



# The Determination of Optimal Machine Life: Fixed Assets Management and Enterprise Value Creation

Xinrui Yuan

*School of Business and Tourism Management, Yunnan University, Yunnan, China 650500  
sherelleyuan@mail.ynu.edu.cn*

## Abstract

This paper summarizes the research process of the method to calculate the optimal machine life, including the MAPI model, annual average cost, and internal rate of return. Considering the cash flow and other possible factors, combining static and dynamic research, and making a comparative analysis find out some limitations and put forward suggestions on the management and use of fixed assets. Finally, companies can make full use of fixed assets, achieve sustainable development, and create maximum benefits.

**Keywords:** *optimal machine life; economic life; management of fixed asset*

## 1. INTRODUCTION

### 1.1. Background

Research on determination of fixed assets has a long tradition and it is acknowledged that investment and renovation of fixed assets are the primary driving force for the development of the national economy, and they are the source of expanding employment and promoting new demands. The first issue to be solved in the renewal decision of fixed assets is to choose a right time to update machines and equipment, which is to determine the optimal use of life. Therefore, researchers have been exploring and studying the methods of calculating the optimal life cycle of fixed assets, in order to use them most efficiently and effectively, and to create higher profits for the company.

### 1.2. Definition

The optimal machine life refers to the period of use that annual average cost of fixed assets can reach the lowest level, which is determined by the economic benefits of the use of fixed assets. According to theories, when a fixed asset has been used for its optimal use life, it is the most reasonable to update it. Updating in advance or later will cause different degrees of economic losses to the company.

### 1.3. Importance

It is important for companies to give a priority to

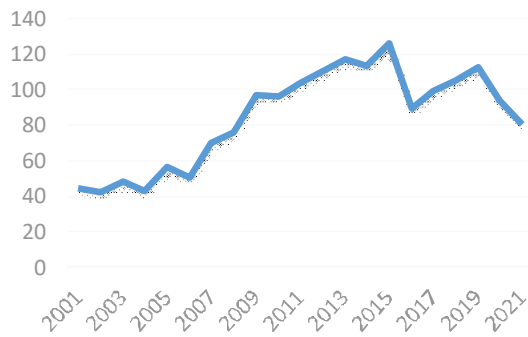
establish and improve the management system of fixed assets, and it is also a breakthrough for enterprises to transform in the future. The company should realize the significance of fixed asset management and based on its own situation, set a management system and establish a perfect internal control in order to save costs and use fixed assets efficiently.

### 1.4. Structure

In the first section, this paper has a brief introduction of the background and current research situation about the optimal machine life and states its definition and importance; in the second section, the paper describes four calculating methods and analyses advantages and limitations; in the third section, the paper expounds relevant factors which will affect the decision-making of updating fixed assets from external environment and internal situations; in the fourth section, this paper introduces some issues in the company management of fixed assets and comes up with some useful solutions; and finally in the conclusion, the paper summarizes and gives advice for future researches.

### 1.5. Situation of research

Searching key word “updating fixed asset” on CNKI (China National Knowledge Infrastructure), there are 3870 articles in total. The research data of the past two decades is as shows in figure 1:



**Figure 1.** Research trend

As we can see in the line graph, the number of articles increased in the first 15 years, reaching at 126 in 2015, and the figure declined in the following year, after that, it grew up gradually and reached at 112 in 2019, and then decreased modestly.

The data shows that in recent years, scholars have continued to study the life cycle and management of fixed assets, aiming to maximize the value of fixed assets and help enterprises make better decisions.

## 2. THE DETERMINATION OF OPTIMAL MACHINE LIFE

This chapter compares the machine's physical life, technical life, and economic life, and explains that the economic life should be used to determine the machine's useful life. After that, it mainly expounds the methods of determining the optimal machine life of fixed assets, including the MAPI model, annual average cost, and internal rate of return, and briefly explains several limitations of each method.

