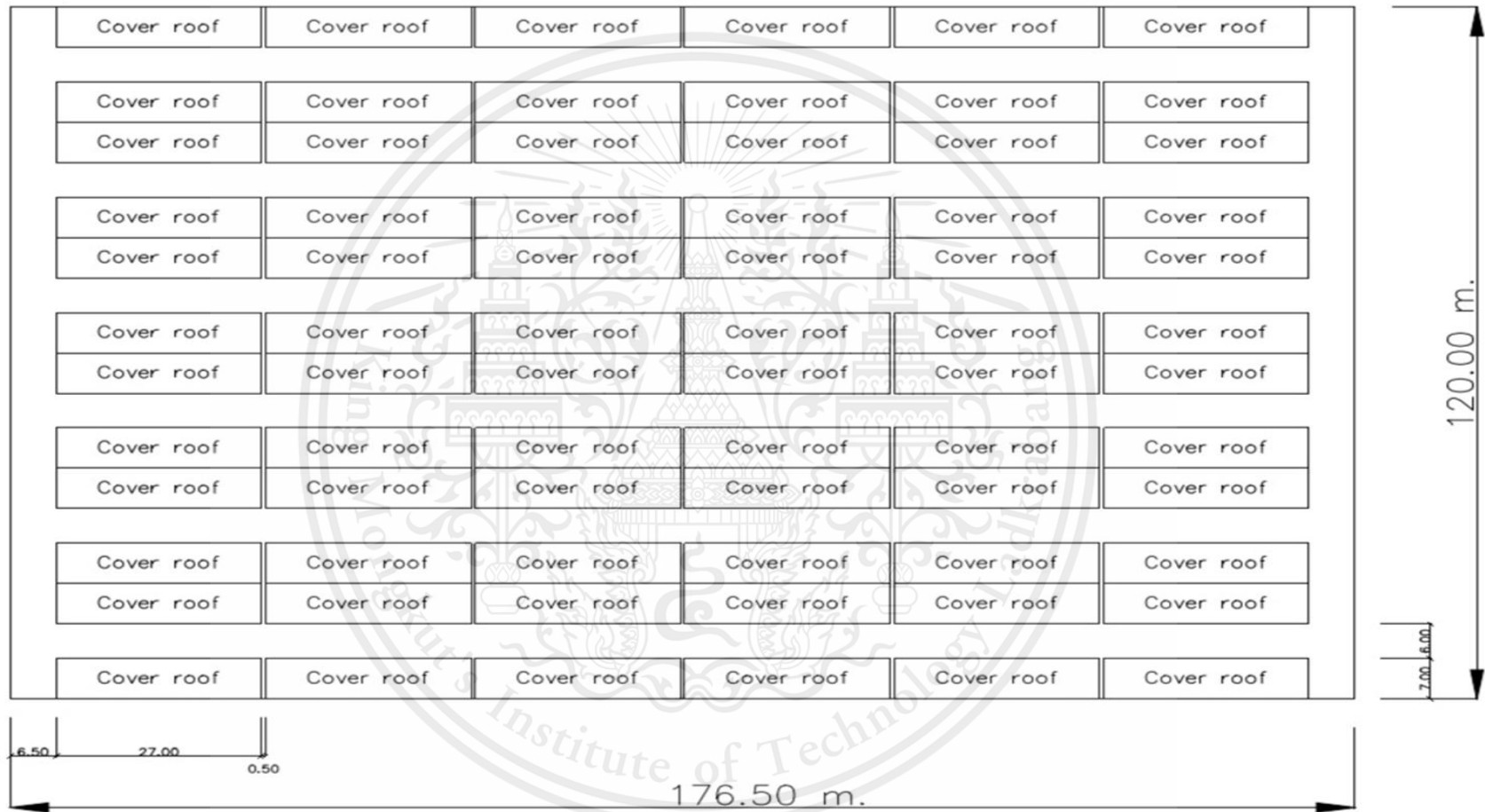


Figure 3.24: The area of car park with the roof at in front of the convention hall.

Table 3.2: The Bill of quantities (BOQ) of car park with the roof.

Item	Description	Quantity	Unit	Material cost		Wages		Cost
				Rate	Amount	Rate	Amount	
1	Rib out the floorboards (Reinforce concrete) old thick 0.15 m	16.50	m ²	-	-	70.00	1,155.00	1,155.00
2	Foundation pile (I) 0.18*8.00 m	22.00	pile	960.00	21,120.00	550.00	12,100.00	33,220.00
3	Lean concrete	1.76	m ³	1,943.60	3,420.74	306	538.56	3,959.30
4	Coarse sand	2.20	m ³	458.33	1,008.33	99	217.80	1,226.13
5	Structural concrete	5.61	m ³	2,158.60	12,109.75	306	1,716.66	13,826.41
6	RB 6	24.42	kg	20.73	506.23	4.1	100.12	606.35
7	DB 12	468.86	kg	19.60	9,189.66	3.3	1,547.24	10,736.89
8	Wooden formwork	7.00	m ²	560.00	3,920.00	133	931.00	4,851.00
9	Circular Hollow Section pipe ø60.5 thick 4 mm	1,102.86	kg	25.70	28,343.50	10.00	11,028.60	39,372.10
10	Circular Hollow Section pipe ø89.1 thick 4 mm	2,718.36	kg	25.70	69,861.85	10	27,183.60	97,045.45
11	Chanel C-125*50*20*3.2 mm.	1,876.80	kg	22.30	41,852.64	10.00	18,768.00	60,620.64
12	Plate 0.30*0.30 thick 12 mm.	22.00	set	600.00	13,200.00	-	-	13,200.00
13	DB 12	62.16	kg	19.60	1,218.34	3.30	205.13	1,423.46
14	Metal sheet 0.04 mm.	348.00	m ²	165.00	57,420.00	70.00	24,360.00	81,780.00
15	Flashing metal sheet	28.00	m	50.00	1,400.00	50.00	1,400.00	2,800.00
16	Painting	125.00	m ²	45.00	5,625.00	38.00	4,750.00	10,375.00
17	LED tube T8	9.00	set	660.00	5,940.00	115.00	1,035.00	6,975.00
18	Electrical System	1.00	set	10,000.00	10,000.00	-	-	10,000.00
19	Gutter System	49.00	m	1,450.00	71,050.00	25.00	1,225.00	72,275.00
20	Includind cost of materials ans labor							465,447.73
21	Factor F 1.3074							143,078.63
22	Total cost							608,526.36
23	Final cost							608,000.00

Remarks: This BOQ is for 2 building but we use just 1 building, so the final cost of this building is around 400,000 baht.

3.2.3.3 Build a building of car park at the soccer field in faculty of architecture.

This scenario will build a car park building at the soccer field at the faculty of architecture. The area of the building is 1600 with the dimension 32m*50m*17.5m. The building has seven floors with 500 parking slots. Collecting fees for students and staffs are first 4 hours free and after 4 hours 40 baht per hour after 12 hours 100 baht per hour. Collecting fees for the outsider is 40 baht per hour after 12 hours 100 baht per hour.

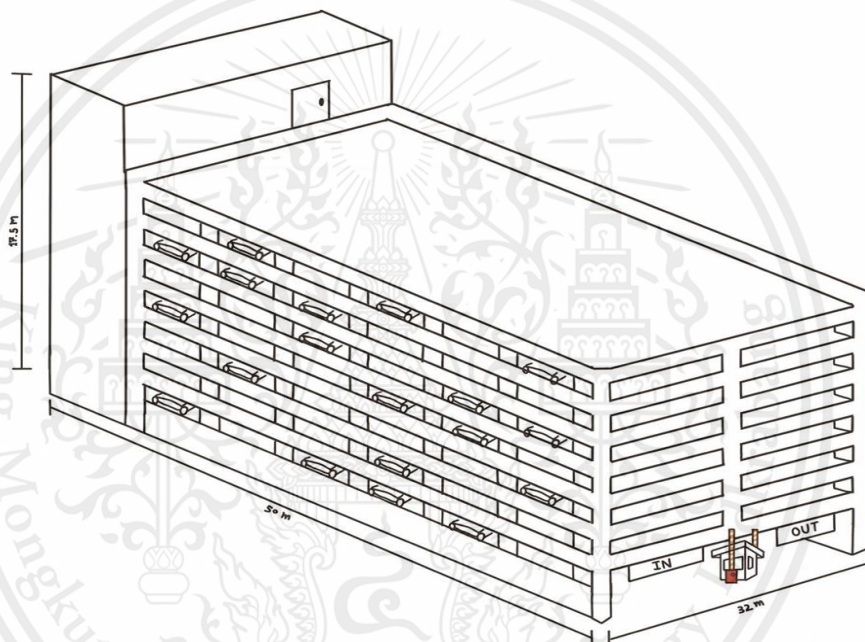


Figure 3.25: The design of the car park building.

Table 3.3: The Bill of quantities (BOQ) of car park building.

No.	List	Total amount (Material cost + Wage)	Cost during construction	Total amount
1.	Parking building construction cost	69,824,581.00	8,811,234.00	78,635,815.00
2.	Make to order equipment cost	878,200.00	110,821.00	989,021.00
3.	Specific equipment cost. Signage work, surveillance camera and Intelligent parking			2,000,510.00
4.	Air conditioning system			
	4.1 Air conditioning cost			1,719,000.00
	4.2 Air conditioning equipment cost	1,177,263.00	148,560.00	1,325,823.00
	4.3 Air conditioner maintenance cost	52,000.00	6,562.00	58,562.00
5.	Elevator installation cost	2,500,000.00	315,478.00	2,815,478.00
6.	Extra cost			2,320,000.00
7.	7.00% VAT			6,290,491.00
Total amount of the parking building construction cost				96,154,700.00

3.2.3.4 Using smart card for entering to the school of engineering.

This scenario will set a car barrier at each entrance of the school of engineering and a smart card for entering. There will be 433 car parks with the 2 entrances in the school of engineering. The only student in the 3rd and 4th year can register the smart card, and staff use the sticker for entering. Register fees is 800 Baht per semester for the student.

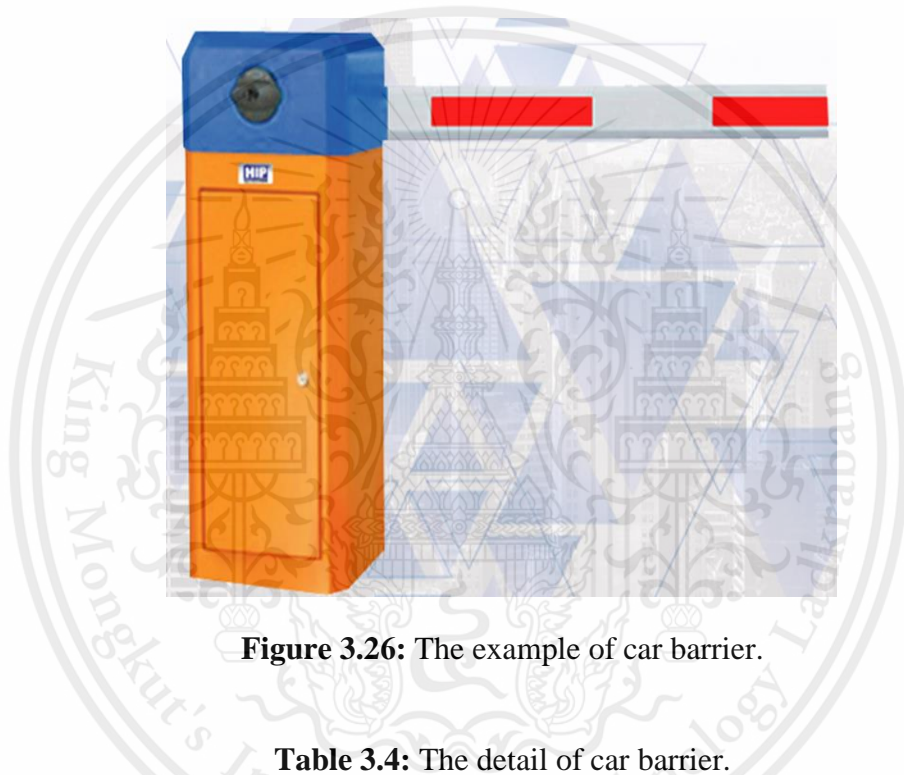


Figure 3.26: The example of car barrier.

Table 3.4: The detail of car barrier.

Function	Specification
Dimension	280*240*997 (mm)
Power Supply	AC110 +-10% AC220 +-10%
Frequency	50HZ. / 60HZ.
Power Consumption	120 Watts
Max. Straight Arm	4 Meters
Description/Speed	3 Seconds
Work Temperature	-20c to 75c
Rerated Humidity	<=90%
Protection Grade	IP44
Remote control Distance	>30m.
Manual Release	Yes
Motor Power Rated	120 Watts
Motor Rated Speed	1600 r / min.
Operation Life	>=600 millions hours.

The cost of the car barrier is 31,500 baht per piece, need 4 pieces. The card reader is 8,640 baht per piece, need 4 pieces. The security house is 35,000 baht per house, need 2 houses. Total amount is 230,560 baht.

3.2.4 Cash-Flow diagram.

Show the Cash-Flow diagram of each scenarios.

3.2.4.1 To buy EV Bus (Electric vehicle Bus).

Table 3.5: Show the economic dimension and estimate income and cost for to buy EV Bus scenario.

Economic dimension	Estimate
1.EV Bus cost	6,000,000 Baht
2.EV charger cost	15,000 Baht
3.Utility(Electricity)	284,310 Baht/year
4.Maintenance	5000/year
5.Parking fees	624 cars/day
6.Drivers (2person)	30,000/month

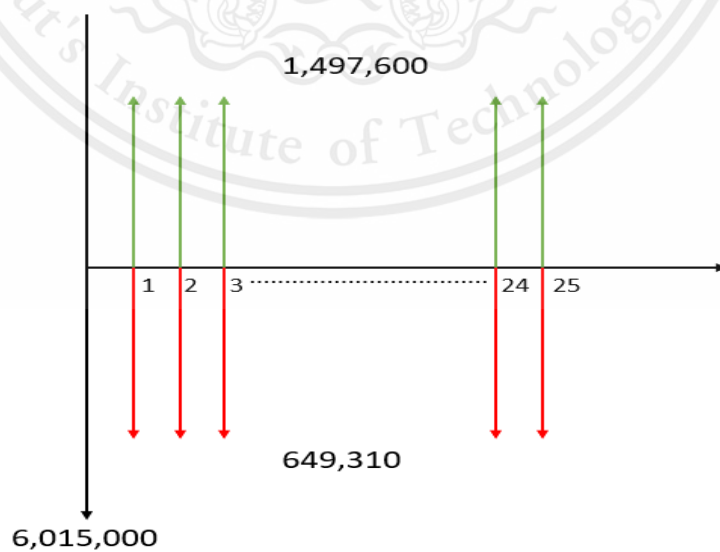


Figure 3.27: The cash-flow diagram to buy EV Bus scenario.

3.2.4.2 Build car park in front of convention hall and buy EV Bus.

Table 3.6: The economic dimension and estimate income and cost for Build car park in front of convention hall and buy EV Bus Scenario.

Economic dimension	Estimate
1.EV Bus cost	6,000,000 Baht
2.EV charger	15,000 Baht
3.Build cover roof	28,800,000 Baht
3.Utility(Electricity)	284,310 Baht/year
4.Maintenance	5000/year
5.Parking fees	624 cars/day
6.Bus Driver (2person)	360,000 Baht/year

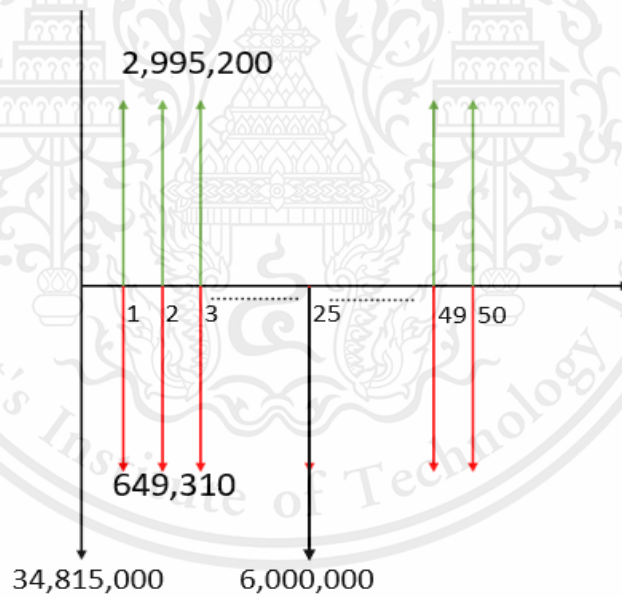


Figure 3.28: The cash-flow diagram for Build car park in front of convention hall and buy EV Bus.

