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DEVELOPMENT OF PYTHON PROGRAMMING LANGUAGE FOR CALCULATING DEPRECIATION OF ENGINEERING ASSETS

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Abstract
This paper describes the development of a Python programme for calculating depreciation of engineering assets using two selected depreciation methods of evaluation based on popularity namely: the straight-line and double declining balance. The programme deployed two mathematical models of linear function and exponential decay, this was followed by definition of the necessary variables, selection of the depreciation method, scripting of formula, coding it into Python, testing, documenting, and debugging codes. The output programme was used to plot bar charts depicting the mathematical models for quick presentation of result and analysis. This helps businesses and organizations to make informed decisions about how best to manage their assets, taking into account factors such as useful life, salvage value, and depreciation method. The programming helps in streamlining of asset management processes, reducing errors, and making data-driven decisions to optimize organizational resources and goals achievement. The paper recommended that the programming language be developed for other method of evaluating depreciation. Overall, this program provides an efficiently fast and accurate method for calculating depreciation of engineering assets for businesses and individuals alike.

Keywords: Programme, Loss of value, Asset, Useful life, Salvage value

1. Introduction

Depreciation, is an accounting technique. It is utilized to distribute the expense of an asset over its lifespan (Kovaleva, 2021). In engineering, assets like machinery, equipment, and buildings hold crucial significance, requiring precise computation of depreciation to manage costs effectively and plan for future replacements.

Engineers can employ various depreciation methods, such as straight-line depreciation, declining balance depreciation, or units of production depreciation, sum of the digits method, new list of price percentage method and sinking fund methods, revaluation, annuity method to list a few each assigning costs differently based on asset type and anticipated useful life (Cotter, 2022; Adekunle, 2014).

Depreciation of engineering assets is a critical aspect of asset management in various industries, including manufacturing, construction, and infrastructural development. Understanding and effectively managing asset depreciation is crucial for optimizing the lifecycle performance, cost-efficiency, and overall sustainability of engineering assets. (Longe, 2018)

Accurate depreciation calculations for engineering assets yield multiple organizational benefits. Financial planning benefits from insights into anticipated replacement costs, while the calculation of goods or service costs incorporates asset usage expenses (Basiodis, 2019). Moreover, meticulous depreciation tracking ensures compliance with accounting standards and regulations, ensuring accurate financial reporting (IFRS Foundation, 2022; Edward, 2013). Therefore, a comprehensive understanding of diverse depreciation methods and the factors influencing engineering asset depreciation calculations is essential in this context.

Adekunle (2014) listed causes of depreciation as wear and tear, obsolescence, depletion, physical factors, effluxion of time and fall in market prices. A thorough understanding of the various depreciation methods and the factors influencing engineering asset depreciation calculations is crucial for accurate financial management and planning in the engineering field. By employing the appropriate depreciation method and considering factors such as asset type and expected useful life, organizations can make informed decisions regarding asset replacement, cost allocation, and financial reporting.

Depreciation is a fundamental accounting principle used to allocate the cost of tangible assets over their useful life (Gheorghe, 2017; Kieso*et al.,* 2016). In the engineering field, where machinery, equipment, and buildings are vital assets subject to wear and eventual replacement, understanding depreciation is crucial (Wimmers, 2010).

According to Bensefia*et al.* (2022), Python programming has gained significant popularity and widespread adoption in various fields due to its versatility, ease of use and extensive library support. Raschka and Mirjalili (2017), provided a comprehensive overview of Python's application in machine learning. It covered various machine learning algorithms, data preprocessing techniques, and evaluation methods using Python libraries such as scikit-learn and Tensor-Flow. The authors showcased Python's effectiveness in developing and deploying machine learning models for tasks such as classification, regression, clustering, and deep learning. (Sharma *et al*., 2021; Xanthidis*et al.,* 2022).

Amin and Gu (2012), focused on the analysis of depreciation patterns and lifecycle cost estimation for engineering systems. The authors discussed various depreciation models and methods, including straight-line, declining balance, and sum-of-the-years-digits, and emphasized the importance of accurate depreciation estimation for effective asset management. Valdez and Estrada (2019), reviewed a paper and provided a comprehensive overview of depreciation and replacement models for capital-intensive industries. It compared different depreciation methods and replacement strategies, stating their applicability in industries with high-value engineering assets and emphasizing the need for accurate asset valuation and replacement planning.