### 2.1. Theoretical Basis for Equipment Life

#### 2.1.1. Physical Life

Physical life refers to the potential useful life of an asset before it actually becomes incapable of producing a good or service. That means, the new equipment is put into use, after physical wear and tear, until it has poor technical performance and cannot be used continuously.

This period of time is how long the asset remains its function and may be longer than its actual useful life, because functional assets may still be replaced by more productive assets. Normally, an asset is able to continue operating physically, but its has been economically obsolete, the asset may become too costly to be profitable [1].

The main factors affecting the physical life of equipment are: equipment structure, processed materials, production types, shifts and maintenance quality. The definition states that if equipment is well maintained, its

physical life can be extended, and restorative repair can also extend its service life.

#### 2.1.2. Technical Life

Technical life refers to the period from equipment is put into use to it loses the value of use due to technological progress [1]. Due to the development of science and technology, an increasing number of alternative machines with advanced technology and competitive price, which makes the existing equipment scrapped in advance before the end of physical life or economic life.

The technical life of equipment is often affected by factors such as its design and manufacturing level, use conditions, maintenance and repair, and can generally be determined through practical testing and statistical analysis.

#### 2.1.3. Economic Life

Economic life refers to the length of time an asset is expected to be useful to the owner. It is also called useful life or depreciable life. The measure of an asset's usefulness is how profitable it is to keep – in other words, an asset generates more income than it costs to maintain and operate in a certain period [1].

The economic life of equipment is directly related to physical performance, physical life, technological progress, and external environment changes. Therefore, equipment renewal should be based on its economic life, which is in line with the principle of maximizing the economic benefits of the enterprise.

### 2.2. Methods of optimal machine life

Estimating the economic life of an asset is important for businesses so that they can determine when it's worthwhile to invest in and allocate sufficient funds to purchase a new equipment.

#### 2.2.1. G·Terborgh: MAPI model

This model assumes that machine's maintenance cost is increased equally every year, and there is no residual value and interest. [2]

$$X = \sqrt{\frac{2M}{\Delta H}} \quad (1)$$

(X: the optimal machine life; M: the purchase cost of the asset; H: the growth of maintenance cost)

When the machine is used longer, its production efficiency will gradually decline. Facing the challenge of new high-efficiency and low-consumption equipment, if the company chooses to continue to use the old machine instead of updating the new equipment, it will

lose the economic benefits that may be saved by a new machine, such as labor costs, maintenance costs, material loss. G·Terborgh calls these opportunity costs the *Cumulative Recessionary Disadvantage*, which refers to the difference of equipment performance between a certain year and the first year, that means, the first year is used as a reference and accumulated from the second year. Therefore,  $\Delta H$  not just means the annual growth of maintenance cost of fixed assets, but from the second year, the costs increase  $\Delta H$  [12].

### 2.2.2. Revised MAPI model

The Terborgh’s MAPI model does not consider the residual value of fixed assets, however during the period of use of fixed assets, the residual value is usually high in the early stage and low in the later stage. If the optimal life is calculated without including this factor, the figure will be bound to inaccuracy, as a result, this algorithm is "simplified" but the practical value is insufficient.

Therefore, researchers revised this method based on the limitation.

$$X = \sqrt{\frac{(2+i)*(M - S_1 - \Delta S)}{\Delta H - \Delta S * i}} \tag{2}$$

(X: the optimal machine life; M: the purchase cost of the asset; H: the growth of maintenance cost; i: interest rate; S1: the residual value of the first year;  $\Delta S$ : the declines of residual value from the second year)

This formula takes into account the average annual depreciation and maintenance costs of fixed assets, as well as interest rates. Comparing the two methods, the deviation is not obvious, but when the degree of the increase in interest rates or maintenance costs, or decrease of residual value are not large, the optimal life may be calculated incorrectly. What’s more important is to compare the opportunity cost of continuing to use the old machinery with the total cost of the new machinery, and make a best decision [2].