3.2.4.3 Build a building of car park at the soccer field in faculty of architecture.

Table 3.7: The economic dimension and estimate income and cost for Build a building of car park at the soccer field in faculty of architecture.

Economic dimension	Estimate
1. Construction cost	96,154,700 Baht
2. Utility(Electricity ,Water)	960,000 Baht/year
3. Security guard	480,000 Baht/year
4. Parking fees	624 cars/day

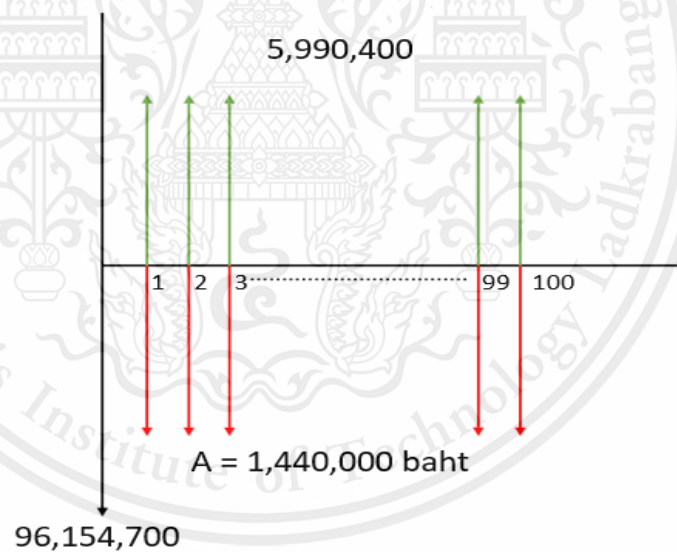


Figure 3.29: The cash-flow diagram for Build a building of car park at the soccer field in faculty of architecture.

3.2.4.4 Using smart card for entering to the school of engineering.

Table 3.8: The economic dimension and estimate income and cost for using smart card for entering to the school of engineering.

Economic dimension	Estimate
1.Car barrier cost	126,000 Baht
2.Card reader (4 pieces)	34,560 Baht
3.The security house (2 houses)	70,000 Baht
4.Security guard (4 person)	480,000 Baht/year
5.Parking fees	800 Baht/semester

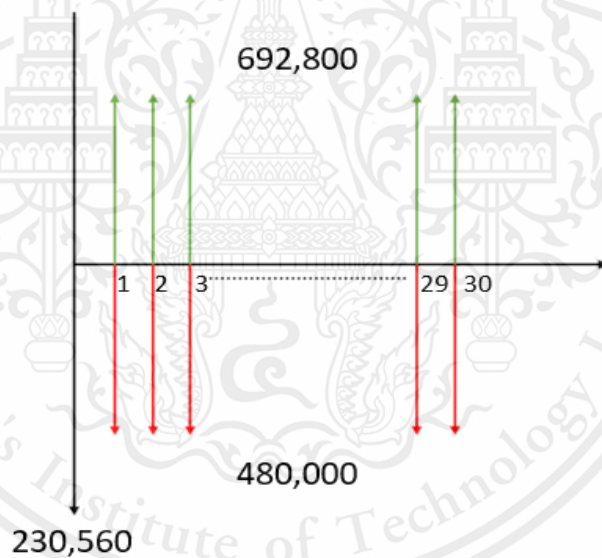


Figure 3.30: The cash-flow diagram for Using smart card for entering to the school of engineering.

3.2.5 Analyzing each scenario by using economics theory.

Calculate economics theory from financial data of each scenario. Each calculation will be compared to show suitable scenarios for proposing a new car park in different financial situation.

3.2.5.1 Benefit/cost analysis.

$$B/C \text{ ratio} = \frac{\text{Benefit}}{\text{Cost}} \quad (3.1)$$

3.2.5.1.1 To buy EV bus

$$PW_{\text{benefit}} = A(P/A, i, n)$$

$$PW_{\text{benefit}} = 1,497,600(P/A, 10\%, 25) = 1,497,600(9.0770)$$

$$PW_{\text{benefit}} = 13,593,715.2 \text{ baht}$$

$$PW_{\text{cost}} = P_0 + A(P/A, i, n)$$

$$PW_{\text{cost}} = 6,015,000 + 649,310(P/A, 10\%, 25)$$

$$PW_{\text{cost}} = 6,015,000 + 649,310(9.0770)$$

$$PW_{\text{cost}} = 11,908,786.9 \text{ baht}$$

B/C analysis

$$B/C = \text{Benefit/Cost} = 13,593,715.2/11,908,786.9$$

$$B/C = 1.141$$

3.2.5.1.2 Build car park in front of convention hall and buy EV bus

$$PW_{\text{benefit}} = A(P/A, i, n)$$

$$PW_{\text{benefit}} = 2,995,200(P/A, 10\%, 50) = 2,995,200(9.9148)$$

$$PW_{\text{benefit}} = 29,696,809 \text{ baht}$$

$$PW_{\text{cost}} = P_0 + A(P/A, i, n)$$

$$PW_{\text{cost}} = 34,815,000 + 649,310(P/A, 10\%, 50) + 6,000,000(P/F, 10\%, 25)$$

$$PW_{\text{cost}} = 34,815,000 + 649,310(9.9148) + 6,000,000(0.0923)$$

$$PW_{\text{cost}} = 41,806,578.8 \text{ baht}$$

B/C analysis

$$B/C = \text{Benefit/Cost} = 29,696,809/41,806,578.8$$

$$B/c = 0.71$$

3.2.5.1.3 Build a building of car park at the soccer field at the faculty of architecture.

$$PW_{\text{benefit}} = A(P/A, i, n)$$

$$PW_{benefit} = 5,990,400(P/A, 10\%, 100) = 5,990,400(9.9993)$$

$$PW_{benefit} = 59,899,806.7 \text{ baht}$$

$$PW_{cost} = P_0 + A(P/A, i, n)$$

$$PW_{cost} = 96,154,700 + 1,440,000(P/A, 10\%, 100)$$

$$PW_{cost} = 96,154,700 + 1,440,000(9.9993)$$

$$PW_{cost} = 110,553,692 \text{ baht}$$

B/C analysis

$$B/C = \text{Benefit/Cost} = 59,899,806.7/110,553,692$$

$$B/c = 0.54$$

3.2.5.1.4 Using smart card for entering carpark of faculty of engineering

$$PW_{benefit} = A(P/A, i, n)$$

$$PW_{benefit} = 692,800(P/A, 10\%, 30) = 692,800(9.4269)$$

$$PW_{benefit} = 6,530,956.32 \text{ baht}$$

$$PW_{cost} = P_0 + A(P/A, i, n)$$

$$PW_{cost} = 230,560 + 480,000(P/A, 10\%, 30)$$

$$PW_{cost} = 230,560 + 480,000(9.4269)$$

$$PW_{cost} = 4,755,472 \text{ baht}$$

B/C analysis

$$B/C = \text{Benefit/Cost} = 6,530,956.32/4,755,472$$

$$B/C = 1.37$$

3.2.5.2 Profitability Index

The profitability index can be computed using the following ratio:

Profitability index (PI) = PV of future cash flows/ Initial investment

The PV of future cash flow can be computed using the following formula [5]:

$$\sum_{t=0}^{n-1} \frac{V_t}{(1+r)^t} = \frac{V_0}{(1+r)^0} + \frac{V_1}{(1+r)^1} + \frac{V_2}{(1+r)^2} + \dots + \frac{V_{n-1}}{(1+r)^{n-1}} \quad (3.2)$$

1. To buy EV bus

Table 3.9: Calculation PV of future cash flows of method 1

t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$
0	1,497,600	1,497,600.00	13	1,497,600	433,801.38
1	1,497,600	1,361,454.55	14	1,497,600	394,364.89
2	1,497,600	1,237,685.95	15	1,497,600	358,513.53
3	1,497,600	1,125,169.05	16	1,497,600	325,921.39
4	1,497,600	1,022,880.95	17	1,497,600	296,292.18
5	1,497,600	929,891.77	18	1,497,600	269,356.52
6	1,497,600	845,356.16	19	1,497,600	244,869.57
7	1,497,600	768,505.60	20	1,497,600	222,608.70
8	1,497,600	698,641.45	21	1,497,600	202,371.54
9	1,497,600	635,128.59	22	1,497,600	183,974.13
10	1,497,600	577,389.63	23	1,497,600	167,249.21
11	1,497,600	524,899.66	24	1,497,600	152,044.74
12	1,497,600	477,181.51			

PV of future cash flows = 14953152.64

Profitability index (PI) = 14953152.64/6015000
= 2.48

2. Build car park in front of convention hall and buy EV bus

Table 3.10: Calculation PV of future cash flows of method 2

t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$
0	2,995,200	2,995,200.00	10	2,995,200	1,154,779.26	20	2,995,200	445,217.39	30	2,995,200	171,650.58	40	2,995,200	66,178.73
1	2,995,200	2,722,909.09	11	2,995,200	1,049,799.33	21	2,995,200	404,743.09	31	2,995,200	156,045.98	41	2,995,200	60,162.48
2	2,995,200	2,475,371.90	12	2,995,200	954,363.03	22	2,995,200	367,948.26	32	2,995,200	141,859.98	42	2,995,200	54,693.16
3	2,995,200	2,250,338.09	13	2,995,200	867,602.75	23	2,995,200	334,498.42	33	2,995,200	128,963.62	43	2,995,200	49,721.06
4	2,995,200	2,045,761.90	14	2,995,200	788,729.77	24	2,995,200	304,089.47	34	2,995,200	117,239.65	44	2,995,200	45,200.96
5	2,995,200	1,859,783.55	15	2,995,200	717,027.07	25	2,995,200	276,444.97	35	2,995,200	106,581.50	45	2,995,200	41,091.78
6	2,995,200	1,690,712.32	16	2,995,200	651,842.79	26	2,995,200	251,313.61	36	2,995,200	96,892.28	46	2,995,200	37,356.17
7	2,995,200	1,537,011.20	17	2,995,200	592,584.35	27	2,995,200	228,466.92	37	2,995,200	88,083.89	47	2,995,200	33,960.15
8	2,995,200	1,397,282.91	18	2,995,200	538,713.05	28	2,995,200	207,697.20	38	2,995,200	80,076.26	48	2,995,200	30,872.87
9	2,995,200	1,270,257.19	19	2,995,200	489,739.13	29	2,995,200	188,815.64	39	2,995,200	72,796.60	49	2,995,200	28,066.24

PV of future cash flows = 32666537.59

Profitability index (PI) = 32666537.59/34815000
= 0.94

3. Build a building of car park at the soccer field at the faculty of architecture

Table 3.11: Calculation PV of future cash flows of method 3

t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$
0	5,990,400	5,990,400.00	10	5,990,400	2,309,558.52	20	5,990,400	890,434.79	30	5,990,400	343,301.16	40	5,990,400	132,357.46
1	5,990,400	5,445,818.18	11	5,990,400	2,099,598.66	21	5,990,400	809,486.17	31	5,990,400	312,091.96	41	5,990,400	120,324.96
2	5,990,400	4,950,743.80	12	5,990,400	1,908,726.05	22	5,990,400	735,896.52	32	5,990,400	283,719.97	42	5,990,400	109,386.33
3	5,990,400	4,500,676.18	13	5,990,400	1,735,205.50	23	5,990,400	668,996.84	33	5,990,400	257,927.24	43	5,990,400	99,442.12
4	5,990,400	4,091,523.80	14	5,990,400	1,577,459.55	24	5,990,400	608,178.94	34	5,990,400	234,479.31	44	5,990,400	90,401.92
5	5,990,400	3,719,567.09	15	5,990,400	1,434,054.13	25	5,990,400	552,889.95	35	5,990,400	213,163.01	45	5,990,400	82,183.57
6	5,990,400	3,381,424.63	16	5,990,400	1,303,685.58	26	5,990,400	502,627.22	36	5,990,400	193,784.55	46	5,990,400	74,712.33
7	5,990,400	3,074,022.39	17	5,990,400	1,185,168.70	27	5,990,400	456,933.84	37	5,990,400	176,167.78	47	5,990,400	67,920.30
8	5,990,400	2,794,565.81	18	5,990,400	1,077,426.10	28	5,990,400	415,394.40	38	5,990,400	160,152.52	48	5,990,400	61,745.73
9	5,990,400	2,540,514.37	19	5,990,400	979,478.27	29	5,990,400	377,631.27	39	5,990,400	145,593.20	49	5,990,400	56,132.48
50	5,990,400	51,029.53	60	5,990,400	19,674.09	70	5,990,400	7,585.21	80	5,990,400	2,924.43	90	5,990,400	1,127.49
51	5,990,400	46,390.48	61	5,990,400	17,885.54	71	5,990,400	6,895.65	81	5,990,400	2,658.57	91	5,990,400	1,024.99
52	5,990,400	42,173.16	62	5,990,400	16,259.58	72	5,990,400	6,268.77	82	5,990,400	2,416.88	92	5,990,400	931.81
53	5,990,400	38,339.24	63	5,990,400	14,781.44	73	5,990,400	5,698.88	83	5,990,400	2,197.17	93	5,990,400	847.10
54	5,990,400	34,853.86	64	5,990,400	13,437.67	74	5,990,400	5,180.80	84	5,990,400	1,997.42	94	5,990,400	770.09
55	5,990,400	31,685.32	65	5,990,400	12,216.06	75	5,990,400	4,709.82	85	5,990,400	1,815.84	95	5,990,400	700.08
56	5,990,400	28,804.84	66	5,990,400	11,105.51	76	5,990,400	4,281.66	86	5,990,400	1,650.76	96	5,990,400	636.44
57	5,990,400	26,186.22	67	5,990,400	10,095.92	77	5,990,400	3,892.41	87	5,990,400	1,500.69	97	5,990,400	578.58
58	5,990,400	23,805.65	68	5,990,400	9,178.11	78	5,990,400	3,538.56	88	5,990,400	1,364.27	98	5,990,400	525.98
59	5,990,400	21,641.50	69	5,990,400	8,343.74	79	5,990,400	3,216.87	89	5,990,400	1,240.24	99	5,990,400	478.17

PV of future cash flows = 65889618.33

Profitability index (PI) = 65889618.33/96154700
= 0.68

4. Using smart card for entering carpark of faculty of engineering

Table 3.12: Calculation PV of future cash flows of method 4

t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$	t(year)	Vt(Bath)	$\frac{V_t}{(1+r)^t}$
0	692,800	692,800.00	10	692,800	267,104.39	20	692,800	102,980.31
1	692,800	629,818.18	11	692,800	242,822.17	21	692,800	93,618.46
2	692,800	572,561.98	12	692,800	220,747.43	22	692,800	85,107.69
3	692,800	520,510.89	13	692,800	200,679.48	23	692,800	77,370.63
4	692,800	473,191.72	14	692,800	182,435.89	24	692,800	70,336.93
5	692,800	430,174.29	15	692,800	165,850.81	25	692,800	63,942.67
6	692,800	391,067.54	16	692,800	150,773.47	26	692,800	58,129.70
7	692,800	355,515.94	17	692,800	137,066.79	27	692,800	52,845.18
8	692,800	323,196.31	18	692,800	124,606.17	28	692,800	48,041.07
9	692,800	293,814.83	19	692,800	113,278.34	29	692,800	43,673.70

PV of future cash flows = 7184062.98

$$\begin{aligned}\text{Profitability index (PI)} &= 7184062.98/195560 \\ &= 36.73\end{aligned}$$

