APPLICATION OF DEPRECIATION, NET PRESENT VALUE, AND INTERNAL RATE OF RETURN IN ENGINEERING PROJECTS: A BRIEF LITERATURE REVIEW

Pema Wangchuk
Department of Humanities and Management, Jigme Namgyel Engineering College, Dewathang
pemawangchuk.jnec@rub.edu.bt

DOI: 10.54417/jaetm.v2i1.55

Abstract- The Net Present Value (NPV), Internal Rate of Return (IRR), and Depreciation Methods are employed in most engineering projects to visualize the true potential of Return on Investment (ROI) in today's capital investment world. Most previous studies have appreciated and indicated the usefulness of each method in determining economically feasible projects. However, some previous studies have applied all methods without a proper distinction between budgeting and accounting concepts and lacked insights into various situations under which each method has differed. This paper aims to explore the circumstances in which all methods differ to determine the most economically and optimal project alternatives. It describes a thematic literature review of the past 17 articles like the peer-reviewed conference and journal articles published from 1969 through 2021. The articles with citations have been randomly selected to analyze the data. The results indicate that the three methods are commonly used in all engineering projects under certain conditions. It concludes that NPV and IRR are capital budgeting methods based on discounted cash flow methods while depreciation is the accounting method based on non-cash discounted methods. The results also demonstrate that different depreciation methods are also employed throughout the project evaluation process to determine the best project alternatives. For an engineer to produce the results and make effective investment decisions, estimating the cost, predicting the savings, and acclimatizing to the budgeting and accounting concepts are crucial under each method.

Keywords- **net-present value,** ***capital budgeting, internal rate of return, capital expenditure, depreciation expenses***

I. INTRODUCTION

The IRR is the discount rate that makes the Net Present Value (NPV) of all cash flows (both positive and negative) equal to zero for a specific project or investment [2]. It is used to evaluate projects or investments of a firm. It estimates a project's breakeven discount rate (or rate of return) which indicates the project's potential for profitability. Based on IRR, a company decides to either accept or reject a project. Likewise, the NPV is used to examine whether a project's net profit is positive or negative. Based on its positive value, a firm may select or reject the project [3].

On the other hand, Depreciation is defined as a decrease in the value due to a lessening in the ability to produce future cash flows, as a result of several causes such as wear and tear and obsolescence [5]. It is an accounting tool important to project managers because it affects the overall justification of a project, equipment, and other capital assets that are used on projects and the profitability of projects to the company. It can also influence the choice of equipment that is needed for a particular project. Two methods of depreciation are straight-line depreciation and accelerated depreciation which is widely adopted in engineering projects.

The main purpose of this paper is to explore the circumstances under which each method differs in engineering projects for making rational decisions. This paper espouses the secondary research method to collect data because the relevant previous facts and figures are rented to draw the findings. The various pertinent engineering periodicals, case studies, and reviews that have more citations are referred to analyse the data. The paper reveals that most project engineers regarded the three methods as useful methods for selecting the project alternatives.

II. INTERNAL RATE OF RETURN AND NET PRESENT VALUE

NPV and IRR are the common capital budgeting techniques used to evaluate projects or investments. An IRR is mainly used to value the project for an individual project while the NPV is preferred when the projects are mutually exclusive. Due to ease of calculation, the IRR is preferred the most in engineering projects. However, investors also prefer to use NPV because it can reinvest cash flows at a cost [1]. One of the conditions applied in NPV is when a project has a choice between two mutually exclusive alternatives, the one yielding the higher NPV should be selected [3]. This indicates that NPV and IRR are employed under certain conditions.

To be more specific, the truncated investment project possesses a unique IRR if the investors choose a truncation period that maximizes the IRR and it is possible and feasible to truncate investment projects at any moment. Nonetheless, it is argued that the logical criteria for the selection of a truncation period are not adopted under this process and stated that the aim of the truncation period should be to maximize the project's present value irrespective of the variability of discounting rate [4].

For instance, the Techno-economic Analysis of Liquid Petroleum Gas in Indonesia adopted the NPV and IRR to study its economic feasibility. The techno-economic analysis of converting gasoline-fueled vehicles into liquid petroleum gas-fueled vehicles in Indonesia was carried out. The Indonesian government had planned to provide free converter kits to convert gasoline-fueled vehicles into LPG fueled vehicles and develop LPG infrastructure. The assessment parameters used to check the feasibility of the project are NPV, payback period (PP), and IRR. The investment feasibility indicator IRR is greater than the bank loan interest, which signifies the investment is feasible for comparison with gasoline fuel. In conclusion, in normal economic conditions, the investment to switch from gasoline to LPG for public transportation in Indonesia is a promising decision [6]. This indicates that the NPV and IRR influenced a critical investment decision of the government.

