The Optimal Machine Life and Depreciation: Evidence from Deppon, Hengli and Shanghai Electric

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Abstract—The key issue during operating management is to maximize the profit by setting an appropriate life cycle of a piece of equipment. Generally, the engineering staff feels strongly that paying for new equipment is justified, whereas the others are convinced that running the old unit is less costly. The work reported in this paper aims to develop a methodology for optimizing machine life and then apply it to real case studies. The first part briefly introduces the importance of determining depreciation and the optimal machine life. Meanwhile, it also describes the process of working out the optimal replacement period in an infinite cycle with the Equivalent Annual Annuity model. In the following main bodies, quantitative and qualitative analyses are carried out in the three typical companies: Deppon Express Company, Hengli Petrochemical Company, and Shanghai Electric Group Co Ltd. The analysis is implemented based on the companies' background, operating process, and financial situation, focusing on depreciation and optimal machine life. All the datum come from the annual financial report. The conclusion is that Deppon Express set up a successful example while high storage costs made Hengli Petrochemical Company does not perform well. Furthermore, Shanghai Electric Group Co Ltd still needs some improvements. These results pave a path for company decisions on machine replacing.

Keywords-Optimal machine life; Deppon Express Company, Hengli Petrochemical Company, Shanghai Electric Group Co Ltd.

ICEMME 2022, November 18-20, Nanjing, People's Republic of China

DOI 10.4108/eai.18-11-2022.2327141

1. INTRODUCTION

In the new global economy, the optimal machine life has become a central issue for management decisions. The economic life of fixed assets plays a key role in determining the relevant cash flow and salvage value. Additionally, with the expansion of the production scale of the companies, the managers pay more and more attention to the optimal machine life because it can help the companies to achieve the maximum profits. However, it is not easy to ensure that the entire life of fixed assets can satisfy the consumers' needs. For example, being replaced too early can lead to the underutilization of productive capacity, while being replaced too late may lead to a low residual value [1].

Fixed assets are the material basis for the survival and development of many public service enterprises. At present, the management mode of fixed assets of public service enterprises lags behind, hindering enterprises' sustainable development. Based on the life cycle management of fixed assets of TC company, this paper investigates the value formation, value transfer, and the purchase, construction, use, operation and maintenance, retirement, and disposal process of physical assets from two aspects of theory and practice. Through the introduction of modern management experience and technology, this study will offer a guideline to promote the improvement of enterprise fixed asset management quality, strengthen the assessment of fixed asset life cycle management, reduce enterprise asset management risks, improve asset use efficiency, improve enterprise economic and social benefits, and promote the sustainable, stable and healthy development of enterprises [2].

This presented article aims to introduce the economic life of fixed assets and deduce the optimal machine life model, which is at the heart of our understanding of addressing the economic problems. In this article, we provide answers to the following questions:

1). How to understand the economic life of fixed assets in the real situation?

2). Whether the three different companies made the optimal choice from the qualitative and quantitative analysis?

3). How is the application of the optimal machine life model used at all three companies?

Firstly, this article shows a certain law followed by the depreciation of fixed assets through the background introduction. Secondly, this article analyses the advantages, disadvantages, and development prospects of fixed assets depreciation of domestic companies through three different cases. Finally, we will summarize the article to make the whole logic line clearer.

2. BASIC DESCRIPTIONS

In the time of economics of scale, firms need machines to help them support high supply and run businesses to make profits. As equipment works, it also experiences depreciation, e.g., damaged physical appearance or parts, backward technology, etc. The path machine bringing companies maximum profits becomes an important question for managers.

When a machine is replaced too early, it leads to loss of profits and extra cost. If it is replaced too late, that will cause higher costs and lower productivity, as well. Thus, more managers care

about machine optimal machine life, which maximizes profits within its effective lifetime and lowers unavoidable costs.