3.2.5.3 Rate of return analysis.

In case of calculating using the present worth (PW), it can be written as the equation as follows:

$$PW_{D,i\%} = PW_{B,i\%} \quad (3.3)$$

Where PW_D is the present equivalent value of the investment (Baht), PW_B is the present equivalent value of the return (Baht), and $i\%$ is the lowest rate of return that makes the present value, or the annual equivalent value of the investment equal present value or annual equivalent value of the benefit received. [1]

3.2.5.3.1 To buy EV bus

$$PW \text{ i}13\% = 1,497,600(P/A, i\%, 25) - 6,015,000 - 649,310(P/A, i\%, 25)$$

$$PW \text{ i}13\% = 1,497,600(7.330) - 6,015,000 - 649,310(7.330)$$

$$PW \text{ i}13\% = 202,965.7$$

$$PW \text{ i}14\% = 1,497,600(P/A, i\%, 25) - 6,015,000 - 649,310(P/A, i\%, 25)$$

$$PW \text{ i}14\% = 1,497,600(6.873) - 6,015,000 - 649,310(6.873)$$

$$PW \text{ i}14\% = -184,702.83$$

$$i = 13 + ((14 - 13) / (202,965.7 + 184,702.83)) \times (202,965.7 - 0) = 13.52\%$$

$$\text{Rate of return} = 13.52\%$$

3.2.5.3.2 Build car park in front of convention hall and buy EV bus

$$PW \text{ i}6\% = 2,995,200(P/A, i\%, 50) - 34,815,000 - 649,310(P/A, i\%, 50) - 6,000,000(P/F, i\%, 25)$$

$$PW \text{ i}6\% = 2,995,200(15.762) - 34,815,000 - 649,310(15.762) - 6,000,000(0.0543)$$

$$PW \text{ i}6\% = 1,835,118.18$$

$$PW \text{ i}7\% = 2,995,200(13.801) - 34,815,000 - 649,310(13.801) - 6,000,000(0.0339)$$

$$PW \text{ i}7\% = -2,642,772.11$$

$$i = 6 + ((7 - 6) / (1,835,118.18 + 2,642,772.11)) \times (1,835,118.18 - 0) = 6.40\%$$

$$\text{Rate of return} = 6.40\%$$

3.2.5.3.3 Build a building of car park at the soccer field at the faculty of architecture.

$$PW \text{ i}4\% = 5,990,400(P/A, i\%, 100) - 96,154,700 - 1,440,000(P/A, i\%, 100)$$

$$PW \text{ i}4\% = 5,990,400(24.505) - 96,154,700 - 1,440,000(24.505)$$

$$PW \text{ i}4\% = 15,352,852$$

$$PW \text{ i}5\% = 5,990,400(P/A, i\%, 100) - 96,154,700 - 1,440,000(P/A, i\%, 100)$$

$$PW \text{ i}5\% = 5,990,400(19.848) - 96,154,700 - 1,440,000(19.848)$$

$$PW \text{ i}5\% = -5,838,360.8$$

$$i = 4 + ((5 - 4) / (15,352,852 + 5,838,360.8)) \times (15,352,852 - 0) = 4.72\%$$

$$\text{Rate of return} = 4.72\%$$

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3.2.5.3.4 Using smart card for entering carpark of faculty of engineering

$$PW_i = 692,800 (P/A, 10\%, 30) - 230,560 - 480,000(P/A, 10\%, 30)$$

$$0 = -230,560 + (692,800 - 480,000)(P/A, i, 30)$$

$$230,560 = 212,800 \left(\frac{(1+i)^{30} - 1}{i(1+i)^{30}} \right)$$

$$i = 0.92, i = 92\%$$

3.2.5.4 Return on Investment

The return on investment (ROI) formula is as follows:

$$\text{Return on investment (ROI)} = \frac{(\text{Final Value of Investment} - \text{Initial Value of Investment})}{\text{Cost of Investment}} * 100\% \quad (3.4)$$

3.2.5.4.1 To buy EV Bus

$$\begin{aligned} \text{Return on investment (ROI)} &= \frac{(1497600 - 649310)}{6015000} * 100\% \\ &= 14.10\% \end{aligned}$$

3.2.5.4.2 Build car park in front of convention hall and buy EV Bus

$$\begin{aligned} \text{Return on investment (ROI)} &= \frac{(2995200 - 649310)}{34815000} * 100\% \\ &= 6.74\% \end{aligned}$$

3.2.5.4.3 Build a building of car park at the soccer field at the faculty of architecture.

$$\begin{aligned} \text{Return on investment (ROI)} &= \frac{(5990400 - 1440000)}{96154700} * 100\% \\ &= 4.73\% \end{aligned}$$

3.2.5.4.4. Using smart card for entering car park of the school of engineering.

$$\text{Return on investment (ROI)} = \frac{(692800 - 480000)}{195560} * 100\%$$

$$= 108.81 \%$$

3.2.5.5 Payback analysis

$$0 = -P + NCF(P/A, i, n_p) \quad (3.5)$$

3.2.5.5.1 To buy EV bus

$$0 = -P + NCF(P/A, I, N_p)$$

$$P = -6,015,000 - 649,310(P/A, 10\%, 25) + 1,497,600(P/A, 10\%, 25)$$

$$P = -6,015,000 - 649,310(9.0770) + 1,497,600(9.0770)$$

$$P = 1,684,928.33$$

$$\text{Revenue/Year} = 1,684,928.33(A/P, 10\%, 25)$$

$$= 1,684,928.33 (0.1102)$$

$$= 185,679.102 \text{ Baht/Year}$$

From equation; $0 = -P + NCF(P/A, I, N_p)$

$$0 = -1,684,928.33 + (185,679.102) (P/A, 10\%, N_p)$$

$$(P/A, 10\%, N_p) = 24.96 \text{ Year} = n_p$$

3.2.5.5.2 Build car park in front of convention hall and buy EV bus

$$0 = -P + NCF(P/A, I, N_p)$$

$$P = -34,815,000 - 649,310(P/A, 10\%, 50) - 6,000,000(P/F, 10\%, 25) + 2,995,200(P/A, 10\%, 50)$$

$$P = -34,815,000 - 649,310(9.9148) - 6,000,000(0.0923) + 2,995,200(9.9148)$$

$$P = -12,109,769.83$$

$$\text{Revenue/Year} = -12,109,769.83 (A/P, 10\%, 50)$$

$$= 1,684,928.33 (0.1009)$$

$$= -1,221,875.776 \text{ Baht/Year}$$

From equation; $0 = -P + NCF(P/A, I, Np)$

$$0 = -(-12,109,769.83) + (-1,221,875.776)(P/A, 10\%, Np)$$

$$(P/A, 10\%, Np) = 49.51 \text{ Year} = np$$

3.2.5.5.3 Build a building of car park at the soccer field at the faculty of architecture.

$$0 = -P + NCF(P/A, I, Np)$$

$$P = -96,154,700 - 1,440,000(P/A, 10\%, 100) + 5,990,400(P/A, 10\%, 100)$$

$$P = -96,154,700 - 1,440,000(9.9993) + 5,990,400(9.9993)$$

$$P = -50,653,885.28$$

$$\text{Revenue/Year} = -50,653,885.28 (A/P, 10\%, 100)$$

$$= -50,653,885.28(0.100)$$

$$= -5,065,388.528 \text{ Baht/Year}$$

From equation; $0 = -P + NCF(P/A, I, Np)$

$$0 = -(-50,653,885.28) + (-5,065,388.528)(P/A, 10\%, Np)$$

$$(P/A, 10\%, Np) = \text{More than 100 Year} = Np$$

3.2.5.5.4 Using smart card for entering car park of the school of engineering.

$$0 = -P + NCF(P/A, I, Np)$$

$$P = -230,560 - 480,000(P/A, 10\%, 30) + 692,800(P/A, 10\%, 30)$$

$$P = -230,560 - 480,000(9.4269) + 692,800(9.4269)$$

$$P = 1,775,484.32$$

$$\text{Revenue/Year} = 1,775,484.32 (A/P, 10\%, 30)$$

$$= 1,684,928.33 (0.1061)$$

$$= 188,378.8864 \text{ Baht/Year}$$

From equation; $0 = -P + NCF(P/A, I, Np)$

$$0 = -1,775,484.32 + (188,378.8864)(P/A, 10\%, Np)$$

$$(P/A, 10\%, Np) = 29.96 \text{ Year} = np$$

3.2.5.6 Net present value method

$$\text{Net Present Value (NPV)} = \left(\sum_{t=1}^n \frac{C_t}{(1+r)^t} \right) - I \quad (3.6)$$

Where,

- NPV = Net present value
- I = Initial investment
- C_t = Net cash inflow for the period
- t = Cash flow period
- n = number of periods
- r = discount rate

3.2.5.6.1 To buy EV bus

Table 3.13: Calculation Net Present Value of method 1

t(year)	Ct(Baht)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Baht)	$\frac{C_t}{(1+r)^t}$
1	848,290	771,172.73	14	848,290	223,381.27
2	848,290	701,066.12	15	848,290	203,073.88
3	848,290	637,332.83	16	848,290	184,612.62
4	848,290	579,393.48	17	848,290	167,829.65
5	848,290	526,721.35	18	848,290	152,572.41
6	848,290	478,837.59	19	848,290	138,702.19
7	848,290	435,306.90	20	848,290	126,092.90
8	848,290	395,733.55	21	848,290	114,629.91
9	848,290	359,757.77	22	848,290	104,209.01
10	848,290	327,052.52	23	848,290	94,735.46
11	848,290	297,320.47	24	848,290	86,123.15
12	848,290	270,291.34	25	848,290	78,293.77
13	848,290	245,719.40			

$$\begin{aligned} \text{Net Present Value (NPV)} &= \left(\sum_{t=1}^{25} \frac{848290}{(1+0.1)^t} \right) - I \\ &= 7699962.28 - 6015000 \\ &= 1684962.28 \text{ baht} \end{aligned}$$

3.2.5.6.2 Build car park in front of convention hall and buy EV bus

Table 3.14: Calculation Net Present Value of method 2

t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$
1	848,290	771,172.73	11	848,290	297,320.47	21	848,290	114,629.91	31	848,290	44,194.79	41	848,290	17,039.01
2	848,290	701,066.12	12	848,290	270,291.34	22	848,290	104,209.01	32	848,290	40,177.08	42	848,290	15,490.01
3	848,290	637,332.83	13	848,290	245,719.40	23	848,290	94,735.46	33	848,290	36,524.62	43	848,290	14,081.82
4	848,290	579,393.48	14	848,290	223,381.27	24	848,290	86,123.15	34	848,290	33,204.20	44	848,290	12,801.66
5	848,290	526,721.35	15	848,290	203,073.88	25	848,290	78,293.77	35	848,290	30,185.64	45	848,290	11,637.87
6	848,290	478,837.59	16	848,290	184,612.62	26	848,290	71,176.16	36	848,290	27,441.49	46	848,290	10,579.88
7	848,290	435,306.90	17	848,290	167,829.65	27	848,290	64,705.60	37	848,290	24,946.81	47	848,290	9,618.07
8	848,290	395,733.55	18	848,290	152,572.41	28	848,290	58,823.27	38	848,290	22,678.92	48	848,290	8,743.70
9	848,290	359,757.77	19	848,290	138,702.19	29	848,290	53,475.70	39	848,290	20,617.20	49	848,290	7,948.82
10	848,290	327,052.52	20	848,290	126,092.90	30	848,290	48,614.27	40	848,290	18,742.91	50	848,290	7,226.20

$$\begin{aligned}
 \text{Net Present Value (NPV)} &= \left(\sum_{t=1}^{50} \frac{2345890}{(1+0.1)^t} \right) - I \\
 &= 8410637.98 - 34815000 \\
 &= -26404326.02 \text{ baht}
 \end{aligned}$$

3.2.5.6.3 Build a building of car park at the soccer field at the faculty of architecture.

Table 3.15: Calculation Net Present Value of method 3

t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Bath)	$\frac{C_t}{(1+r)^t}$
1	4,550,400	4,136,727.27	11	4,550,400	1,594,887.44	21	4,550,400	614,898.15	31	4,550,400	237,069.86	41	4,550,400	91,400.69
2	4,550,400	3,760,661.16	12	4,550,400	1,449,897.67	22	4,550,400	558,998.32	32	4,550,400	215,518.05	42	4,550,400	83,091.54
3	4,550,400	3,418,782.87	13	4,550,400	1,318,088.79	23	4,550,400	508,180.29	33	4,550,400	195,925.50	43	4,550,400	75,537.76
4	4,550,400	3,107,984.43	14	4,550,400	1,198,262.54	24	4,550,400	461,982.08	34	4,550,400	178,114.09	44	4,550,400	68,670.69
5	4,550,400	2,825,440.39	15	4,550,400	1,089,329.58	25	4,550,400	419,983.71	35	4,550,400	161,921.90	45	4,550,400	62,427.90
6	4,550,400	2,568,582.17	16	4,550,400	990,299.62	26	4,550,400	381,803.37	36	4,550,400	147,201.73	46	4,550,400	56,752.64
7	4,550,400	2,335,074.70	17	4,550,400	900,272.38	27	4,550,400	347,093.98	37	4,550,400	133,819.75	47	4,550,400	51,593.31
8	4,550,400	2,122,795.18	18	4,550,400	818,429.44	28	4,550,400	315,539.98	38	4,550,400	121,654.32	48	4,550,400	46,903.01
9	4,550,400	1,929,813.80	19	4,550,400	744,026.76	29	4,550,400	286,854.53	39	4,550,400	110,594.84	49	4,550,400	42,639.10
10	4,550,400	1,754,376.18	20	4,550,400	676,387.96	30	4,550,400	260,776.84	40	4,550,400	100,540.76	50	4,550,400	38,762.82
51	4,550,400	35,238.92	61	4,550,400	13,586.13	71	4,550,400	5,238.04	81	4,550,400	2,019.49	91	4,550,400	778.60
52	4,550,400	32,035.38	62	4,550,400	12,351.03	72	4,550,400	4,761.86	82	4,550,400	1,835.90	92	4,550,400	707.82
53	4,550,400	29,123.08	63	4,550,400	11,228.21	73	4,550,400	4,328.96	83	4,550,400	1,669.00	93	4,550,400	643.47
54	4,550,400	26,475.52	64	4,550,400	10,207.46	74	4,550,400	3,935.42	84	4,550,400	1,517.27	94	4,550,400	584.97
55	4,550,400	24,068.66	65	4,550,400	9,279.51	75	4,550,400	3,577.65	85	4,550,400	1,379.34	95	4,550,400	531.80
56	4,550,400	21,880.60	66	4,550,400	8,435.92	76	4,550,400	3,252.41	86	4,550,400	1,253.95	96	4,550,400	483.45
57	4,550,400	19,891.45	67	4,550,400	7,669.02	77	4,550,400	2,956.74	87	4,550,400	1,139.95	97	4,550,400	439.50
58	4,550,400	18,083.14	68	4,550,400	6,971.83	78	4,550,400	2,687.94	88	4,550,400	1,036.32	98	4,550,400	399.55
59	4,550,400	16,439.22	69	4,550,400	6,338.03	79	4,550,400	2,443.58	89	4,550,400	942.11	99	4,550,400	363.22
60	4,550,400	14,944.74	70	4,550,400	5,761.85	80	4,550,400	2,221.44	90	4,550,400	856.46	100	4,550,400	330.20

$$\begin{aligned}
 \text{Net Present Value (NPV)} &= \left(\sum_{t=1}^{100} \frac{4550400}{(1+0.1)^t} \right) - I \\
 &= 45500697.97 - 96154700 \\
 &= -50654002.03 \text{ baht}
 \end{aligned}$$

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3.2.5.6.4 Using smart card for entering carpark of faculty of engineering.