Similarly, the case study on the Economic Viability of Solar Home Systems in Bangladesh has been conducted to check the economic possibility of installing solar home systems (SHS) in rural villages of Gazipur District, Bangladesh. Bangladesh Rural Development Committee (BRAC) offers the SHSs services at an interest rate of 15% and 2 cases were considered for the research. In the first case, SHSs was used mainly for commercial or income-generating purposes whereby IRR (39%) was greater than the interest rate and in the second case, SHSs was used for household lighting purpose whereby IRR was less than the interest rate. Therefore, depending on the IRR of each case, it was concluded that SHSs are economically viable for commercial and income generation purposes [7]. Both studies have concluded that IRR is so critical in making investment decisions for a project.

Additionally, the Techno-economic assessment of mechanical recycling of challenging post-consumer plastic packaging waste was conducted in Belgium to combat the challenges related to the post-consumer plastic packaging waste for people in Flanders. The study emphasizes checking the economic viability of recycling plastic waste fractions (i.e., polypropylene bottles and trays (PP rigid), polystyrene trays (PS rigid), polyethylene films (PE films) and mixed polyolefin rigid (MPO rigid)) that are currently incinerated or landfilled in Flanders. It was stated that the interest rate for the investment involved in recycling is 15% and the IRR of PP rigid, PS rigid and PE films are 13%, 14% and 13% respectively. For MPO rigid the IRR is negative. So economically, this investment is not accepted [8]. From this analysis, it is concluded that IRR plays a decisive role in choosing the best alternatives.

The Performance analysis of electricity generation from grid-connected photovoltaic systems using the All-Sky Index for Smart City projects in Thailand has also implemented depreciation and IRR to assess the project possibilities. This study shows the promotion of solar energy as a new promising renewable energy source for the Smart City projects in Thailand. For Smart City projects with simulated PV system size at 100 kW, the highest performance was shown by the Redeemer Pattaya project. TEA analysis gave NPV of 5.11 million Baht, PI 2.212, ROI 121.22%, IRR 15.75%, BCR 2.334 and PB 6.18 years, the project with the lowest performance was the Chiang Rai Municipality project with an NPV 4.35 million Baht, PI 2.033, ROI 103.32%, IRR 14.30%, BCR 2.145 and PB 6.74 years. The project with the highest

performance has been selected since the value of IRR is greater [9]. This study shows that the IRR is the main decision variable considered when selecting an economically feasible project.

Similarly, another project "Economic Conditions for Developing Hydrogen Production Based on Coal Gasification with Carbon Capture and Storage in Poland" has also implemented capital budgeting tools such as NPV and IRR. Upon performing analysis, the best result was achieved in the case of the hard coal gasification without CCS (HC_H2_0), resulting in an NPV value of EUR −142 million and an approximate IRR at the level of 5.7%. The second-best result was achieved in the case of hard coal gasification technology with CCS units (HC_H2_1). That variant has an NPV of EUR −366 million and IRR for this variant is 5.1%. For the lignite gasification without CCS (L_H2_0), the NPV achieved was EUR −662 million. For the fourth technology analyzed, lignite gasification with a CCS system (L_H2_1), the NPV amounted to EUR −904 million. For both of those technological variants, a negative IRR was determined. Hence, the first two projects are acceptable since they have a positive value of IRR [10].

On the other hand, the cases study on the depreciation of automobiles: An international comparison has highlighted the importance of implementing depreciation in the automobile industry. The study reveals that older automobiles have lesser efficient and technologically obsolete, over-aged capital stocks which are associated with a higher environmental burden. The study used automobile prices and generates depreciation data for a sample of 54 car models from 30 countries. The results found that overall, geometric depreciation appears to be a good approximation to real depreciation rates. Depreciation rates are significantly lower in developing countries compared to industrialized countries and it has been observed that while using corrected prices the depreciation rates increase substantially. It has been also shown that the average depreciation in OECD (organization for economic operation and development) countries is 31%, whereas in non-OECD countries it is about 15%. Besides prices for new cars, the economic life of automobiles is particularly dependent on real income. In the long run, an income increases of $1000 is likely to increase the annual depreciation rate by 2.7% in OECD countries and 3.6% in non-OECD countries [11]. From these findings, it has been learned the importance of depreciation in making decisions and conclusions concerning the automobile industry. In the same way, the impact of depreciation expenses on the performance of trade in Serbia has been also reviewed as the depreciation expenses have an impact on overall operating costs, profits and tax liabilities in projects. It shows that in 2014, the percentage share of depreciation in the Gross Domestic Product of trade in Slovenia amounted to 7.82%, and in Australia 2.90%. These differences are primarily caused by several economic factors such as; the use of productive technology, market structure, the different methodology of calculating depreciation and others [12].