Yates and Winder (2018), examined the impact of asset depreciation on the performance and maintenance costs of industrial machinery. It investigated the relationship between asset age, depreciation, and equipment failure rates, highlighting difficulties in the computing process and the importance of considering depreciation in maintenance planning and decision-making processes.The calculation of depreciation for engineering assets is guided by accounting standards and regulations and influenced by factors such as asset type, useful life, and salvage value.

The straight-line method is the most commonly employed depreciation method, assuming a constant depreciation rate over the useful life of the asset. The depreciation expense is computed as the asset's cost minus any salvage value, divided by the useful life (Mitchell, 2020). The declining balance method is another prevalent approach, assuming an accelerated depreciation rate by applying a fixed percentage to the remaining book value each year (Wahlen*et al.,* 2015).

For assets with higher initial depreciation, the declining balance method is often used. The sum of digits method determines depreciation based on the actual usage of the asset, dividing the cost minus salvage value by the expected total units of production over the asset's useful life (Adekunle, 2014). Several factors, including asset type, useful life, salvage value, and changes in usage or operating conditions, can impact the calculation of depreciation for engineering assets. Additionally, the choice of depreciation method significantly affects the calculated depreciation expense. (Gowrishankar and Venna 2018; Ejiogu, 2018)

Accurate depreciation calculation plays a vital role in effective financial planning and management, aiding in informed decision-making about asset management and replacement. Software tools and spreadsheets are available to facilitate efficient and precise depreciation calculations. Precise depreciation calculation for engineering assets is crucial for effective asset management and financial planning.

The selection of the appropriate depreciation method and accurate data on cost, useful life, and salvage value are critical. Accounting standards, guidelines, and software tools assist in accurate and efficient depreciation calculations.

2. Material and Methods

Materials:
The materials used in software development are:
1. Python programming language: Python provides a flexible and versatile environment for developing the depreciation estimation program.

2. Integrated Development Environment (IDE): Choose a suitable IDE for writing and running Python code, such as PyCharm, Visual Studio Code, or Jupyter Notebook.
3. Depreciation formulas: Determine the depreciation method(s) to be implemented in the program, such as straight-line, declining balance, or sum-of-the-years'-digits. Obtain the relevant formulas for each depreciation method.

However, the materials and methods used to calculate engineering assets can vary, but the following steps are generally used:
1. Determine the cost of the asset: This includes the purchase price, installation costs, and any other costs necessary to put the asset into service.
2. Determine the useful life of the asset: This is the period over which the asset is expected to be used before it needs to be replaced.
3. Determine the salvage value of the asset: This is the estimated value of the asset at the end of its useful life.
4. Select the appropriate depreciation method: This can include the straight-line method, declining balance method, or units of production method.
5. Calculate the annual depreciation expense: This is calculated by dividing the depreciable cost (cost minus salvage value) by the useful life of the asset.
6. Record the depreciation expense: This is recorded on the company's financial statements, reducing the value of the asset and increasing the accumulated depreciation account.

The materials and methods used to calculate engineering assets can vary depending on the complexity of the asset and the accuracy of the data available. Generally, accounting software programs and spreadsheets are used to assist in the calculation process, allowing for accurate and efficient calculations. Accurate and consistent calculation of engineering assets is more important for effective financial planning and management. It allows companies to make informed decisions about asset management and replacement, ensuring that the assets are utilized efficiently and effectively. (Gosal, 2023; Manea and Dragoi, 2010)

Steps Involved in Calculation

The following steps were taken in developing Python programming for calculating depreciation and showed in Figure 1.
1. Define the necessary variables: The necessary variables include the cost of the asset, the useful life of the asset, the salvage value of the asset, and the selected depreciation method.
2. Select the appropriate depreciation method: Choose the depreciation method that best suits your needs. This can include straight-line, declining balance, or units of production method.
3. Write the formula for calculating depreciation: Based on the selected depreciation method, write the formula for calculating depreciation. For example, the formula for straight-line depreciation is (cost – salvage value) / useful life.
4. Code the formula in Python: Once you have written the formula, code it into Python, using the variables you have defined.
5. Test the code: Test the code with different variables to ensure that it works correctly
6. Incorporate the code into a program: If you plan to use this code in a larger program, incorporate it into that program, ensuring that it works correctly with the other components of the program.
7. Document the code: Document the code, including comments that explain what each line of code does, making it easier for others to understand and use the code.
8. Debug the code: Debug the code, fixing any issues that arise during testing.