Table 3.16: Calculation Net Present Value of method 4

t(year)	Ct(Baht)	$\frac{C_t}{(1+r)^t}$	t(year)	Ct(Baht)	$\frac{C_t}{(1+r)^t}$
1	212,800	193,454.55	16	212,800	46,311.48
2	212,800	175,867.77	17	212,800	42,101.35
3	212,800	159,879.79	18	212,800	38,273.95
4	212,800	145,345.26	19	212,800	34,794.50
5	212,800	132,132.06	20	212,800	31,631.36
6	212,800	120,120.05	21	212,800	28,755.79
7	212,800	109,200.05	22	212,800	26,141.62
8	212,800	99,272.77	23	212,800	23,765.11
9	212,800	90,247.97	24	212,800	21,604.65
10	212,800	82,043.61	25	212,800	19,640.59
11	212,800	74,585.10	26	212,800	17,855.08
12	212,800	67,804.64	27	212,800	16,231.89
13	212,800	61,640.58	28	212,800	14,756.26
14	212,800	56,036.89	29	212,800	13,414.79
15	212,800	50,942.63	30	212,800	12,195.26

$$\begin{aligned}
 \text{Net Present Value (NPV)} &= \left(\sum_{t=1}^{30} \frac{212800}{(1+0.1)^t} \right) - I \\
 &= 2006047.40 - 195560 \\
 &= 1810487.4 \text{ baht}
 \end{aligned}$$

3.2.5.7 Annual Worth analysis

$$AW = PW(A/P, i\%, n) \quad (3.7)$$

3.2.5.7.1 To buy EV Bus.

$$AW = 1,684,962.28 (A/P, 10\%, 25)$$

$$AW = 1,684,962.28 (0.1102)$$

$$AW = 185,682.843$$

3.2.5.7.2 Build car park in front of convention hall and buy EV Bus.

$$AW = -26404326.02 (A/P, 10\%, 50)$$

$$AW = -26,404,326.02 (0.1009)$$

$$AW = -2,664,196.495$$

3.2.5.7.3 Build a building of car park at the soccer field in the school of architecture.

$$AW = -50,654,002.03 (A/P, 10\%, 100)$$

$$AW = -50,654,002.03 (0.1000)$$

$$AW = -5065400.203$$

3.2.5.7.4 Using smart card for entering car park of the school of engineering.

$$AW = 1810487.4 (A/P,10\%,30)$$

$$AW = 1,810,487.4 (0.1061)$$

$$AW = 192092.7131$$

3.3 Interesting Problems

The main purpose of this feasibility study is to purpose suitable car parking spots for students and staff at the school of engineering KMITL. However, the school of engineering is located in the same area as the school of architecture. There would be problems of construction and car parking management.

3.4 Proposed Solution

In the making the decision to find the suitable car park from these scenarios. There is the best one choosing the scenarios must base on the finance of the school of engineering. We can choose more than one scenario and adapt them in which it might be more efficient than other scenarios.

3.5 Summary

This chapter described the detail of collecting data, the detail of 4 scenarios, and the calculation of the economics theory in which these can help to analyze and compare each scenario to show the best-suited car parking.

CHAPTER 4

EXPERIMENTAL RESULT

4.1 Introduction

This chapter shows the research operations from calculating the data to assist in investment decisions in each method of study, the possibilities of finding suitable parking for students and staff. The results of the tests are summarized in section 4.2.

4.2 Testing Summary

4.2.1 Benefit/cost analysis

Table 4.1: The comparison benefit/cost analysis.

No.	Method	Benefit/Cost
1	Buy EV bus.	1.14
2	Build car park in front of convention hall and buy EV bus.	0.71
3	Build a building of car park at soccer field in faculty of architecture.	0.54
4	Using smart card for entering carpark of faculty of engineering.	1.37

If the calculated benefit/cost ratio of a project is greater than 1, it is decided to invest or accept that project. Because the project will obtain a larger present value return on all cash inflows than the investment funds.

4.2.2 Rate of return analysis

Table 4.2: The comparison rate of return analysis.

No.	Method	Rate of return
1	Buy EV bus.	13.52 %
2	Build car park in front of convention hall and buy EV bus.	6.40 %
3	Build a building of car park at soccer field in faculty of architecture.	4.72 %
4	Using smart card for entering carpark of faculty of engineering.	92 %

If the rate of return is greater than the financial cost, it means that the investment is profitable. If the rate of return is less than the financial costs, this shows that the investment should be rejected.

4.2.3 Net present value

Table 4.3: The comparison net present value.

No.	Method	Net present value (Baht)
1	Buy EV bus.	168,492.82
2	Build car park in front of convention hall and buy EV bus.	-26,404,326.02
3	Build a building of car park at soccer field in faculty of architecture.	-50,654,002.03
4	Using smart card for entering carpark of faculty of engineering.	1,810,487.40

The net present value is the expected return on investment in this project. The project returns more than the invested capital if the net present value is positive; if the net present value is negative, the projected return is less than the invested capital.

4.2.4 Return on investment.

Table 4.4: The comparison returns on investment.

No.	Method	Return on investment
1	Buy EV bus.	14.01 %
2	Build car park in front of convention hall and buy EV bus.	6.74 %
3	Build a building of car park at soccer field in faculty of architecture.	4.73 %
4	Using smart card for entering carpark of faculty of engineering.	108.81 %

Return on investment is a number that represents the return on investment that can be used to compare various investments to choose the investment that yields the highest return on investment.

4.2.5 Payback analysis

Table 4.5: The comparison payback analysis.

No.	Method	Payback analysis (Year)
1	Buy EV bus.	24.96
2	Build car park in front of convention hall and buy EV bus.	49.51
3	Build a building of car park at soccer field in faculty of architecture.	>100
4	Using smart card for entering carpark of faculty of engineering.	29.96

Payback analysis is a mathematical tool for calculating an investment's payback time. The payback period is the amount of time it would take to repay the investment using the cash flow generated by the asset or project.

4.2.6 Annual worth analysis

Table 4.6: The comparison annual worth analysis.

No.	Method	Annual worth analysis
1	Buy EV bus.	185,682.84
2	Build car park in front of convention hall and buy EV bus.	-2,664,196.50
3	Build a building of car park at soccer field in faculty of architecture.	-5,065,400.20
4	Using smart card for entering carpark of faculty of engineering.	192,092.71

In instances where there are multiple options, the option with the highest NPV is the most appealing to pick from. All alternatives with $AW \geq 0$ are selected in instances where the alternatives are independent.

4.2.7 Profitability index

Table 4.7: The comparison profitability index.

No.	Method	Profitability index
1	Buy EV bus.	2.48
2	Build car park in front of convention hall and buy EV bus.	0.94
3	Build a building of car park at soccer field in faculty of architecture.	0.68
4	Using smart card for entering carpark of faculty of engineering.	36.73

Profitability index is the ratio between the present value of the net cash inflow that is expected to be received in a project and divided by the present value of the cash originally invested in the project.

4.2.8 Compare of all methods.

Table 4.8: The comparison of all methods.

Method	B/C	IRR	NPV (Baht)	ROI	PB (Year)	AW	PI
1. Buy EV bus.	1.14	13.52 %	168,492.82	14.01 %	24.96	185,682.84	2.48
2. Build car park in front of convention hall and buy EV bus.	0.71	6.40 %	-26,404,326.02	6.74 %	49.51	-2,664,196.50	0.94
3. Build a building of car park at soccer field in faculty of architecture.	0.54	4.72 %	-50,654,002.03	4.73 %	>100	-5,065,400.20	0.68
4. Using smart card for entering carpark of faculty of engineering.	1.37	92 %	1,810,487.40	108.81 %	29.96	192,092.71	36.73

4.3 Evaluation

The tests discussed in section 4.2 demonstrate that tools to assist in investment decisions are efficient. It will assist in determining how to resolve the problem. Therefore, in this section, we will evaluate, implement, and discuss about the best suited parking spaces.

4.4 Testing and Evaluation Summary

This chapter describes the process of deciding on how to select a solution using the tools for project analysis and evaluation. The chapter begins with benefit/cost analysis (4.2.1) to show that the benefit/cost of the first method (To buy EV bus) is 1.14, the second method (Build car park in front of convention hall and buy EV bus) is 0.71, the third method (Build a building of car park at soccer field in faculty of architecture) is 0.54, and the fourth method (Using smart card for entering carpark of faculty of engineering) is 1.37. Next, the rate of return analysis (4.2.2) of the first method (To buy EV bus) is 13.52%, the second method (Build car park in front of convention hall and buy EV bus) is 6.40%, the third method (Build a building of car park at soccer field in faculty of architecture) is 4.72%, and the fourth method (Using smart card for entering carpark of faculty of engineering) is 92%. Then, Net present value (4.2.3) of the first method (To buy EV bus) is about 168,492 baht, the second method (Build car park in front of convention hall and buy EV bus) is about -26,404,326 baht, the third method (Build a building of car park at soccer field in faculty of architecture) is about -50,654,002 baht, and the fourth method (Using smart card for entering carpark of faculty of engineering) is about 1,810,487 baht as you can see the fourth method (Using smart card for entering carpark of faculty of engineering) is the highest value and the lowest value is the third method (Build a building of car park at soccer field in faculty of architecture). After that, the Return on investment (4.2.4) of the first method (To buy EV bus) is 14.01%, the second method (Build car park in front of convention hall and buy EV bus) is 7.74%, the third method (Build a building of car park at soccer field in faculty of architecture) is 4.73%, and the fourth method (Using smart card for entering carpark of faculty of engineering) is 108.81%. And afterward,

the payback analysis (4.2.5) of the first method (To buy EV bus) is about 25 years, the second method (Build car park in front of convention hall and buy EV bus) is about 50 years, the third method (Build a building of car park at soccer field in faculty of architecture) is more than 100 years, and the fourth method (Using smart card for entering carpark of faculty of engineering) is about 30 years as you can see the first method (To buy EV bus) is the minimum value and the maximum value is the third method (Build a building of car park at soccer field in faculty of architecture). Following that, the annual worth analysis (4.2.6) of the first method (To buy EV bus) is about 185682, the second method (Build car park in front of convention hall and buy EV bus) is about -2664196, the third method (Build a building of car park at soccer field in faculty of architecture) is about -5065400, and the fourth method (Using smart card for entering carpark of faculty of engineering) is about 192092 as you can see the fourth method (Using smart card for entering carpark of faculty of engineering) is the highest and the lowest value is the third method (Build a building of car park at soccer field in faculty of architecture). Lastly, the profitability index (4.2.7) of the first method (To buy EV bus) is 2.48, the second method (Build car park in front of convention hall and buy EV bus) is 0.94, the third method (Build a building of car park at soccer field in faculty of architecture) is 0.68, and the fourth method (Using smart card for entering carpark of faculty of engineering) is 36.73 as you can see the fourth method (Using smart card for entering carpark of faculty of engineering) is the highest and the lowest value is the third method (Build a building of car park at soccer field in faculty of architecture).

CHAPTER 5

CONCLUSION

5.1 Introduction

In this chapter, we first summarize the work described in this report (section 5.2). This allows us to compare and summarize the best solutions to find a suitable carpark for students and staffs in chapter 5.3 and future work will be discussed in chapter 5.3.1.

5.2 Summary

This is a summary of each chapter.

Chapter 1 introduces the state of the problems, objective, research scopes, and research proposal.

Chapter 2 reviews of the economics theory to analyze the 4 scenarios.

Chapter 3 describes the design and implementation of collecting data of the number of the car park, collecting the number of student's car and staff's car, plan the four scenarios to purpose new car park, cash-flow diagram of each scenarios, and using economic theory to find the suitable scenarios for proposing a new car park in the different financial situation at school of engineering, KMITL.

Chapter 4 describes details the research operations from calculating the data to assist in investment decisions in each method.

Chapter 5 presents tools to assist a decisions marker to choose the most suitable solution and conclude which method is the most suitable.

5.3 Conclusions

The aim of this project was to find a suitable car parking spaces for students and staffs from school of engineering, KMITL. This study can summarize the problems as follows: Parking is not enough to meet the needs, the number of vehicles outnumbered the parking lot and is likely to be increased. The researchers has proposed 4 scenarios to solve the problems.

Tools for Project Analysis and Evaluation were used to support decision-making in selecting the best insufficient parking method out of four scenarios. Firstly, the benefit/cost of the fourth method (Using smart card for entering carpark of faculty of engineering) is 1.37 that means it is decided to invest or accept that project. Because the project will receive a return on all cash inflows in terms of present value higher than the investment funds. Next, the rate of return analysis of the fourth method (Using smart card for entering carpark of faculty of engineering) is the highest, so this is the best method. Then, Net present value of the fourth method (Using smart card for entering carpark of faculty of engineering) is about 1,810,487 baht it positive and the highest value, which means the project returns more than the investment capital. After that, the Return on investment of the fourth method (Using smart card for entering carpark of faculty of engineering) is the highest valuation indicates a large profit margin to the investment money. And afterward, the payback analysis of the first method (To buy EV bus) is the lowest value that means investments will pay back in only just about 25 years. Following that, the annual worth analysis of the fourth method (Using smart card for entering carpark of faculty of engineering) and the first method (To buy EV bus) are positive but the fourth method (Using smart card for entering carpark of faculty of engineering) is more positive that means a larger annual worth of net cash flows for revenue options. Lastly, the profitability index of the fourth method (Using smart card for entering carpark of faculty of engineering) is 36.73, implying that it returns about 36 times.

According to the results, the fourth method (Using smart card for entering carpark of faculty of engineering) is the best way to tackle insufficient parking space.

5.3.1 Key Points

There are some key points which can be shaping the future of work as follows:

5.3.1.1 User satisfaction

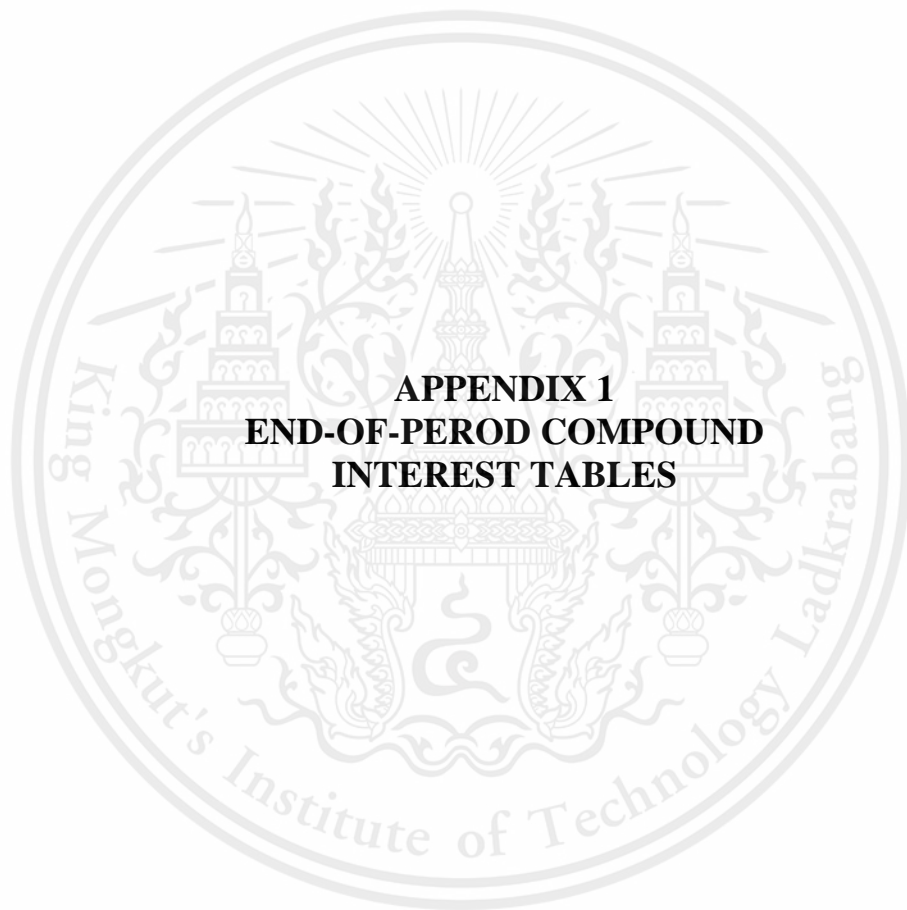
A user satisfaction survey should be conducted on what improvements can be made to further develop the solution.

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APPENDIX 1
END-OF-PERIOD COMPOUND
INTEREST TABLES

Table 6.1: End-of-Period Compound Interest Factors of 1%.