The effect of the implementation of two depreciation methods such as straight-line and double-declining depreciation methods to the Return on Investment and the Net Present Values are used in Nam Con 2 Phase Pipeline Project 2019-2037 in Vietnam. This is one of the FDI gas pipeline projects in Vietnam. The researchers found out that the double-declining depreciation method improves the ROI and NPV of the project compared to straight-line depreciation. Both methods have been employed to calculate the values of NPV. As depicted in the project, these projects are found feasible after analyzing the NPV values [13]. The importance of employing capital budgeting and accounting tools in engineering projects has been illustrated coherently in the study.

III. DEPRECIATION

The Korean Government has implemented a nuclear phase-out policy in 2017. Nuclear power plants accounted for 30.0% of total power generation in 2016. This figure dropped to 25.9% at the end of 2019, and the average capacity factor (CF) of nuclear power plants dropped from about 89.1% to 69.2%. For this project, the Korean Government adopted two methods namely, the Decelerated Depreciation Method (DDM), and the straight-line depreciation method (SLM) to analyze the depreciation. The results show that the decrease in CF of nuclear power plants harms the sustainable development of the nuclear power industry. At this early stage of depreciation, DDM has an advantage over SLM. In addition, DDM can provide a better signal to shareholders by calculating lower net losses or higher net profits in the early stages of a project or immediately after attracting large investments [14].

Another case study on the impact of brands on depreciation in the automobile industry compares the impact of brands on the depreciation rate of cars from the true market values. This study shows that the brands of automobiles car have a greater impact on depreciation. Further, it is found that the depreciation rate is lower in developing countries than the industrialized countries. So, the manufacturer has adopted a strategy for marketing different products. The lowest average depreciation rate stands out as top performances vehicles. That is, the highest tier brand of the automobile with the low depreciation rate is considered high rankings by consumer reports and other organizations concerning user liability, utility and comfort. Another characteristic of top-tier brands is the affordable purchase prices relative to the brands [15].

In addition, the case study on the energy impact of luminaries' depreciation on urban lighting reveals that the significant impact of luminaries' protection against dust entry can be seen in the reduction in depreciation. This luminaries' capability is defined by the IP rating. The severity of the loss (depreciation) is determined by the nature and density of environmental pollution, as well as the degree of dust and water protection provided by the luminaries. This is the most significant source of depreciation, and it is also the one that provides for large recovery through maintenance operations. Overseeing facilities and, starting with the design stage, depreciation is compensated. Maintenance procedures are used to keep it running smoothly during its life. The researches reveal that the depreciation of luminaries with an IP 6X rating is modest and almost independent of the level of pollution in the environment [16].

Moreover, the case study on alternative depreciation policies for promoting combined heat and power (CHP) development in Brazil shows that Brazil's fiscal incentive policies for developing CHP schemes should be evaluated in light of the decline in tax revenues. Accelerated depreciation strategies reduce government revenue in the early years of a project while increasing private investors' net profits. Nonetheless, the alternative depreciation approach encourages technology shifts and increases the viability of initiatives that would not have been installed otherwise. The 5 to 10-year depreciation schedule may also reflect the fact that industrial CHP plants typically operate for 8000 hours per year, or with capacity factors higher than conventional large-scale thermal plants. When compared to the figures for large thermal power plants, this suggests that the physical depreciation of the equipment utilized in CHP facilities is higher [17].

IV. CONCLUSION:

Reviewing the previous articles on NPV, IRR and Depreciations Methods, the reviewer established that all three methods are abundantly employed in the most expensive engineering projects undertaken by the states and gigantic companies across the globe. It was also concluded that some project implementers adopted all three methods for evaluating the economically feasible projects based on the investment decision-making–process. The result also stipulated that NPV and IRR evaluation methods are associated with capital budgeting whereas the depreciation method is considered one of the accounting techniques.

Moreover, the result revealed some critical conditions applied to select the best alternatives under each method. A project is said to be more viable if the IRR is higher than the minimum attractive rate of return of the initial investment and vice-versa. In engineering projects, the IRR is considered an essential economic assessment parameter to evaluate the economic viability of any project. The NPV and IRR evaluation methods are simultaneously used to assess the projects despite their conditions being different. It discovered that NPV is determined as the difference between the present value of cash inflows and the present value of cash outflows over some time while the IRR is applied to estimate the best return of a project's investment.