The key is to figure out salvage value and cash flow for deciding when to replace the machine. First, salvage value is the expected sale value when the machine reaches its lifetime, and usually, it is calculated within a long period. Additionally, when the machine depreciates rate is higher in its first year, it could have a lower depreciation rate in the remaining time of its lifetime. Moreover, some formulas help us calculate the equivalent annual annuity of cash flow:

$$\mathrm{CF} = \mathrm{PV} \times \frac{\mathrm{r}}{1-\frac{1}{(1+\mathrm{r})^{\mathrm{T}}}} \tag{1}$$

where CF is cash flows, PV is the present value, and r is the discount rate. The equivalent annuity is the constant cash flow intensity, which has the same present value of the original inflow and outflow stream. The second formula is:

$$\mathrm{EAA} = \mathrm{NPV} \times \frac{\mathrm{r}}{1-\frac{1}{(1+\mathrm{r})^{\mathrm{n}}}} \tag{2}$$

where EAA is an equivalent annual annuity, NPV is the net present value, and r is the discount rate. It means how much annual cash flow can include capital investment and its corresponding cost. That implies during the life cycle. Annual cost recovers a capital investment and its spending of capital. After that, we could figure out if the machine reaches its optimal life. Then we need to compare their cash flow in different years, and we need to replace that with the largest cash flow. If we keep using the machine, it might cause more costs, such as higher repairing costs and lower productivity. Thus, we would better buy a brand-new machine made with higher technology. Then, we use NPV=EAA/r, which gives us the net present value when we replace the machine.

Moreover, we should Comprehensively consider the status of the equipment during each life cycle, such as purchase, operation, maintenance, transformation, scrapping, and withdrawal from the operation. If the wear of the machine can be fixed and it does not influence the usage, it should be repaired and charged a certain transformation fee or service fee rather than buy a brand new one. Therefore, it is necessary to consider how to minimize the life cycle (which can be used for a long time) and maximize the benefit (the highest benefit brought by the equipment production) to maximize the profit of the equipment during the life cycle.

3. THE CASE OF DEPPON EXPRESS

Deppon Express is a comprehensive logistics supplier. The company has established a solid network foundation and a strong talent pool and quality brand image by intensive cultivation in the field of logistics for nearly 25 years. The main business of the Deppon Express can be divided into three parts: an express business, express delivery business, and other business. Deppon express started with the express business, carries out business delivery business for strategic transformation in 2013, and developed business delivery business in an all-around way

in 2018. Additionally, the express business has maintained relatively high growth. Besides, the other business is Warehousing and supply chain operations. The company revenue consists of express business revenue and delivery business revenue, accounting for 97.11% of total revenue in 2020. The composition of the revenue is shown in Figure 1. In 2020, the operating revenue of the express delivery business was 16.662 billion yuan, which increased by 13.60 % from the previous year's number, accounting for 60.58% of total revenue. The mainstream market price war does not influence the express delivery business, so the price per kilogram remains stable. In the future, with the development of the business scale of bulk express delivery and continuous maturity of the application technology, the company can enhance the profitability level under the premise of ensuring quality. Moreover, the operation of the express business was 10.048 billion yuan, down 6.50% from the previous year, accounting for 36.53% of the total revenue. As the bulk express delivery continues to mature, the company will adjust the express business's development strategy, improving the business operation capability and maintaining the leading position in the field of highway express. Finally, the other business saw an increase to 794 million yuan. Table. 1 summarizes the revenue by sector [4].