1% End-of-Period Compound Interest Factors 1%									
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.010	.9901	1.0100	.990	1.0000	1.000	0	0	1
2	1.020	.9803	.5075	1.970	.4975	2.010	.980	.498	2
3	1.030	.9706	.3400	2.941	.3300	3.030	2.921	.993	3
4	1.041	.9610	.2563	3.902	.2463	4.060	5.804	1.488	4
5	1.051	.9515	.2060	4.853	.1960	5.101	9.610	1.980	5
6	1.062	.9420	.1725	5.795	.1625	6.152	14.321	2.471	6
7	1.072	.9327	.1486	6.728	.1386	7.214	19.917	2.960	7
8	1.083	.9235	.1307	7.652	.1207	8.286	26.381	3.448	8
9	1.094	.9143	.1167	8.566	.1067	9.369	33.696	3.934	9
10	1.105	.9053	.1056	9.471	.0956	10.462	41.843	4.418	10
11	1.116	.8963	.0965	10.368	.0865	11.567	50.807	4.901	11
12	1.127	.8874	.0888	11.255	.0788	12.683	60.569	5.381	12
13	1.138	.8787	.0824	12.134	.0724	13.809	71.113	5.861	13
14	1.149	.8700	.0769	13.004	.0669	14.947	82.422	6.338	14
15	1.161	.8613	.0721	13.865	.0621	16.097	94.481	6.814	15
16	1.173	.8528	.0679	14.718	.0579	17.258	107.273	7.289	16
17	1.184	.8444	.0643	15.562	.0543	18.430	120.783	7.761	17
18	1.196	.8360	.0610	16.398	.0510	19.615	134.996	8.232	18
19	1.208	.8277	.0581	17.226	.0481	20.811	149.895	8.702	19
20	1.220	.8195	.0554	18.046	.0454	22.019	165.466	9.169	20
21	1.232	.8114	.0530	18.857	.0430	23.239	181.695	9.635	21
22	1.245	.8034	.0509	19.660	.0409	24.472	198.566	10.100	22
23	1.257	.7954	.0489	20.456	.0389	25.716	216.066	10.563	23
24	1.270	.7876	.0471	21.243	.0371	26.973	234.180	11.024	24
25	1.282	.7798	.0454	22.023	.0354	28.243	252.894	11.483	25
26	1.295	.7720	.0439	22.795	.0339	29.526	272.196	11.941	26
27	1.308	.7644	.0424	23.560	.0324	30.821	292.070	12.397	27
28	1.321	.7568	.0411	24.316	.0311	32.129	312.505	12.852	28
29	1.335	.7493	.0399	25.066	.0299	33.450	333.486	13.304	29
30	1.348	.7419	.0387	25.808	.0287	34.785	355.002	13.756	30
31	1.361	.7346	.0377	26.542	.0277	36.133	377.039	14.205	31
32	1.375	.7273	.0367	27.270	.0267	37.494	399.586	14.653	32
33	1.389	.7201	.0357	27.990	.0257	38.869	422.629	15.099	33
34	1.403	.7130	.0348	28.703	.0248	40.258	446.157	15.544	34
35	1.417	.7059	.0340	29.409	.0240	41.660	470.158	15.987	35
36	1.431	.6989	.0332	30.108	.0232	43.077	494.621	16.428	36
40	1.489	.6717	.0305	32.835	.0205	48.886	596.856	18.178	40
48	1.612	.6203	.0263	37.974	.0163	61.223	820.146	21.598	48
50	1.645	.6080	.0255	39.196	.0155	64.463	879.418	22.436	50
60	1.817	.5504	.0222	44.955	.0122	81.670	1192.806	26.533	60
70	2.007	.4983	.0199	50.169	.00993	100.7	1528.647	30.470	70
72	2.047	.4885	.0196	51.150	.00955	104.7	1597.867	31.239	72
80	2.217	.4511	.0182	54.888	.00822	121.7	1879.877	34.249	80
90	2.449	.4084	.0169	59.161	.00690	144.9	2240.567	37.872	90
100	2.705	.3697	.0159	63.029	.00587	170.5	2605.776	41.343	100
120	3.300	.3030	.0143	69.701	.00435	230.0	3334.115	47.835	120
240	10.89	.09181	.0110	90.819	.00101	989	6878.602	75.739	240
360	35.95	.02782	.0103	97.218	.000286	3495	8720.432	89.699	360
480	118.65	.00843	.0101	99.157	.000085	11765	9511.158	95.920	480
∞	∞	0	.01	100	0	∞	10000	100	∞

Table 6.2.: End-of-Period Compound Interest Factors of 2%.

2%		End-of-Period Compound Interest Factors							2%	
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N	
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G		
1	1.020	.9804	1.0200	.980	1.0000	1.000	0	0	1	
2	1.040	.9612	.5150	1.942	.4950	2.020	.961	.495	2	
3	1.061	.9423	.3468	2.884	.3268	3.060	2.846	.987	3	
4	1.082	.9238	.2626	3.808	.2426	4.122	5.617	1.475	4	
5	1.104	.9057	.2122	4.713	.1922	5.204	9.240	1.960	5	
6	1.126	.8880	.1785	5.601	.1585	6.308	13.680	2.442	6	
7	1.149	.8706	.1545	6.472	.1345	7.434	18.903	2.921	7	
8	1.172	.8535	.1365	7.325	.1165	8.583	24.878	3.396	8	
9	1.195	.8368	.1225	8.162	.1025	9.755	31.572	3.868	9	
10	1.219	.8203	.1113	8.983	.0913	10.950	38.955	4.337	10	
11	1.243	.8043	.1022	9.787	.0822	12.169	46.998	4.802	11	
12	1.268	.7885	.0946	10.575	.0746	13.412	55.671	5.264	12	
13	1.294	.7730	.0881	11.348	.0681	14.680	64.948	5.723	13	
14	1.319	.7579	.0826	12.106	.0626	15.974	74.800	6.179	14	
15	1.346	.7430	.0778	12.849	.0578	17.293	85.202	6.631	15	
16	1.373	.7284	.0737	13.578	.0537	18.639	96.129	7.080	16	
17	1.400	.7142	.0700	14.292	.0500	20.012	107.555	7.526	17	
18	1.428	.7002	.0667	14.992	.0467	21.412	119.458	7.968	18	
19	1.457	.6864	.0638	15.678	.0438	22.841	131.814	8.407	19	
20	1.486	.6730	.0612	16.351	.0412	24.297	144.600	8.843	20	
21	1.516	.6598	.0588	17.011	.0388	25.783	157.796	9.276	21	
22	1.546	.6468	.0566	17.658	.0366	27.299	171.379	9.705	22	
23	1.577	.6342	.0547	18.292	.0347	28.845	185.331	10.132	23	
24	1.608	.6217	.0529	18.914	.0329	30.422	199.630	10.555	24	
25	1.641	.6095	.0512	19.523	.0312	32.030	214.259	10.974	25	
26	1.673	.5976	.0497	20.121	.0297	33.671	229.199	11.391	26	
27	1.707	.5859	.0483	20.707	.0283	35.344	244.431	11.804	27	
28	1.741	.5744	.0470	21.281	.0270	37.051	259.939	12.214	28	
29	1.776	.5631	.0458	21.844	.0258	38.792	275.706	12.621	29	
30	1.811	.5521	.0446	22.396	.0246	40.568	291.716	13.025	30	
31	1.848	.5412	.0436	22.938	.0236	42.379	307.954	13.426	31	
32	1.885	.5306	.0426	23.468	.0226	44.227	324.403	13.823	32	
33	1.922	.5202	.0417	23.989	.0217	46.112	341.051	14.217	33	
34	1.961	.5100	.0408	24.499	.0208	48.034	357.882	14.608	34	
35	2.000	.5000	.0400	24.999	.0200	49.994	374.883	14.996	35	
36	2.040	.4902	.0392	25.489	.0192	51.994	392.040	15.381	36	
40	2.208	.4529	.0366	27.355	.0166	60.402	461.993	16.889	40	
48	2.587	.3865	.0326	30.673	.0126	79.354	605.966	19.756	48	
50	2.692	.3715	.0318	31.424	.0118	84.579	642.361	20.442	50	
60	3.281	.3048	.0288	34.761	.00877	114.1	823.698	23.696	60	
70	4.000	.2500	.0267	37.499	.00667	150.0	999.834	26.663	70	
72	4.161	.2403	.0263	37.984	.00633	158.1	1034.056	27.223	72	
80	4.875	.2051	.0252	39.745	.00516	193.8	1166.787	29.357	80	
90	5.943	.1683	.0240	41.587	.00405	247.2	1322.170	31.793	90	
100	7.245	.1380	.0232	43.098	.00320	312.2	1464.753	33.986	100	
120	10.765	.0929	.0220	45.355	.00205	488.3	1710.416	37.711	120	
240	115.889	.00863	.0202	49.569	.00017	5744	2374.880	47.911	240	
360	1248	.00080	.0200	49.960	.0000160	62328	2483.568	49.711	360	
480	13430	.00007	.0200	49.996	.0000015	671460	2498.027	49.964	480	
∞	∞	0	.02	50	0	∞	2500	50	∞	

Table 6.3.: End-of-Period Compound Interest Factors of 3%.

3%		End-of-Period Compound Interest Factors						3%	
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.030	.9709	1.0300	.971	1.0000	1.000	0	0	1
2	1.061	.9426	.5226	1.913	.4926	2.030	.943	.493	2
3	1.093	.9151	.3535	2.829	.3235	3.091	2.773	.980	3
4	1.126	.8885	.2690	3.717	.2390	4.184	5.438	1.463	4
5	1.159	.8626	.2184	4.580	.1884	5.309	8.889	1.941	5
6	1.194	.8375	.1846	5.417	.1546	6.468	13.076	2.414	6
7	1.230	.8131	.1605	6.230	.1305	7.662	17.955	2.882	7
8	1.267	.7894	.1425	7.020	.1125	8.892	23.481	3.345	8
9	1.305	.7664	.1284	7.786	.0984	10.159	29.612	3.803	9
10	1.344	.7441	.1172	8.530	.0872	11.464	36.309	4.256	10
11	1.384	.7224	.1081	9.253	.0781	12.808	43.533	4.705	11
12	1.426	.7014	.1005	9.954	.0705	14.192	51.248	5.148	12
13	1.469	.6810	.0940	10.635	.0640	15.618	59.420	5.587	13
14	1.513	.6611	.0885	11.296	.0585	17.086	68.014	6.021	14
15	1.558	.6419	.0838	11.938	.0538	18.599	77.000	6.450	15
16	1.605	.6232	.0796	12.561	.0496	20.157	86.348	6.874	16
17	1.653	.6050	.0760	13.166	.0460	21.762	96.028	7.294	17
18	1.702	.5874	.0727	13.754	.0427	23.414	106.014	7.708	18
19	1.754	.5703	.0698	14.324	.0398	25.117	116.279	8.118	19
20	1.806	.5537	.0672	14.877	.0372	26.870	126.799	8.523	20
21	1.860	.5375	.0649	15.415	.0349	28.676	137.550	8.923	21
22	1.916	.5219	.0627	15.937	.0327	30.537	148.509	9.319	22
23	1.974	.5067	.0608	16.444	.0308	32.453	159.657	9.709	23
24	2.033	.4919	.0590	16.936	.0290	34.426	170.971	10.095	24
25	2.094	.4776	.0574	17.413	.0274	36.459	182.434	10.477	25
26	2.157	.4637	.0559	17.877	.0259	38.553	194.026	10.853	26
27	2.221	.4502	.0546	18.327	.0246	40.710	205.731	11.226	27
28	2.288	.4371	.0533	18.764	.0233	42.931	217.532	11.593	28
29	2.357	.4243	.0521	19.188	.0221	45.219	229.414	11.956	29
30	2.427	.4120	.0510	19.600	.0210	47.575	241.361	12.314	30
31	2.500	.4000	.0500	20.000	.0200	50.003	253.361	12.668	31
32	2.575	.3883	.0490	20.389	.0190	52.503	265.399	13.017	32
33	2.652	.3770	.0482	20.766	.0182	55.078	277.464	13.362	33
34	2.732	.3660	.0473	21.132	.0173	57.730	289.544	13.702	34
35	2.814	.3554	.0465	21.487	.0165	60.462	301.627	14.037	35
40	3.262	.3066	.0433	23.115	.0133	75.401	361.750	15.650	40
45	3.782	.2644	.0408	24.519	.0108	92.720	420.632	17.156	45
50	4.384	.2281	.0389	25.730	.00887	112.8	477.480	18.558	50
55	5.082	.1968	.0373	26.774	.00735	136.1	531.741	19.860	55
60	5.892	.1697	.0361	27.676	.00613	163.1	583.053	21.067	60
65	6.830	.1464	.0351	28.453	.00515	194.3	631.201	22.184	65
70	7.918	.1263	.0343	29.123	.00434	230.6	676.087	23.215	70
75	9.179	.1089	.0337	29.702	.00367	272.6	717.698	24.163	75
80	10.641	.0940	.0331	30.201	.00311	321.4	756.087	25.035	80
85	12.336	.0811	.0326	30.631	.00265	377.9	791.353	25.835	85
90	14.300	.0699	.0323	31.002	.00226	443.3	823.630	26.567	90
95	16.578	.0603	.0319	31.323	.00193	519.3	853.074	27.235	95
100	19.219	.0520	.0316	31.599	.00165	607.3	879.854	27.844	100
∞	∞	0	.03	33.333	0	∞	1111.111	33.333	∞

Table 6.4.: End-of-Period Compound Interest Factors of 4%.

4%		End-of-Period Compound Interest Factors						4%	
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.040	.9615	1.0400	.962	1.0000	1.000	0	0	1
2	1.082	.9246	.5302	1.886	.4902	2.040	.925	.490	2
3	1.125	.8890	.3603	2.775	.3203	3.122	2.703	.974	3
4	1.170	.8548	.2755	3.630	.2355	4.246	5.267	1.451	4
5	1.217	.8219	.2246	4.452	.1846	5.416	8.555	1.922	5
6	1.265	.7903	.1908	5.242	.1508	6.633	12.506	2.386	6
7	1.316	.7599	.1666	6.002	.1266	7.898	17.066	2.843	7
8	1.369	.7307	.1485	6.733	.1085	9.214	22.181	3.294	8
9	1.423	.7026	.1345	7.435	.0945	10.583	27.801	3.739	9
10	1.480	.6756	.1233	8.111	.0833	12.006	33.881	4.177	10
11	1.539	.6496	.1141	8.760	.0741	13.486	40.377	4.609	11
12	1.601	.6246	.1066	9.385	.0666	15.026	47.248	5.034	12
13	1.665	.6006	.1001	9.986	.0601	16.627	54.455	5.453	13
14	1.732	.5775	.0947	10.563	.0547	18.292	61.962	5.866	14
15	1.801	.5553	.0899	11.118	.0499	20.024	69.735	6.272	15
16	1.873	.5339	.0858	11.652	.0458	21.825	77.744	6.672	16
17	1.948	.5134	.0822	12.166	.0422	23.698	85.958	7.066	17
18	2.026	.4936	.0790	12.659	.0390	25.645	94.350	7.453	18
19	2.107	.4746	.0761	13.134	.0361	27.671	102.893	7.834	19
20	2.191	.4564	.0736	13.590	.0336	29.778	111.565	8.209	20
21	2.279	.4388	.0713	14.029	.0313	31.969	120.341	8.578	21
22	2.370	.4220	.0692	14.451	.0292	34.248	129.202	8.941	22
23	2.465	.4057	.0673	14.857	.0273	36.618	138.128	9.297	23
24	2.563	.3901	.0656	15.247	.0256	39.083	147.101	9.648	24
25	2.666	.3751	.0640	15.622	.0240	41.646	156.104	9.993	25
26	2.772	.3607	.0626	15.983	.0226	44.312	165.121	10.331	26
27	2.883	.3468	.0612	16.330	.0212	47.084	174.138	10.664	27
28	2.999	.3335	.0600	16.663	.0200	49.968	183.142	10.991	28
29	3.119	.3207	.0589	16.984	.0189	52.966	192.121	11.312	29
30	3.243	.3083	.0578	17.292	.0178	56.085	201.062	11.627	30
31	3.373	.2965	.0569	17.588	.0169	59.328	209.956	11.937	31
32	3.508	.2851	.0559	17.874	.0159	62.701	218.792	12.241	32
33	3.648	.2741	.0551	18.148	.0151	66.210	227.563	12.540	33
34	3.794	.2636	.0543	18.411	.0143	69.858	236.261	12.832	34
35	3.946	.2534	.0536	18.665	.0136	73.652	244.877	13.120	35
40	4.801	.2083	.0505	19.793	.0105	95.026	286.530	14.477	40
45	5.841	.1712	.0483	20.720	.00826	121.0	325.403	15.705	45
50	7.107	.1407	.0466	21.482	.00655	152.7	361.164	16.812	50
55	8.646	.1157	.0452	22.109	.00523	191.2	393.689	17.807	55
60	10.520	.0951	.0442	22.623	.00420	238.0	422.997	18.697	60
65	12.799	.0781	.0434	23.047	.00339	295.0	449.201	19.491	65
70	15.572	.0642	.0427	23.395	.00275	364.3	472.479	20.196	70
75	18.945	.0528	.0422	23.680	.00223	448.6	493.041	20.821	75
80	23.050	.0434	.0418	23.915	.00181	551.2	511.116	21.372	80
85	28.044	.0357	.0415	24.109	.00148	676.1	526.938	21.857	85
90	34.119	.0293	.0412	24.267	.00121	828.0	540.737	22.283	90
95	41.511	.0241	.0410	24.398	.000987	1013	552.731	22.655	95
100	50.505	.0198	.0408	24.505	.000808	1238	563.125	22.980	100
∞	∞	0	.04	25	0	∞	625	25	∞

Table 6.5.: End-of-Period Compound Interest Factors of 5%.