In addition, the study also highlighted the applications of different depreciation methods in a project to compute the tax and the value of assets. The use of depreciation methods differed from project to project depending on the firm's depreciation policies. Like the other two methods, the depreciation calculation is also considered the fundamental parameter for making investment decisions because it impacts the net profit of the firm. The study further stated that most engineering projects use the accelerated depreciation method for tax purposes to reduce taxable income in the initial year of the asset's life [14-15]. The

condition applied is that the higher the depreciation value more will be the loss and vice versa. And, a project with a lower depreciation value may be recommended for a project.

Ultimately, the reviewer believes that it is essential for an engineer or project manager to distinguish between capital budgeting and accounting techniques when a project is being evaluated for ROI. Moreover, the reviewer recommends conducting research into the assumptions and estimates of all three methods, which will help engineers and project managers make good investment decisions besides contributing to existing literature reviews.

ACKNOWLEDGEMENTS

This paper would not have been possible without the exceptional support of JNEC JAETM and three anonymous reviewers for their critical comments and suggestions on my raw manuscript. The generosity and expertise of one and all have improved this paper in innumerable ways and saved me from many errors; those that inevitably remain are entirely my responsibility. Thank you all once again.

REFERENCES

[1] Asma Arshad, "Present value is better than the internal rate of return**",** Interdisciplinary Journal of Contemporary Research in Business, pp.212-219,2012.

[2] Corporate Finance Institute, CFI, n.d. [Online]. Available:https://corporatefinanceinstitute.com/resources/knowledge/finance/internal-rate-return-irr/. [Accessed 17 October 2021].

[3] Helena. G. Wieloch, "Project net present value estimation under uncertainty", Central European Journal of Operations Research. Vol.27,pp,179-197,2019.

[4] Kenneth J. Arrow. David Levhari, "Uniqueness of the internal rate of return with variable life of investment", The Economic Journal, Vol.79, pp.560-566,1969.

[5] Oreilly, "Oreilly," n.d. [Online]. Available: https://www.oreilly.com/library/view/engineering-economy/9789332503601/xhtml/chapter008.xhtml. [Accessed 17 October 2021]

[6] M. Setiyo, " Techno-economic Analysis of Liquid Petroleum Gas-Fueled Vehicles as Public Transportation in Indonesia," International Journal of Energy Economics and Policy, vol. 6, no. 3, pp. 495-500, 201

[7] M. H. Mondal, "Economic viability of solar home systems: Case study of Bangladesh," Renewable Energy, vol. 35, pp. 1125-1129, 2010.

[8] M. Larrain, S. V. Passel, G. Thomassen, B. V. Gorp, T. T. Nhu, S. Huysveld, K. M. Geem, S. D. Meester and P. Billen, "Techno-economic assessment of mechanical recycling of challenging post-consumer plastic packaging waste," Resources, Conservation and Recycling, pp. 1-13, 2021.

[9] P. Narkwatchara, C. Ratanatamskul and A. Chandrachai, "Performance analysis of electricity generation from grid-connected photovoltaic system using All-Sky Index for Smart City projects in Thailand," Renewable Energy, vol. 171, pp. 315-327, 2021.

[10] R. Kaplan and M. Kopacz, "Economic Conditions for Developing Hydrogen Production Based on Coal Gasification with Carbon Capture and Storage in Poland," Energies, vol. 13, no. 19, pp. 5074-5094, 2020.

[11] K. Storchmann, "On the depreciation of automobiles: An international comparison," Transportation, vol. 31, pp. 371-348, 2004.

[12] R. Lukic, A. Hanic and A. Hanic, "The impact of depreciation expense on the performance of trade in Serbia," International Review, pp. 1-16, 2016.

[13] E. and W. M. Daryanto, "A case study of Nam Con 2 Phase 2 pipeline project, Vietnam for the period of 2019-2037," South East Asia Journal of Contemporary Bussiness, Economic and Law, vol. 17, no. 3, pp. 8-12, 2018.

[14] S. S. Bang and S. Y. Park, "Effect of Depreciation Method for a Long-Term Tangible Assets on

Sustainable Management: From a Nuclear Power Generation Cost Perspective under the Nuclear Phase-Out Policy," Sustainability, vol. 13, no. 9, pp. 1-15, 2021.

[15] N. Terry, B. Shao and J. Marr, "The Impact of Brand on Depreciation in the Automobile Industry," International Advances in Economic Research, vol. 24, pp. 291-293, 2018.

[16] M. Coureaux and E. Manzano, "The energy impact of luminaire depreciation on urban lighting," energy for sustainable development, vol. 17, pp. 357-362, 2013.

[17] J. B. Soares, A. S. Szklo and M. T. Tolmasquim, "Alternative depreciation policies for promoting combined heat and power (CHP) development in Brazil," Energy, vol. 31, pp. 1151-1166, 2006.