These steps can be followed to develop a Python program for calculating depreciation accurately, efficiently, and user friendly. Although, the specific steps may vary depending on the type of asset and the depreciation method used.

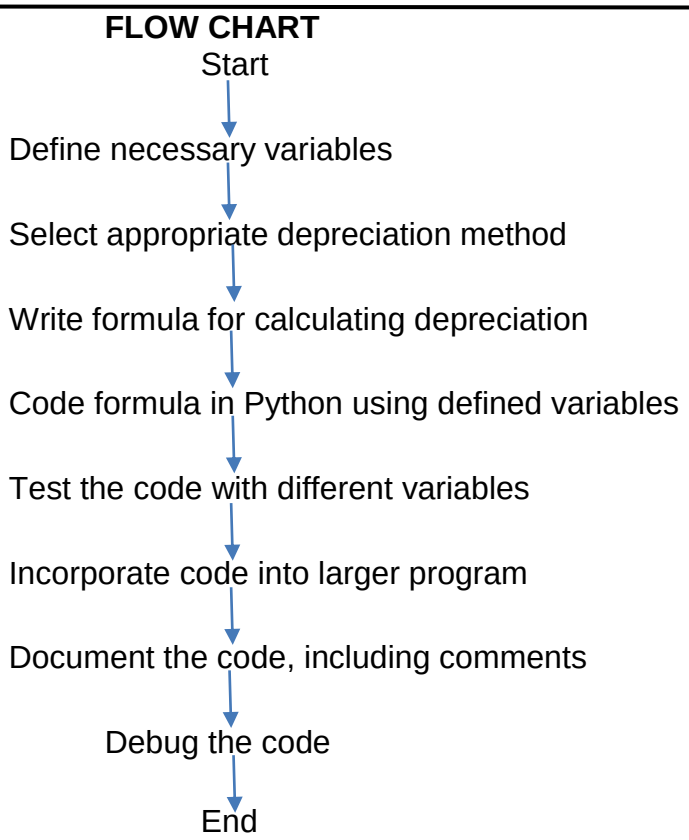

Figure 1: Flow chart on developing python coding for estimating depreciation

3. Result and Discussion

The programme was written correctly and the variables were entered accurately, the programme produced an output value for the depreciation of the asset as shown in Figure 2 and 3. The program was tested with different variables to ensure that it produced accurate results, and any errors or bugs were fixed through debugging. The developed program worked correctly; the results was analyzed to determine the impact of different variables on the depreciation calculation. Figure 2 produced an inverse linear graph of $y = -1600x + 11600$,where y is the value over time period of x and -1600 is the annual depreciation charges. Figure 3 produced an exponential function $= 12{,}500\, e^{-0.223x}$. The results showed how the useful life of the asset affects the depreciation value and how the choice of depreciation method affects the rate of depreciation. From the graphs, straight line seems a better method as corroborated by the result obtained by (Cotter, 2022). Overall, a well-designed and correctly functioning Python program for calculating engineering asset depreciation provided an accurate and useful information to businesses and organizations looking to manage their assets effectively.