5% End-of-Period Compound Interest Factors 5%									
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.050	.9524	1.0500	.952	1.0000	1.000	0	0	1
2	1.103	.9070	.5378	1.859	.4878	2.050	.907	.488	2
3	1.158	.8638	.3672	2.723	.3172	3.153	2.635	.967	3
4	1.216	.8227	.2820	3.546	.2320	4.310	5.103	1.439	4
5	1.276	.7835	.2310	4.329	.1810	5.526	8.237	1.903	5
6	1.340	.7462	.1970	5.076	.1470	6.802	11.968	2.358	6
7	1.407	.7107	.1728	5.786	.1228	8.142	16.232	2.805	7
8	1.477	.6768	.1547	6.463	.1047	9.549	20.970	3.245	8
9	1.551	.6446	.1407	7.108	.0907	11.027	26.127	3.676	9
10	1.629	.6139	.1295	7.722	.0795	12.578	31.652	4.099	10
11	1.710	.5847	.1204	8.306	.0704	14.207	37.499	4.514	11
12	1.796	.5568	.1128	8.863	.0628	15.917	43.624	4.922	12
13	1.886	.5303	.1065	9.394	.0565	17.713	49.988	5.322	13
14	1.980	.5051	.1010	9.899	.0510	19.599	56.554	5.713	14
15	2.079	.4810	.0963	10.380	.0463	21.579	63.288	6.097	15
16	2.183	.4581	.0923	10.838	.0423	23.657	70.160	6.474	16
17	2.292	.4363	.0887	11.274	.0387	25.840	77.140	6.842	17
18	2.407	.4155	.0855	11.690	.0355	28.132	84.204	7.203	18
19	2.527	.3957	.0827	12.085	.0327	30.539	91.328	7.557	19
20	2.653	.3769	.0802	12.462	.0302	33.066	98.488	7.903	20
21	2.786	.3589	.0780	12.821	.0280	35.719	105.667	8.242	21
22	2.925	.3418	.0760	13.163	.0260	38.505	112.846	8.573	22
23	3.072	.3256	.0741	13.489	.0241	41.430	120.009	8.897	23
24	3.225	.3101	.0725	13.799	.0225	44.502	127.140	9.214	24
25	3.386	.2953	.0710	14.094	.0210	47.727	134.228	9.524	25
26	3.556	.2812	.0696	14.375	.0196	51.113	141.259	9.827	26
27	3.733	.2678	.0683	14.643	.0183	54.669	148.223	10.122	27
28	3.920	.2551	.0671	14.898	.0171	58.403	155.110	10.411	28
29	4.116	.2429	.0660	15.141	.0160	62.323	161.913	10.694	29
30	4.322	.2314	.0651	15.372	.0151	66.439	168.623	10.969	30
31	4.538	.2204	.0641	15.593	.0141	70.761	175.233	11.238	31
32	4.765	.2099	.0633	15.803	.0133	75.299	181.739	11.501	32
33	5.003	.1999	.0625	16.003	.0125	80.064	188.135	11.757	33
34	5.253	.1904	.0618	16.193	.0118	85.067	194.417	12.006	34
35	5.516	.1813	.0611	16.374	.0111	90.320	200.581	12.250	35
40	7.040	.1420	.0583	17.159	.00828	120.8	229.545	13.377	40
45	8.985	.1113	.0563	17.774	.00626	159.7	255.315	14.364	45
50	11.467	.0872	.0548	18.256	.00478	209.3	277.915	15.223	50
55	14.636	.0683	.0537	18.633	.00367	272.7	297.510	15.966	55
60	18.679	.0535	.0528	18.929	.00283	353.6	314.343	16.606	60
65	23.840	.0419	.0522	19.161	.00219	456.8	328.691	17.154	65
70	30.426	.0329	.0517	19.343	.00170	588.5	340.841	17.621	70
75	38.833	.0258	.0513	19.485	.00132	756.7	351.072	18.018	75
80	49.561	.0202	.0510	19.596	.00103	971.2	359.646	18.353	80
85	63.254	.0158	.0508	19.684	.000803	1245	366.801	18.635	85
90	80.730	.0124	.0506	19.752	.000627	1595	372.749	18.871	90
95	103.0	.00971	.0505	19.806	.000490	2041	377.677	19.069	95
100	131.5	.00760	.0504	19.848	.000383	2610	381.749	19.234	100
∞	∞	0	.05	20	0	∞	400	20	∞

Table 6.6.: End-of-Period Compound Interest Factors of 6%.

6%		End-of-Period Compound Interest Factors							6%	
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N	
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G		
1	1.060	.9434	1.0600	.943	1.0000	1.000	0	0	1	
2	1.124	.8900	.5454	1.833	.4854	2.060	.890	.485	2	
3	1.191	.8396	.3741	2.673	.3141	3.184	2.569	.961	3	
4	1.262	.7921	.2886	3.465	.2286	4.375	4.946	1.427	4	
5	1.338	.7473	.2374	4.212	.1774	5.637	7.935	1.884	5	
6	1.419	.7050	.2034	4.917	.1434	6.975	11.459	2.330	6	
7	1.504	.6651	.1791	5.582	.1191	8.394	15.450	2.768	7	
8	1.594	.6274	.1610	6.210	.1010	9.897	19.842	3.195	8	
9	1.689	.5919	.1470	6.802	.0870	11.491	24.577	3.613	9	
10	1.791	.5584	.1359	7.360	.0759	13.181	29.602	4.022	10	
11	1.898	.5268	.1268	7.887	.0668	14.972	34.870	4.421	11	
12	2.012	.4970	.1193	8.384	.0593	16.870	40.337	4.811	12	
13	2.133	.4688	.1130	8.853	.0530	18.882	45.963	5.192	13	
14	2.261	.4423	.1076	9.295	.0476	21.015	51.713	5.564	14	
15	2.397	.4173	.1030	9.712	.0430	23.276	57.555	5.926	15	
16	2.540	.3936	.0990	10.106	.0390	25.673	63.459	6.279	16	
17	2.693	.3714	.0954	10.477	.0354	28.213	69.401	6.624	17	
18	2.854	.3503	.0924	10.828	.0324	30.906	75.357	6.960	18	
19	3.026	.3305	.0896	11.158	.0296	33.760	81.306	7.287	19	
20	3.207	.3118	.0872	11.470	.0272	36.786	87.230	7.605	20	
21	3.400	.2942	.0850	11.764	.0250	39.993	93.114	7.915	21	
22	3.604	.2775	.0830	12.042	.0230	43.392	98.941	8.217	22	
23	3.820	.2618	.0813	12.303	.0213	46.996	104.701	8.510	23	
24	4.049	.2470	.0797	12.550	.0197	50.816	110.381	8.795	24	
25	4.292	.2330	.0782	12.783	.0182	54.865	115.973	9.072	25	
26	4.549	.2198	.0769	13.003	.0169	59.156	121.468	9.341	26	
27	4.822	.2074	.0757	13.211	.0157	63.706	126.860	9.603	27	
28	5.112	.1956	.0746	13.406	.0146	68.528	132.142	9.857	28	
29	5.418	.1846	.0736	13.591	.0136	73.640	137.310	10.103	29	
30	5.743	.1741	.0726	13.765	.0126	79.058	142.359	10.342	30	
31	6.088	.1643	.0718	13.929	.0118	84.802	147.286	10.574	31	
32	6.453	.1550	.0710	14.084	.0110	90.890	152.090	10.799	32	
33	6.841	.1462	.0703	14.230	.0103	97.343	156.768	11.017	33	
34	7.251	.1379	.0696	14.368	.00960	104.2	161.319	11.228	34	
35	7.686	.1301	.0690	14.498	.00897	111.4	165.743	11.432	35	
40	10.286	.0972	.0665	15.046	.00646	154.8	185.957	12.359	40	
45	13.765	.0727	.0647	15.456	.00470	212.7	203.110	13.141	45	
50	18.420	.0543	.0634	15.762	.00344	290.3	217.457	13.796	50	
55	24.650	.0406	.0625	15.991	.00254	394.2	229.322	14.341	55	
60	32.988	.0303	.0619	16.161	.00188	533.1	239.043	14.791	60	
65	44.145	.0227	.0614	16.289	.00139	719.1	246.945	15.160	65	
70	59.076	.0169	.0610	16.385	.00103	967.9	253.327	15.461	70	
75	79.057	.0126	.0608	16.456	.000769	1301	258.453	15.706	75	
80	105.8	.00945	.0606	16.509	.000573	1747	262.549	15.903	80	
85	141.6	.00706	.0604	16.549	.000427	2343	265.810	16.062	85	
90	189.5	.00528	.0603	16.579	.000318	3141	268.395	16.189	90	
95	253.5	.00394	.0602	16.601	.000238	4209	270.437	16.290	95	
100	339.3	.00295	.0602	16.618	.000177	5638	272.047	16.371	100	
∞	∞	0	.06	16.667	0	∞	277.778	16.667	∞	

Table 6.7.: End-of-Period Compound Interest Factors of 7%.

7% End-of-Period Compound Interest Factors 7%									
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.070	.9346	1.0700	.935	1.0000	1.000	0	0	1
2	1.145	.8734	.5531	1.808	.4831	2.070	.873	.483	2
3	1.225	.8163	.3811	2.624	.3111	3.215	2.506	.955	3
4	1.311	.7629	.2952	3.387	.2252	4.440	4.795	1.416	4
5	1.403	.7130	.2439	4.100	.1739	5.751	7.647	1.865	5
6	1.501	.6663	.2098	4.767	.1398	7.153	10.978	2.303	6
7	1.606	.6227	.1856	5.389	.1156	8.654	14.715	2.730	7
8	1.718	.5820	.1675	5.971	.0975	10.260	18.789	3.147	8
9	1.838	.5439	.1535	6.515	.0835	11.978	23.140	3.552	9
10	1.967	.5083	.1424	7.024	.0724	13.816	27.716	3.946	10
11	2.105	.4751	.1334	7.499	.0634	15.784	32.466	4.330	11
12	2.252	.4440	.1259	7.943	.0559	17.888	37.351	4.703	12
13	2.410	.4150	.1197	8.358	.0497	20.141	42.330	5.065	13
14	2.579	.3878	.1143	8.745	.0443	22.550	47.372	5.417	14
15	2.759	.3624	.1098	9.108	.0398	25.129	52.446	5.758	15
16	2.952	.3387	.1059	9.447	.0359	27.888	57.527	6.090	16
17	3.159	.3166	.1024	9.763	.0324	30.840	62.592	6.411	17
18	3.380	.2959	.0994	10.059	.0294	33.999	67.622	6.722	18
19	3.617	.2765	.0968	10.336	.0268	37.379	72.599	7.024	19
20	3.870	.2584	.0944	10.594	.0244	40.995	77.509	7.316	20
21	4.141	.2415	.0923	10.836	.0223	44.865	82.339	7.599	21
22	4.430	.2257	.0904	11.061	.0204	49.006	87.079	7.872	22
23	4.741	.2109	.0887	11.272	.0187	53.436	91.720	8.137	23
24	5.072	.1971	.0872	11.469	.0172	58.177	96.255	8.392	24
25	5.427	.1842	.0858	11.654	.0158	63.249	100.676	8.639	25
26	5.807	.1722	.0846	11.826	.0146	68.676	104.981	8.877	26
27	6.214	.1609	.0834	11.987	.0134	74.484	109.166	9.107	27
28	6.649	.1504	.0824	12.137	.0124	80.698	113.226	9.329	28
29	7.114	.1406	.0814	12.278	.0114	87.347	117.162	9.543	29
30	7.612	.1314	.0806	12.409	.0106	94.461	120.972	9.749	30
31	8.145	.1228	.0798	12.532	.00980	102.1	124.655	9.947	31
32	8.715	.1147	.0791	12.647	.00907	110.2	128.212	10.138	32
33	9.325	.1072	.0784	12.754	.00841	118.9	131.643	10.322	33
34	9.978	.1002	.0778	12.854	.00780	128.3	134.951	10.499	34
35	10.677	.0937	.0772	12.948	.00723	138.2	138.135	10.669	35
40	14.974	.0668	.0750	13.332	.00501	199.6	152.293	11.423	40
45	21.002	.0476	.0735	13.606	.00350	285.7	163.756	12.036	45
50	29.457	.0339	.0725	13.801	.00246	406.5	172.905	12.529	50
55	41.315	.0242	.0717	13.940	.00174	575.9	180.124	12.921	55
60	57.946	.0173	.0712	14.039	.00123	813.5	185.768	13.232	60
65	81.273	.0123	.0709	14.110	.000872	1147	190.145	13.476	65
70	114.0	.00877	.0706	14.160	.000620	1614	193.519	13.666	70
75	159.9	.00625	.0704	14.196	.000441	2270	196.104	13.814	75
80	224.2	.00446	.0703	14.222	.000314	3189	198.075	13.927	80
85	314.5	.00318	.0702	14.240	.000223	4479	199.572	14.015	85
90	441.1	.00227	.0702	14.253	.000159	6287	200.704	14.081	90
95	618.7	.00162	.0701	14.263	.000113	8824	201.558	14.132	95
100	867.7	.00115	.0701	14.269	.0000808	12382	202.200	14.170	100
∞	∞	0	.07	14.286	0	∞	204.082	14.286	∞

Table 6.8.: End-of-Period Compound Interest Factors of 8%.