### 2.2.3. Annual average cost

$$UAC_n = \frac{I - R_n * (1+i)^{-n} + \sum_{t=1}^n C_t * (1+i)^{-t}}{(P / A, i, n)} \tag{3}$$

(UACn: the annual average cost for n years; I:original value of fixed asset; Rn:residual value of fixed assets after n years; Ct: operation cost in the Tth period; i: interest rate; n: estimated useful life)

This method is to calculate the total present value of the fixed asset, and then use the PVIFA to amortize it to each year to calculate the annual average cost. The

advantage of this method is that it can ensure the lowest average annual cost of use of fixed assets, however, for an enterprise, the main purpose is not to guarantee the lowest cost, but the maximum benefit [10].

In other words, this method does not take into account the efficiency of fixed assets [15]. With the continuous use, the efficiency will gradually decrease, and the production of waste and defective will increase accordingly, and the consumption of materials will also increase. The income created and the actual benefits then gradually decline. In addition, this method ignores the change of price, including the products and the new equipment [15]. With the progress of science and technology, novel products with higher efficiency, better quality and more functions will compete with those produced by old equipment, so that the revenue created by old equipment will be greatly reduced. Meanwhile, with the advancement of technology and the improvement of labor productivity [15], enterprises can buy new fixed assets with higher productivity and less consumables at lower prices, so that achieving higher efficiency and higher profits. Without thinking about these factors, annual average cost may cause some deviations.

### 2.2.4. Internal rate of return

The determination of the optimal machine life must comprehensively consider two factors: cost and revenue. If capital investments are the same each year, internal rate of return can be used as the standard to determine the optimal life of fixed assets [9][15].

The application and promotion of this method in practice will shorten the service life of fixed assets, especially machinery and equipment, and accelerate the renewal of fixed assets. Under the premise of limited capital investment by the enterprise, it can not only ensure the maximum profit and return, but also help to accelerate the technological update of the enterprise.

**TABLE 1.** COMPARISON OF PROS AND CONS OF METHODS

<i>Methods</i>	<i>Advantages</i>	<i>Limitations</i>
G·Terborgh MAPI model	Easy to understand; Simple to calculate	Ignore residual value; Ignore tax and interest rate; Not applicable to actual scenarios
Revised MAPI model	Consider residual value and interest rate	Not consider new machines; Ignore tax
Annual average cost	Consider residual value in each year	Not consider new machines; Not consider the efficiency;

		Ignore the change of price
Internal rate of return	Consider cost and revenue & whole life of machines	Complex calculation; Multiple IRRs may occur

To sum up, the method of determining the economic life of fixed assets should take income, cost and capital as the starting point, and consider various factors such as the price and efficiency of new fixed assets. The rate is the standard to determine the economic life of the fixed assets.

### 3. RELEVANT FACTORS OF OPTIMAL MACHINE LIFE

This chapter mainly expounds the relevant factors affecting the useful life of assets, including the external environment, and internal factors when operating fixed assets.

#### 3.1. External Environment

##### 3.1.1. Market

For products with fast updates and short use life, the service life should not be too long, in order to adapt to the rapid changes in the market and continue to innovate to increase market share. For products with a long life cycle, which are standardized products and there are small differences [6]. Extending the life cycle can reduce the operating cost of fixed assets and improve the competitive advantage of the company.

##### 3.1.2. Technology advancement and price changes

We should compare the value created by using old and new equipment. For old equipment, enterprises should consider the production efficiency and the benefits, and consider the maintenance and other costs for continuing to use. For new equipment, under the innovation of technology, enterprises should consider its purchase cost, if replacing an identical equipment, it may be much cheaper; if updating a new equipment, it may improve efficiency or reduce consumables [6].