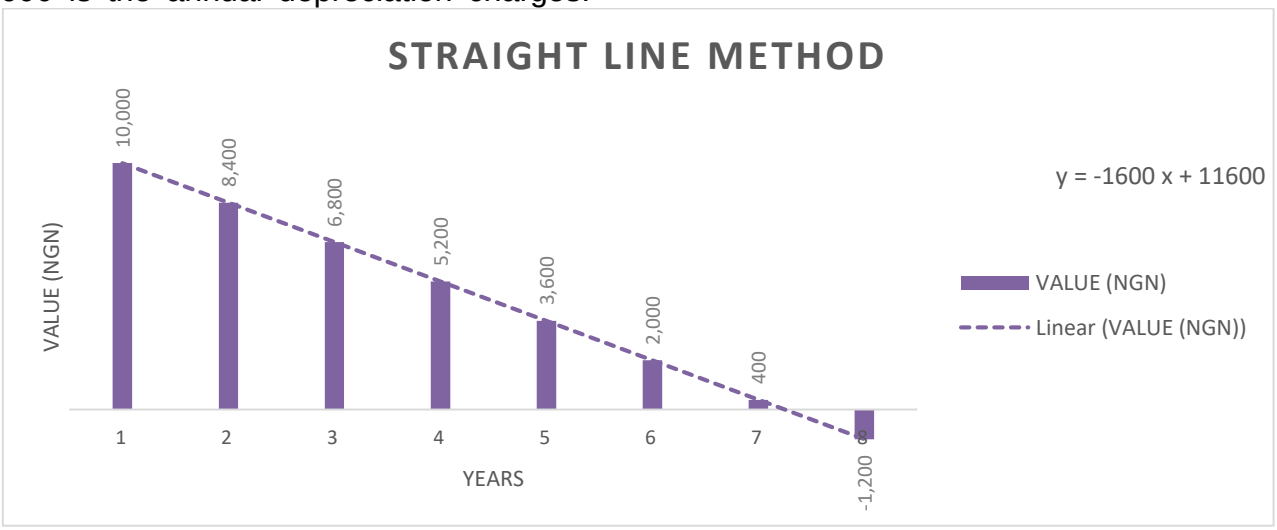

Figure 2. Straight line method

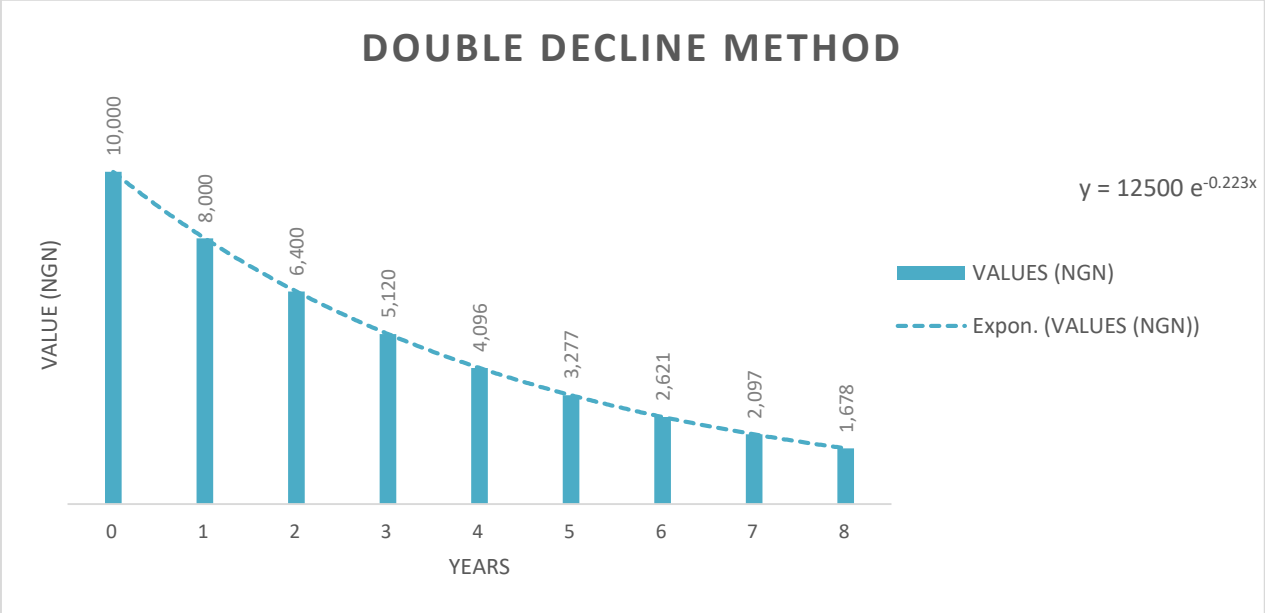

Figure 3. Double declining method

4. Conclusion

The programming language developed for calculating depreciation of engineering assets provided faster, accurate and efficient results that can help businesses and organizations make informed decisions about their asset management strategies. By defining the necessary variables, selecting the appropriate depreciation method, writing the formula for calculating depreciation, coding it into Python, testing, incorporating it into a programme, documenting, and debugging codes, helps developers in the creation of reliably result-oriented programmme that can be used to analyze the impact of different variables on the depreciation calculation and make visual presentation of results. Businesses and organizations can make informed decisions about how best to manage their assets, taking into account factors such as useful life, salvage value, and depreciation method. The programming helps in streamlining of asset management processes, reducing errors, and making data-driven decisions to optimize organizational resources and goals achievement. It recommended that the programming language be developed for other method of evaluating depreciation.

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