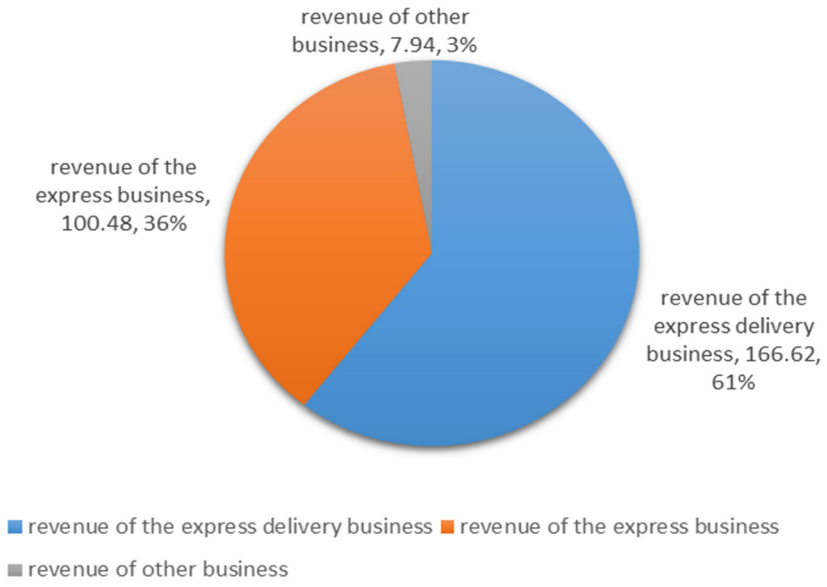

Figure 1. The composition of the revenue [4]

The rapid growth of the express delivery volume sets a higher requirement of the operation quality of Transit Yard. Therefore, to improve the efficiency of transshipment and sorting quality, the company received a new upgrade and reconstruction of the equipment of Transit Yard, which leads to the result that depreciation as a percentage of revenue increased by 0.56 %.

In the case of Deppon express, the fixed assets can be divided into four categories, electric vehicles, other transport machines, machinery equipment, and electronics and office equipment. The depreciation method of all fixed assets is the straight-line method demonstrated in the annual report. According to annals, the periods of depreciation these four types of assets are two years, five-to-six years, three-to-ten years, and three years respectively. The residual ratios are

0%, 5%, 0-5%, and 0% respectively, thus inferring that the yearly depreciation rates are 50%, 15.83%-19%, 9.5%-33.3%, and 33.3%. The detailed results are listed in Table. 2 [4].

At the end of each year, the firm reviews the useful life, estimated residual value, and depreciation method. If there is a difference between the estimated value and real value, the useful life of the fixed assets should be adjusted. From 2017 to 2020, according to the annual report, the depreciation method, the useful life, residual ratio, and yearly depreciation rate remained unchanged, which demonstrates that the estimated value is consistent with the actual condition. Furthermore, the estimated period of the useful life conforms to the minimum requirements of useful life, according to the regulations of the People's Republic of China on the implementation of the Enterprise Income Tax Law.

TABLE I. REVENUE BY SECTOR FOR DEPPON EXPRESS (UNIT: BILLION) [4]

Revenue by sector	2020	2019	Change (%)
Revenue of express delivery business	16.662	14.667	13.60
Revenue of express business	10.048	10.746	-6.50
Revenue of other business	0.794	0.509	55.82
sum	27.503	25.922	6.10

TABLE II. DEPRECIATION METHODS [4]

Category	Method	Period	Residual ratio	Yearly depreciation rate
Electronic vehicles	Straight-line method	2 years	0%	50%
Other transport machines	Straight-line method	5-6 years	5%	15.83-19%
Machinery equipment	Straight-line method	3-10 years	0-5%	9.5-33.3%
Electronics and office equipment	Straight-line method	3 years	0%	33.3%

4. THE CASE OF HENGLI PETROCHEMICAL COMPANY

4.1 Main business conditions

As shown in the following Figure 2, Hengli Petrochemical Company's main business includes the production, R & D and sales of PX, acetic acid, PTA, ethylene glycol, polyester chip, civil polyester filament, industrial polyester filament, polyester film, engineering plastics, and PBS / PBAT biodegradable new materials involved in the upstream, middle and downstream business fields of the whole industrial chain of refining, petrochemical and polyester new materials. It is the first enterprise in the industry to realize the integrated operation and

development of the whole industrial chain of "crude oil aromatics, olefin PTA and ethylene glycol polyester new materials" [5, 6].