The precision of new machinery and equipment is improved, the amount of materials consumed to produce the same number of products is reduced, and the utilization rate of raw materials is improved. That is to say, the resulting reduction in the raw material cost per unit product will also increase the revenue created by the new machinery and equipment, thereby affecting the economic life of fixed assets.

#### 3.1.3. Discount rate

For enterprises, the discount rate should be determined according to the cost of capital of enterprises to update fixed assets. Different companies will have different capital costs and discount rates due to the different ways and degrees of difficulty in obtaining capital.

The annual cost has a positive relationship with the discount rate, and the sensitivity of the annual cost of use to the discount rate changes is different between new and old equipment with different service years. As a result, there will be a sudden change in optimal life when the discount rate changes continuously, and it will also affect the optimal renewal period of fixed assets at a sudden change. Generally, when the interest rate rises, the operation cost of the old equipment will increase slowly, so that the economic life becomes longer, and the replacement cycle of fixed assets is prolonged [3].

When the interest rate is higher than a standard level, the after-tax operating cost of the new equipment is always higher than that of the old equipment, so that the enterprise will not replace the fixed assets, but will continue to use the old equipment; while the interest rate is lower than a standard level, the after-tax operation cost of new equipment is lower than that of old equipment, and enterprises may frequently update equipment, which may cause a waste of resources.

#### 3.2. Internal environment

##### 3.2.1. Depreciation

Depreciation expense is a part of the operating cost of fixed assets and will reduce the profit, but if there is no cash outflow in a certain period, the increased cost will make the company pay less income tax and reduce the cash outflow [11]. Therefore, the annual depreciation of fixed assets can be deducted from taxes. If the depreciation amount is higher, the tax savings are more so that companies can benefit from that.

For some fixed assets which have large capital investment and normally infrequent renewal, the depreciation time of fixed assets affects the project cycle. The longer the equipment can be depreciated, the longer it can be used.

##### 3.2.2. Allocation income

If one product is produced by many different types of machinery, the operating income must be distributed among the different types of machinery in a standard way. However, factors such as residual value and natural life of machinery should be considered. Companies had better use the market price of semi-finished products as the standard to determine the operating income of a certain type of machinery [15].

As for the residual value, companies should consider that if it is lower than the book value, it can also deduct the tax.

### 3.2.3. Other factors

If there is a construction and installation period for the renewal of fixed assets, it should be considered when discounting the internal rate of return of new equipment [15].

## 4. ENTERPRISE MANAGEMENT AND VALUE CREATION OF FIXED ASSETS

In order to avoid fixed asset management risks such as accidental damage, insufficient renovation, inefficiency, and improper maintenance. Enterprises should carry out effective management during the acquisition, operation and retirement of fixed assets. It can improve efficiency, reduce costs, ensure safety, and ultimately enhance the overall competitiveness of enterprises [14].

### 4.1. Existing Management Issues

#### 4.1.1. Non-standardized purchase

During the purchasing process, there will be several problems like unreasonable standards of asset allocation which leads to fail to purchase assets according to the business characteristics and actual demands. Besides, since financial funds are not the only source of assets purchased, the assets purchased by companies cannot be recorded in time, resulting in purchases that are not under the supervision of the asset management department or the purchasing are not standardized. Finally, the standard of the assets is too high or too low, and it does not meet the needs of actual business use.

Many enterprises only consider the standards when applying for purchasing, but not consider the actual use benefits. In addition, the financial department is more concerned with controlling the total amount of funds but ignores the allocation requirements, while the procurement department may lack information or misjudge. Departments only blindly strive for the right to use assets, but do not pay attention to whether the assets are fully utilized in their own departments [5]. Obviously, the department has already had the kind of asset, but because they do not know the current situation, they are still buying the same asset blindly. As a result, the fixed assets are wasted or idle, which is undoubtedly unfavorable for the enterprises' development.

#### 4.1.2. Inadequate operation system

Some companies have not formulated a standard system of acceptance or a registration management system, in addition, the system has not established a

reward and punishment mechanism and lacks the support of the internal control system, it has not played a role in supervising the management of assets, resulting in failure to protect their rights in a timely manner when there are quality problems of fixed assets.