8%		End-of-Period Compound Interest Factors							8%	
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N	
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G		
1	1.080	.9259	1.0800	.926	1.0000	1.000	0	0	1	
2	1.166	.8573	.5608	1.783	.4808	2.080	.857	.481	2	
3	1.260	.7938	.3880	2.577	.3080	3.246	2.445	.949	3	
4	1.360	.7350	.3019	3.312	.2219	4.506	4.650	1.404	4	
5	1.469	.6806	.2505	3.993	.1705	5.867	7.372	1.846	5	
6	1.587	.6302	.2163	4.623	.1363	7.336	10.523	2.276	6	
7	1.714	.5835	.1921	5.206	.1121	8.923	14.024	2.694	7	
8	1.851	.5403	.1740	5.747	.0940	10.637	17.806	3.099	8	
9	1.999	.5002	.1601	6.247	.0801	12.488	21.808	3.491	9	
10	2.159	.4632	.1490	6.710	.0690	14.487	25.977	3.871	10	
11	2.332	.4289	.1401	7.139	.0601	16.645	30.266	4.240	11	
12	2.518	.3971	.1327	7.536	.0527	18.977	34.634	4.596	12	
13	2.720	.3677	.1265	7.904	.0465	21.495	39.046	4.940	13	
14	2.937	.3405	.1213	8.244	.0413	24.215	43.472	5.273	14	
15	3.172	.3152	.1168	8.559	.0368	27.152	47.886	5.594	15	
16	3.426	.2919	.1130	8.851	.0330	30.324	52.264	5.905	16	
17	3.700	.2703	.1096	9.122	.0296	33.750	56.588	6.204	17	
18	3.996	.2502	.1067	9.372	.0267	37.450	60.843	6.492	18	
19	4.316	.2317	.1041	9.604	.0241	41.446	65.013	6.770	19	
20	4.661	.2145	.1019	9.818	.0219	45.762	69.090	7.037	20	
21	5.034	.1987	.0998	10.017	.0198	50.423	73.063	7.294	21	
22	5.437	.1839	.0980	10.201	.0180	55.457	76.926	7.541	22	
23	5.871	.1703	.0964	10.371	.0164	60.893	80.673	7.779	23	
24	6.341	.1577	.0950	10.529	.0150	66.765	84.300	8.007	24	
25	6.848	.1460	.0937	10.675	.0137	73.106	87.804	8.225	25	
26	7.396	.1352	.0925	10.810	.0125	79.954	91.184	8.435	26	
27	7.988	.1252	.0914	10.935	.0114	87.351	94.439	8.636	27	
28	8.627	.1159	.0905	11.051	.0105	95.339	97.569	8.829	28	
29	9.317	.1073	.0896	11.158	.00962	104.0	100.574	9.013	29	
30	10.063	.0994	.0888	11.258	.00883	113.3	103.456	9.190	30	
31	10.868	.0920	.0881	11.350	.00811	123.3	106.216	9.358	31	
32	11.737	.0852	.0875	11.435	.00745	134.2	108.857	9.520	32	
33	12.676	.0789	.0869	11.514	.00685	146.0	111.382	9.674	33	
34	13.690	.0730	.0863	11.587	.00630	158.6	113.792	9.821	34	
35	14.785	.0676	.0858	11.655	.00580	172.3	116.092	9.961	35	
40	21.725	.0460	.0839	11.925	.00386	259.1	126.042	10.570	40	
45	31.920	.0313	.0826	12.108	.00259	386.5	133.733	11.045	45	
50	46.902	.0213	.0817	12.233	.00174	573.8	139.593	11.411	50	
55	68.914	.0145	.0812	12.319	.00118	848.9	144.006	11.690	55	
60	101.3	.00988	.0808	12.377	.000798	1253	147.300	11.902	60	
65	148.8	.00672	.0805	12.416	.000541	1847	149.739	12.060	65	
70	218.6	.00457	.0804	12.443	.000368	2720	151.533	12.178	70	
75	321.2	.00311	.0802	12.461	.000250	4003	152.845	12.266	75	
80	472.0	.00212	.0802	12.474	.000170	5887	153.800	12.330	80	
85	693.5	.00144	.0801	12.482	.000116	8656	154.492	12.377	85	
90	1019	.000981	.0801	12.488	.0000786	12724	154.993	12.412	90	
95	1497	.000668	.0801	12.492	.0000535	18702	155.352	12.437	95	
100	2200	.000455	.0800	12.494	.0000364	27485	155.611	12.455	100	
∞	∞	0	.08	12.5	0	∞	156.25	12.5	∞	

Table 6.9.: End-of-Period Compound Interest Factors of 9%.

9% End-of-Period Compound Interest Factors 9%									
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.090	.9174	1.0900	.917	1.0000	1.000	0	0	1
2	1.188	.8417	.5685	1.759	.4785	2.090	.842	.478	2
3	1.295	.7722	.3951	2.531	.3051	3.278	2.386	.943	3
4	1.412	.7084	.3087	3.240	.2187	4.573	4.511	1.393	4
5	1.539	.6499	.2571	3.890	.1671	5.985	7.111	1.828	5
6	1.677	.5963	.2229	4.486	.1329	7.523	10.092	2.250	6
7	1.828	.5470	.1987	5.033	.1087	9.200	13.375	2.657	7
8	1.993	.5019	.1807	5.535	.0907	11.028	16.888	3.051	8
9	2.172	.4604	.1668	5.995	.0768	13.021	20.571	3.431	9
10	2.367	.4224	.1558	6.418	.0658	15.193	24.373	3.798	10
11	2.580	.3875	.1469	6.805	.0569	17.560	28.248	4.151	11
12	2.813	.3555	.1397	7.161	.0497	20.141	32.159	4.491	12
13	3.066	.3262	.1336	7.487	.0436	22.953	36.073	4.818	13
14	3.342	.2992	.1284	7.786	.0384	26.019	39.963	5.133	14
15	3.642	.2745	.1241	8.061	.0341	29.361	43.807	5.435	15
16	3.970	.2519	.1203	8.313	.0303	33.003	47.585	5.724	16
17	4.328	.2311	.1170	8.544	.0270	36.974	51.282	6.002	17
18	4.717	.2120	.1142	8.756	.0242	41.301	54.886	6.269	18
19	5.142	.1945	.1117	8.950	.0217	46.018	58.387	6.524	19
20	5.604	.1784	.1095	9.129	.0195	51.160	61.777	6.767	20
21	6.109	.1637	.1076	9.292	.0176	56.765	65.051	7.001	21
22	6.659	.1502	.1059	9.442	.0159	62.873	68.205	7.223	22
23	7.258	.1378	.1044	9.580	.0144	69.532	71.236	7.436	23
24	7.911	.1264	.1030	9.707	.0130	76.790	74.143	7.638	24
25	8.623	.1160	.1018	9.823	.0118	84.701	76.926	7.832	25
26	9.399	.1064	.1007	9.929	.01072	93.3	79.586	8.016	26
27	10.245	.0976	.0997	10.027	.00973	102.7	82.124	8.191	27
28	11.167	.0895	.0989	10.116	.00885	113.0	84.542	8.357	28
29	12.172	.0822	.0981	10.198	.00806	124.1	86.842	8.515	29
30	13.268	.0754	.0973	10.274	.00734	136.3	89.028	8.666	30
31	14.462	.0691	.0967	10.343	.00669	149.6	91.102	8.808	31
32	15.763	.0634	.0961	10.406	.00610	164.0	93.069	8.944	32
33	17.182	.0582	.0956	10.464	.00556	179.8	94.931	9.072	33
34	18.728	.0534	.0951	10.518	.00508	197.0	96.693	9.193	34
35	20.414	.0490	.0946	10.567	.00464	215.7	98.359	9.308	35
40	31.409	.0318	.0930	10.757	.00296	337.9	105.376	9.796	40
45	48.327	.0207	.0919	10.881	.00190	525.9	110.556	10.160	45
50	74.358	.0134	.0912	10.962	.00123	815.1	114.325	10.430	50
55	114.4	.00874	.0908	11.014	.00079	1260	117.036	10.626	55
60	176.0	.00568	.0905	11.048	.00051	1945	118.968	10.768	60
65	270.8	.00369	.0903	11.070	.000334	2998	120.334	10.870	65
70	416.7	.00240	.0902	11.084	.000216	4619	121.294	10.943	70
75	641.2	.00156	.0901	11.094	.000141	7113	121.965	10.994	75
80	986.6	.00101	.0901	11.100	.0000913	10951	122.431	11.030	80
85	1518	.000659	.0901	11.104	.0000593	16855	122.753	11.055	85
90	2336	.000428	.0900	11.106	.0000386	25939	122.976	11.073	90
95	3593	.000278	.0900	11.108	.0000251	39917	123.129	11.085	95
100	5529	.000181	.0900	11.109	.0000163	61423	123.234	11.093	100
∞	∞	0	.09	11.111	0	∞	123.457	11.111	∞

Table 6.10.: End-of-Period Compound Interest Factors of 10%.

10% End-of-Period Compound Interest Factors 10%									
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.100	.9091	1.1000	.909	1.0000	1.000	0	0	1
2	1.210	.8264	.5762	1.736	.4762	2.100	.826	.476	2
3	1.331	.7513	.4021	2.487	.3021	3.310	2.329	.937	3
4	1.464	.6830	.3155	3.170	.2155	4.641	4.378	1.381	4
5	1.611	.6209	.2638	3.791	.1638	6.105	6.862	1.810	5
6	1.772	.5645	.2296	4.355	.1296	7.716	9.684	2.224	6
7	1.949	.5132	.2054	4.868	.1054	9.487	12.763	2.622	7
8	2.144	.4665	.1874	5.335	.0874	11.436	16.029	3.004	8
9	2.358	.4241	.1736	5.759	.0736	13.579	19.421	3.372	9
10	2.594	.3855	.1627	6.145	.0627	15.937	22.891	3.725	10
11	2.853	.3505	.1540	6.495	.0540	18.531	26.396	4.064	11
12	3.138	.3186	.1468	6.814	.0468	21.384	29.901	4.388	12
13	3.452	.2897	.1408	7.103	.0408	24.523	33.377	4.699	13
14	3.797	.2633	.1357	7.367	.0357	27.975	36.800	4.996	14
15	4.177	.2394	.1315	7.606	.0315	31.772	40.152	5.279	15
16	4.595	.2176	.1278	7.824	.0278	35.950	43.416	5.549	16
17	5.054	.1978	.1247	8.022	.0247	40.545	46.582	5.807	17
18	5.560	.1799	.1219	8.201	.0219	45.599	49.640	6.053	18
19	6.116	.1635	.1195	8.365	.0195	51.159	52.583	6.286	19
20	6.727	.1486	.1175	8.514	.0175	57.275	55.407	6.508	20
21	7.400	.1351	.1156	8.649	.0156	64.002	58.110	6.719	21
22	8.140	.1228	.1140	8.772	.0140	71.403	60.689	6.919	22
23	8.954	.1117	.1126	8.883	.0126	79.543	63.146	7.108	23
24	9.850	.1015	.1113	8.985	.0113	88.497	65.481	7.288	24
25	10.835	.0923	.1102	9.077	.0102	98.347	67.696	7.458	25
26	11.918	.0839	.1092	9.161	.00916	109.2	69.794	7.619	26
27	13.110	.0763	.1083	9.237	.00826	121.1	71.777	7.770	27
28	14.421	.0693	.1075	9.307	.00745	134.2	73.650	7.914	28
29	15.863	.0630	.1067	9.370	.00673	148.6	75.415	8.049	29
30	17.449	.0573	.1061	9.427	.00608	164.5	77.077	8.176	30
31	19.194	.0521	.1055	9.479	.00550	181.9	78.640	8.296	31
32	21.114	.0474	.1050	9.526	.00497	201.1	80.108	8.409	32
33	23.225	.0431	.1045	9.569	.00450	222.3	81.486	8.515	33
34	25.548	.0391	.1041	9.609	.00407	245.5	82.777	8.615	34
35	28.102	.0356	.1037	9.644	.00369	271.0	83.987	8.709	35
40	45.259	.0221	.1023	9.779	.00226	442.6	88.953	9.096	40
45	72.890	.0137	.1014	9.863	.00139	718.9	92.454	9.374	45
50	117.4	.00852	.1009	9.915	.00086	1164	94.889	9.570	50
55	189.1	.00529	.1005	9.947	.00053	1881	96.562	9.708	55
60	304.5	.00328	.1003	9.967	.00033	3035	97.701	9.802	60
65	490.4	.00204	.1002	9.980	.00020	4894	98.471	9.867	65
70	789.7	.00127	.1001	9.987	.00013	7887	98.987	9.911	70
75	1272	.00079	.1001	9.992	.000079	12709	99.332	9.941	75
80	2048	.00049	.1000	9.995	.000049	20474	99.561	9.961	80
85	3299	.00030	.1000	9.997	.000030	32980	99.712	9.974	85
90	5313	.00019	.1000	9.998	.000019	53120	99.812	9.983	90
95	8557	.00012	.1000	9.999	.000012	85557	99.877	9.989	95
100	13781	.00007	.1000	9.999	.000007	137796	99.920	9.993	100
∞	∞	0	.10	10	0	∞	100	10	∞

Table 6.11.: End-of-Period Compound Interest Factors of 11%.

11%		End-of-Period Compound Interest Factors						11%	
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.110	.9009	1.1100	.901	1.0000	1.000	0	0	1
2	1.232	.8116	.5839	1.713	.4739	2.110	.812	.474	2
3	1.368	.7312	.4092	2.444	.2992	3.342	2.274	.931	3
4	1.518	.6587	.3223	3.102	.2123	4.710	4.250	1.370	4
5	1.685	.5935	.2706	3.696	.1606	6.228	6.624	1.792	5
6	1.870	.5346	.2364	4.231	.1264	7.913	9.297	2.198	6
7	2.076	.4817	.2122	4.712	.1022	9.783	12.187	2.586	7
8	2.305	.4339	.1943	5.146	.0843	11.859	15.225	2.958	8
9	2.558	.3909	.1806	5.537	.0706	14.164	18.352	3.314	9
10	2.839	.3522	.1698	5.889	.0598	16.722	21.522	3.654	10
11	3.152	.3173	.1611	6.207	.0511	19.561	24.695	3.979	11
12	3.498	.2858	.1540	6.492	.0440	22.713	27.839	4.288	12
13	3.883	.2575	.1482	6.750	.0382	26.212	30.929	4.582	13
14	4.310	.2320	.1432	6.982	.0332	30.095	33.945	4.862	14
15	4.785	.2090	.1391	7.191	.0291	34.405	36.871	5.127	15
16	5.311	.1883	.1355	7.379	.0255	39.190	39.695	5.379	16
17	5.895	.1696	.1325	7.549	.0225	44.501	42.409	5.618	17
18	6.544	.1528	.1298	7.702	.0198	50.396	45.007	5.844	18
19	7.263	.1377	.1276	7.839	.0176	56.939	47.486	6.057	19
20	8.062	.1240	.1256	7.963	.0156	64.203	49.842	6.259	20
21	8.949	.1117	.1238	8.075	.0138	72.265	52.077	6.449	21
22	9.934	.1007	.1223	8.176	.0123	81.214	54.191	6.628	22
23	11.026	.0907	.1210	8.266	.0110	91.148	56.186	6.797	23
24	12.239	.0817	.1198	8.348	.00979	102.2	58.066	6.956	24
25	13.585	.0736	.1187	8.422	.00874	114.4	59.832	7.104	25
26	15.080	.0663	.1178	8.488	.00781	128.0	61.490	7.244	26
27	16.739	.0597	.1170	8.548	.00699	143.1	63.043	7.375	27
28	18.580	.0538	.1163	8.602	.00626	159.8	64.497	7.498	28
29	20.624	.0485	.1156	8.650	.00561	178.4	65.854	7.613	29
30	22.892	.0437	.1150	8.694	.00502	199.0	67.121	7.721	30
31	25.410	.0394	.1145	8.733	.00451	221.9	68.302	7.821	31
32	28.206	.0355	.1140	8.769	.00404	247.3	69.401	7.915	32
33	31.308	.0319	.1136	8.801	.00363	275.5	70.423	8.002	33
34	34.752	.0288	.1133	8.829	.00326	306.8	71.372	8.084	34
35	38.575	.0259	.1129	8.855	.00293	341.6	72.254	8.159	35
40	65.001	.0154	.1117	8.951	.00172	581.8	75.779	8.466	40
45	109.5	.00913	.1110	9.008	.00101	986.6	78.155	8.676	45
50	184.6	.00542	.1106	9.042	.000599	1669	79.734	8.819	50
55	311.0	.00322	.1104	9.062	.000355	2818	80.771	8.913	55
60	524.1	.00191	.1102	9.074	.000210	4755	81.446	8.976	60
65	883.1	.00113	.1101	9.081	.000125	8019	81.882	9.017	65
70	1488	.000672	.1101	9.085	.0000740	13518	82.161	9.044	70
75	2507	.000399	.1100	9.087	.0000439	22785	82.340	9.061	75
80	4225	.000237	.1100	9.089	.0000260	38401	82.453	9.072	80
85	7120	.000140	.1100	9.090	.0000155	64714	82.524	9.079	85
90	11997	.000083	.1100	9.090	.0000092	109053	82.570	9.083	90
95	20215	.000049	.1100	9.090	.0000054	183768	82.598	9.086	95
100	34064	.000029	.1100	9.091	.0000032	309665	82.616	9.088	100
∞	∞	0	.11	9.091	0	∞	82.645	9.091	∞

Table 6.12.: End-of-Period Compound Interest Factors of 12%.