The company does not carry out strict supervision system or regular maintenance during the use of assets, which will shorten the service life of assets and resulted in the loss of assets. Additionally, responsibilities in asset management are also unclear, resulting in a low sense of responsibility and low enthusiasm for asset management. Without the compensation system, it is difficult to find relevant personnel to be responsible for the damage of assets and difficult for companies to protect their rights [5][7].

#### 4.1.3. Irregular disposal

Inventory of fixed assets can determine the condition and productivity of fixed assets, and help enterprises distinguish between assets that can be used and assets to be disposed of [7].

During the inventory, employees only record obvious information, such as asset model, quantity, but ignore some inconspicuous information, such as asset service life, degree of wear and tear. In addition, the professional quality of the inventory personnel arranged by the company is relatively low, and they do not have a clear understanding of the importance of asset inventory, and not report the details of the fixed assets with serious damage or wear, so that the company could not maintain and replace these fixed assets in time, which eventually led to the poor performance of fixed asset and negative effect on the company.

### 4.2. Management of fixed assets

#### 4.2.1. Formulate asset acquisition standards

Before purchasing equipment, companies had better set a reasonable procurement plan and correspondingly, asset purchase should be approved by seniors. The financial department can conduct a comprehensive and in-depth analysis of the asset data purchased by each department through the asset management system to allocate budget funds and improve the level of asset allocation.

In addition, the relevant management should be carried out in accordance with the company regulations for fixed assets. The senior management and the financial department should conduct real-time supervision of the asset management of each department, require them to allocate assets reasonably, and timely enter asset information into the asset management system to be included in the scope of supervision.

In spite of considering the budget, the management

or the financial department should also pay full attention to the basic nature and primary social functions of the entity when approving the asset purchase application. Enterprises should reasonably plan the quantity and standards of their asset purchases, so that the assets can not only be useful, but also improve the actual efficiency. Consequently, when purchasing, management should not only consider the rational allocation, but also make full use of the assets [4][5].

#### 4.2.2. *Strengthen asset process management*

Enterprises should formulate a system of acceptance and upgrade the registration system to ensure the fixed assets to be protected in time when there are some quality issues, besides, enterprises strictly supervise and regularly maintain the assets in the course of the use process to ensure that the service life of the assets is within a reasonable range and prevent the loss of assets. To enhance the asset user's sense of responsibility, management should identify the users and implement the asset claim system. Besides, it is also necessary to strengthen the supervision of the whole process from procurement to scrapping of fixed assets, especially the post-event monitoring [13].

Management departments can, through spot checks and supervise, add the condition of using fixed assets to the performance appraisal of the person in charge of, in order to urge the employees to pay more attention to the management of fixed assets, improve the efficiency of asset use, and effectively avoid asset waste or idle.

#### 4.2.3. *Standardize the asset disposal process*

When departments dispose of fixed assets, they must report the disposal of assets to the competent department for review or the financial department for approval. After approval, the asset management department will uniformly undertake the relevant procedures to dispose. Strict supervision is carried out in daily management, such as the value, source, use, depreciation and other contents of fixed assets should be marked in detail.

At the same time, independent asset management personnel are set up to ensure that the accounting records are consistent with the actual assets when conducting spot checks on the use of fixed assets in important departments [4][5][8].

When the asset manager changes, it is necessary to strictly follow the regulation of the departure verification system to verify the use of fixed assets during the leader's tenure, organize professionals to supervise the transfer of fixed assets, and prevent the problem of unprovoked loss of assets, in order to provide a practical reference for subsequent use and understanding of the actual situation of assets.

In conclusion, the company should attach great

importance to the decision of the renewal of fixed assets, not only to be satisfied with the short-term benefits, but to consider more issues for long-term benefits as well. That is to say, we should regard the process when fixed asset before and after updating as a whole, rather than two separate parts, so as to determine optimal machine life. Only in this way can we achieve maximum benefits.

In future research, companies should consider how to extend the service life of the equipment to use most economically and effectively.

## 5. CONCLUSION

The renewal and transformation of fixed assets is conducive to enterprises to maintain reproduction and improve operation efficiency.

In accounting, annual average cost is used widely, because this method is easy to understand and simple to calculate, and at the same time, the depreciation amount extracted in each year or month during the effective use period of fixed assets is equal, so that the cost of equipment is stable and comparable.

However, this method only focuses on the length of the use time of fixed assets but does not consider the intensity and efficiency of fixed assets use. Therefore, the depreciation expense in each period is always equal, which leads to this method is only suitable for fixed assets that are used in roughly the same way across periods, and repair and maintenance costs do not change significantly over the life of the asset, such as buildings, large equipment (PPE).

When the utilization rate is high in a certain year and the output of the product produced increases, depreciation expense allocated to each unit of the product is bound to decrease. Therefore, in the following research and calculations, this situation should be considered and calculated efficiently.

It is of great significance for the determination of the service life and replacement of fixed assets. We cannot just be satisfied with the calculation, but also comprehensively consider other relevant factors such as the depreciation, the supply and demand, the discount rate, so that we can make the decision to update machines and determine the optimal life. Eventually, enterprises achieve the most use of fixed assets and improve economic efficiency.

## REFERENCES

- [1] C. Hu and Z. Yang "Using the economic life of equipment to determine its renewal period." *Hoisting and Conveying Machinery*. 09(2001):15-16.
- [2] F. Xu "Calculation Method of Economic Life of

- Fixed Assets." *Journal of Shanxi University of Finance and Economics*. 03(1983):33-36.
- [3] J. Wang, and H. Long "Recursive Two-dimensional Decision-Making for Fixed Assets Renewal." *Finance and Accounting Monthly*. 19(2019):36-42.
- [4] J.Lin "Influence of New Accounting Standards on Enterprise Fixed Assets Management and Countermeasures." *Modern Enterprise*. 03(2022): 174-175.
- [5] Jiang Jiaqi."Research on problems and countermeasures of fixed assets management in administrative Institutions." *Quality & Marketing*.05(2022):160-162.
- [6] L. Zhang "Approaches to extend the economic life of projects." *Journal of Changchun University*. 06(2008): 36-39.
- [7] Q.Wang "Thinking about Strengthening the Management of Fixed Assets in Administrative Institutions." *Accounting Learning*. 23(2021):175-176.
- [8] R. Han "Depreciation Improvement Strategy of Original Fixed Assets in Administrative Institutions." *Accounting Learning*. 05(2021): 94-95.
- [9] S. Tang "The application of the annual average net present value method in the decision-making of fixed assets renewal." *Finance and Accounting Monthly* .19(2015): 38-39
- [10] S. Zhang, Luo, and H. Ma "Analysis of the best time to update fixed assets." *Research and Exploration in Laboratory*.07(2006):881-883.
- [11] X. Hao "Application and Defects of Average Annual Cost Method in Fixed Asset Renewal Decision." *Reform & Openning*. 04(2010):81-82.
- [12] Y. Bei "A discussion on the calculation method of the economic life of fixed assets." *Accounting Research*. 05(1988): 43-48.
- [13] Y. Liu "Measures to Strengthen Fixed Assets Management in Basic Administrative Institutions." *Modern Enterprise*. 02(2022):15-16.
- [14] Y. Wang "Strengthen equipment management to realize asset value preservation and appreciation." *China Plant Engineering*.12(2014):37-38.
- [15] Z. Xiao, Y. Huang, and L. Jian "On the method of determining the economic life of fixed assets." *Journal of Central South Huiversity (Social Science)* 9.06(2003):774-778.

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