12% End-of-Period Compound Interest Factors 12%									
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.120	.8929	1.1200	.893	1.0000	1.000	0	0	1
2	1.254	.7972	.5917	1.690	.4717	2.120	.797	.472	2
3	1.405	.7118	.4163	2.402	.2963	3.374	2.221	.925	3
4	1.574	.6355	.3292	3.037	.2092	4.779	4.127	1.359	4
5	1.762	.5674	.2774	3.605	.1574	6.353	6.397	1.775	5
6	1.974	.5066	.2432	4.111	.1232	8.115	8.930	2.172	6
7	2.211	.4523	.2191	4.564	.0991	10.089	11.644	2.551	7
8	2.476	.4039	.2013	4.968	.0813	12.300	14.471	2.913	8
9	2.773	.3606	.1877	5.328	.0677	14.776	17.356	3.257	9
10	3.106	.3220	.1770	5.650	.0570	17.549	20.254	3.585	10
11	3.479	.2875	.1684	5.938	.0484	20.655	23.129	3.895	11
12	3.896	.2567	.1614	6.194	.0414	24.133	25.952	4.190	12
13	4.363	.2292	.1557	6.424	.0357	28.029	28.702	4.468	13
14	4.887	.2046	.1509	6.628	.0309	32.393	31.362	4.732	14
15	5.474	.1827	.1468	6.811	.0268	37.280	33.920	4.980	15
16	6.130	.1631	.1434	6.974	.0234	42.753	36.367	5.215	16
17	6.866	.1456	.1405	7.120	.0205	48.884	38.697	5.435	17
18	7.690	.1300	.1379	7.250	.0179	55.750	40.908	5.643	18
19	8.613	.1161	.1358	7.366	.0158	63.440	42.998	5.838	19
20	9.646	.1037	.1339	7.469	.0139	72.052	44.968	6.020	20
21	10.804	.0926	.1322	7.562	.0122	81.699	46.819	6.191	21
22	12.100	.0826	.1308	7.645	.0108	92.503	48.554	6.351	22
23	13.552	.0738	.1296	7.718	.0096	104.603	50.178	6.501	23
24	15.179	.0659	.1285	7.784	.0085	118.155	51.693	6.641	24
25	17.000	.0588	.1275	7.843	.0075	133.334	53.105	6.771	25
26	19.040	.0525	.1267	7.896	.00665	150.3	54.418	6.892	26
27	21.325	.0469	.1259	7.943	.00590	169.4	55.637	7.005	27
28	23.884	.0419	.1252	7.984	.00524	190.7	56.767	7.110	28
29	26.750	.0374	.1247	8.022	.00466	214.6	57.814	7.207	29
30	29.960	.0334	.1241	8.055	.00414	241.3	58.782	7.297	30
31	33.555	.0298	.1237	8.085	.00369	271.3	59.676	7.381	31
32	37.582	.0266	.1233	8.112	.00328	304.8	60.501	7.459	32
33	42.092	.0238	.1229	8.135	.00292	342.4	61.261	7.530	33
34	47.143	.0212	.1226	8.157	.00260	384.5	61.961	7.596	34
35	52.800	.0189	.1223	8.176	.00232	431.7	62.605	7.658	35
40	93.051	.0107	.1213	8.244	.00130	767.1	65.116	7.899	40
45	164.0	.00610	.1207	8.283	.00074	1358	66.734	8.057	45
50	289.0	.00346	.1204	8.304	.00042	2400	67.762	8.160	50
55	509.3	.00196	.1202	8.317	.00024	4236	68.408	8.225	55
60	897.6	.00111	.1201	8.324	.00013	7472	68.810	8.266	60
65	1582	.00063	.1201	8.328	.000076	13174	69.058	8.292	65
70	2788	.00036	.1200	8.330	.000043	23223	69.210	8.308	70
75	4913	.00020	.1200	8.332	.000024	40934	69.303	8.318	75
80	8658	.00012	.1200	8.332	.000014	72146	69.359	8.324	80
85	15259	.000066	.1200	8.333	.0000079	127152	69.393	8.328	85
90	26892	.000037	.1200	8.333	.0000045	224091	69.414	8.330	90
95	47393	.000021	.1200	8.333	.0000025	394931	69.426	8.331	95
100	83522	.000012	.1200	8.333	.0000014	696011	69.434	8.332	100
∞	∞	0	.12	8.333	0	∞	69.444	8.333	∞

Table 6.13.: End-of-Period Compound Interest Factors of 13%.

13% End-of-Period Compound Interest Factors 13%									
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.130	.8850	1.1300	.885	1.0000	1.000	0	0	1
2	1.277	.7831	.5995	1.668	.4695	2.130	.783	.469	2
3	1.443	.6931	.4235	2.361	.2935	3.407	2.169	.919	3
4	1.630	.6133	.3362	2.974	.2062	4.850	4.009	1.348	4
5	1.842	.5428	.2843	3.517	.1543	6.480	6.180	1.757	5
6	2.082	.4803	.2502	3.998	.1202	8.323	8.582	2.147	6
7	2.353	.4251	.2261	4.423	.0961	10.405	11.132	2.517	7
8	2.658	.3762	.2084	4.799	.0784	12.757	13.765	2.869	8
9	3.004	.3329	.1949	5.132	.0649	15.416	16.428	3.201	9
10	3.395	.2946	.1843	5.426	.0543	18.420	19.080	3.516	10
11	3.836	.2607	.1758	5.687	.0458	21.814	21.687	3.813	11
12	4.335	.2307	.1690	5.918	.0390	25.650	24.224	4.094	12
13	4.898	.2042	.1634	6.122	.0334	29.985	26.674	4.357	13
14	5.535	.1807	.1587	6.302	.0287	34.883	29.023	4.605	14
15	6.254	.1599	.1547	6.462	.0247	40.417	31.262	4.837	15
16	7.067	.1415	.1514	6.604	.0214	46.672	33.384	5.055	16
17	7.986	.1252	.1486	6.729	.0186	53.739	35.388	5.259	17
18	9.024	.1108	.1462	6.840	.0162	61.725	37.271	5.449	18
19	10.197	.0981	.1441	6.938	.0141	70.749	39.037	5.627	19
20	11.523	.0868	.1424	7.025	.0124	80.947	40.685	5.792	20
21	13.021	.0768	.1408	7.102	.0108	92.470	42.221	5.945	21
22	14.714	.0680	.1395	7.170	.00948	105.5	43.649	6.088	22
23	16.627	.0601	.1383	7.230	.00832	120.2	44.972	6.220	23
24	18.788	.0532	.1373	7.283	.00731	136.8	46.196	6.343	24
25	21.231	.0471	.1364	7.330	.00643	155.6	47.326	6.457	25
26	23.991	.0417	.1357	7.372	.00565	176.9	48.369	6.561	26
27	27.109	.0369	.1350	7.409	.00498	200.8	49.328	6.658	27
28	30.633	.0326	.1344	7.441	.00439	227.9	50.209	6.747	28
29	34.616	.0289	.1339	7.470	.00387	258.6	51.018	6.830	29
30	39.116	.0256	.1334	7.496	.00341	293.2	51.759	6.905	30
31	44.201	.0226	.1330	7.518	.00301	332.3	52.438	6.975	31
32	49.947	.0200	.1327	7.538	.00266	376.5	53.059	7.039	32
33	56.440	.0177	.1323	7.556	.00234	426.5	53.626	7.097	33
34	63.777	.0157	.1321	7.572	.00207	482.9	54.143	7.151	34
35	72.069	.0139	.1318	7.586	.00183	546.7	54.615	7.200	35
40	132.8	.00753	.1310	7.634	.000986	1014	56.409	7.389	40
45	244.6	.00409	.1305	7.661	.000534	1874	57.515	7.508	45
50	450.7	.00222	.1303	7.675	.000289	3460	58.187	7.581	50
55	830.5	.00120	.1302	7.683	.000157	6380	58.591	7.626	55
60	1530	.00065	.1301	7.687	.000085	11762	58.831	7.653	60
∞	∞	0	.13	7.692	0	∞	59.172	7.692	∞

Table 6.14.: End-of-Period Compound Interest Factors of 14%.

14%									
End-of-Period Compound Interest Factors									
14%									
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G	
1	1.140	.8772	1.1400	.877	1.0000	1.000	0	0	1
2	1.300	.7695	.6073	1.647	.4673	2.140	.769	.467	2
3	1.482	.6750	.4307	2.322	.2907	3.440	2.119	.913	3
4	1.689	.5921	.3432	2.914	.2032	4.921	3.896	1.337	4
5	1.925	.5194	.2913	3.433	.1513	6.610	5.973	1.740	5
6	2.195	.4556	.2572	3.889	.1172	8.536	8.251	2.122	6
7	2.502	.3996	.2332	4.288	.0932	10.730	10.649	2.483	7
8	2.853	.3506	.2156	4.639	.0756	13.233	13.103	2.825	8
9	3.252	.3075	.2022	4.946	.0622	16.085	15.563	3.146	9
10	3.707	.2697	.1917	5.216	.0517	19.337	17.991	3.449	10
11	4.226	.2366	.1834	5.453	.0434	23.045	20.357	3.733	11
12	4.818	.2076	.1767	5.660	.0367	27.271	22.640	4.000	12
13	5.492	.1821	.1712	5.842	.0312	32.089	24.825	4.249	13
14	6.261	.1597	.1666	6.002	.0266	37.581	26.901	4.482	14
15	7.138	.1401	.1628	6.142	.0228	43.842	28.862	4.699	15
16	8.137	.1229	.1596	6.265	.0196	50.980	30.706	4.901	16
17	9.276	.1078	.1569	6.373	.0169	59.118	32.430	5.089	17
18	10.575	.0946	.1546	6.467	.0146	68.394	34.038	5.263	18
19	12.056	.0829	.1527	6.550	.0127	78.969	35.531	5.424	19
20	13.743	.0728	.1510	6.623	.0110	91.025	36.914	5.573	20
21	15.668	.0638	.1495	6.687	.00954	104.8	38.190	5.711	21
22	17.861	.0560	.1483	6.743	.00830	120.4	39.366	5.838	22
23	20.362	.0491	.1472	6.792	.00723	138.3	40.446	5.955	23
24	23.212	.0431	.1463	6.835	.00630	158.7	41.437	6.062	24
25	26.462	.0378	.1455	6.873	.00550	181.9	42.344	6.161	25
26	30.167	.0331	.1448	6.906	.00480	208.3	43.173	6.251	26
27	34.390	.0291	.1442	6.935	.00419	238.5	43.929	6.334	27
28	39.204	.0255	.1437	6.961	.00366	272.9	44.618	6.410	28
29	44.693	.0224	.1432	6.983	.00320	312.1	45.244	6.479	29
30	50.950	.0196	.1428	7.003	.00280	356.8	45.813	6.542	30
31	58.083	.0172	.1425	7.020	.00245	407.7	46.330	6.600	31
32	66.215	.0151	.1421	7.035	.00215	465.8	46.798	6.652	32
33	75.485	.0132	.1419	7.048	.00188	532.0	47.222	6.700	33
34	86.053	.0116	.1416	7.060	.00165	607.5	47.605	6.743	34
35	98.100	.0102	.1414	7.070	.00144	693.6	47.952	6.782	35
40	188.9	.00529	.1407	7.105	.000745	1342	49.238	6.930	40
45	363.7	.00275	.1404	7.123	.000386	2591	49.996	7.019	45
50	700.2	.00143	.1402	7.133	.000200	4995	50.438	7.071	50
55	1348	.00074	.1401	7.138	.000104	9623	50.691	7.102	55
60	2596	.00039	.1401	7.140	.000054	18535	50.836	7.120	60
∞	∞	0	.14	7.143	0	∞	51.020	7.143	∞

Table 6.15.: End-of-Period Compound Interest Factors of 15%.

15%		End-of-Period Compound Interest Factors							15%	
N	Single Payment		Uniform Payment Series				Arithmetic Gradient		N	
	Compound Amount Factor F/P	Present Worth Factor P/F	Capital Recovery Factor A/P	Present Worth Factor P/A	Sinking Fund Factor A/F	Compound Amount Factor F/A	Present Worth Factor P/G	Uniform Payment Factor A/G		
1	1.150	.8696	1.1500	.870	1.0000	1.000	0	0	1	
2	1.323	.7561	.6151	1.626	.4651	2.150	.756	.465	2	
3	1.521	.6575	.4380	2.283	.2880	3.473	2.071	.907	3	
4	1.749	.5718	.3503	2.855	.2003	4.993	3.786	1.326	4	
5	2.011	.4972	.2983	3.352	.1483	6.742	5.775	1.723	5	
6	2.313	.4323	.2642	3.784	.1142	8.754	7.937	2.097	6	
7	2.660	.3759	.2404	4.160	.0904	11.067	10.192	2.450	7	
8	3.059	.3269	.2229	4.487	.0729	13.727	12.481	2.781	8	
9	3.518	.2843	.2096	4.772	.0596	16.786	14.755	3.092	9	
10	4.046	.2472	.1993	5.019	.0493	20.304	16.979	3.383	10	
11	4.652	.2149	.1911	5.234	.0411	24.349	19.129	3.655	11	
12	5.350	.1869	.1845	5.421	.0345	29.002	21.185	3.908	12	
13	6.153	.1625	.1791	5.583	.0291	34.352	23.135	4.144	13	
14	7.076	.1413	.1747	5.724	.0247	40.505	24.972	4.362	14	
15	8.137	.1229	.1710	5.847	.0210	47.580	26.693	4.565	15	
16	9.358	.1069	.1679	5.954	.0179	55.717	28.296	4.752	16	
17	10.761	.0929	.1654	6.047	.0154	65.075	29.783	4.925	17	
18	12.375	.0808	.1632	6.128	.0132	75.836	31.156	5.084	18	
19	14.232	.0703	.1613	6.198	.0113	88.212	32.421	5.231	19	
20	16.367	.0611	.1598	6.259	.00976	102.4	33.582	5.365	20	
21	18.822	.0531	.1584	6.312	.00842	118.8	34.645	5.488	21	
22	21.645	.0462	.1573	6.359	.00727	137.6	35.615	5.601	22	
23	24.891	.0402	.1563	6.399	.00628	159.3	36.499	5.704	23	
24	28.625	.0349	.1554	6.434	.00543	184.2	37.302	5.798	24	
25	32.919	.0304	.1547	6.464	.00470	212.8	38.031	5.883	25	
26	37.857	.0264	.1541	6.491	.00407	245.7	38.692	5.961	26	
27	43.535	.0230	.1535	6.514	.00353	283.6	39.289	6.032	27	
28	50.066	.0200	.1531	6.534	.00306	327.1	39.828	6.096	28	
29	57.575	.0174	.1527	6.551	.00265	377.2	40.315	6.154	29	
30	66.212	.0151	.1523	6.566	.00230	434.7	40.753	6.207	30	
31	76.144	.0131	.1520	6.579	.00200	501.0	41.147	6.254	31	
32	87.565	.0114	.1517	6.591	.00173	577.1	41.501	6.297	32	
33	100.7	.00993	.1515	6.600	.00150	664.7	41.818	6.336	33	
34	115.8	.00864	.1513	6.609	.00131	765.4	42.103	6.371	34	
35	133.2	.00751	.1511	6.617	.00113	881.2	42.359	6.402	35	
40	267.9	.00373	.1506	6.642	.000562	1779	43.283	6.517	40	
45	538.8	.00186	.1503	6.654	.000279	3585	43.805	6.583	45	
50	1084	.00092	.1501	6.661	.000139	7218	44.096	6.620	50	
55	2180	.00046	.1501	6.664	.000069	14524	44.256	6.641	55	
60	4384	.00023	.1500	6.665	.000034	29220	44.343	6.653	60	
∞	∞	0	.15	6.667	0	∞	44.444	6.667	∞	