4.2 Management of fixed assets in existing projects

4.2.1 Crude oil

As shown in Figure 3, crude oil is an important raw material for Hengli petrochemical. The raw design materials of the refining section of the Hengli refining and petrochemical integration project are 12 million tons/year of Saudi Arabian heavy crude oil, 6 million tons of Saudi Arabian medium crude oil, and 2 million tons of Malin crude oil, with a total of 20 million tons of crude oil. In the current situation where crude oil futures are not optimistic, the company is difficult to hedge, and the risk exposure of this cost is too large. If the exchange rate changes significantly or the crude oil price changes significantly, Hengli Petrochemical will suffer high inventory losses and have a negative impact on the company's performance. Considering exchange rate is 1 Saudi Riyal = 1.7237 yuan; the unit price of crude oil: 3400 yuan / ton and the total crude oil: 20 million tons, one obtains the net cash flow: 20000000 * 3400 = 68,000,000,000 (yuan). If the oil price falls by 400 yuan, then the next cash flow will be: 20000000 * 3000 = 60,000,000,000(yuan) The loss will be:8,000,000,000(yuan).

4.2.2 PX (xylene)

First of all, with the technological breakthrough of independent intellectual property rights of p-xylene and the decentralization of project approval authority, several sets of p-xylene production units will be built or expanded in China in the next few years. It is expected that by 2022, the production capacity of p-xylene in China will exceed 32 million tons, the new capacity will be greater than the domestic net demand in the same period, and the supply of p-xylene will move from shortage to surplus. After excess demand for products, unsold products' storage cost will become the Hengli petrochemical burden.

Secondly: at present, all p-xylene production units adopt the accelerated depreciation policy in the case of excess product demand in the future. The accelerated depreciation policy will lead to a rapid decline in the residual value of the machine. The future cash flow brought by the product is not enough to make up for the loss caused by rapid depreciation. Hengli Petrochemical will suffer high cash flow losses [6].

4.3 Problem-solving method

4.3.1 Project transformation

"Sustainable transformation": the project can shift from environmental degradation and pollution intensity to cleaner production. Suppose we vigorously develop the ecological industry and gradually move from an economy dominated by crude oil to an energy structure dominated by renewable energy in the energy field, through these actions. In that case, the project has a great probability of realizing ecological modernization.

4.3.2 Establish a cost control system

All aspects of cost control, including procurement, manufacturing, marketing, and management, should be placed within the scope of enterprise cost control. The cost is divided into material

cost, labor cost, and management cost. The first thing for enterprise cost control is to control the main aspects of the cost, starting from the raw materials and labor that account for a high proportion of the cost. The top management issues the cost control index. According to this index and the requirements of the cost plan, the subordinate units finally form the overall cost plan through communication and coordination between the same level and between the superior and the subordinate [7].

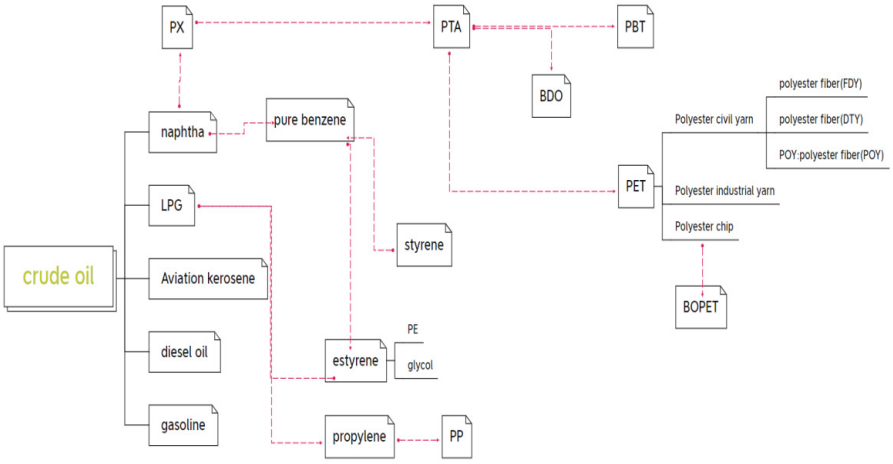

Figure 2. Hengli petrochemical industry chain integration [8]

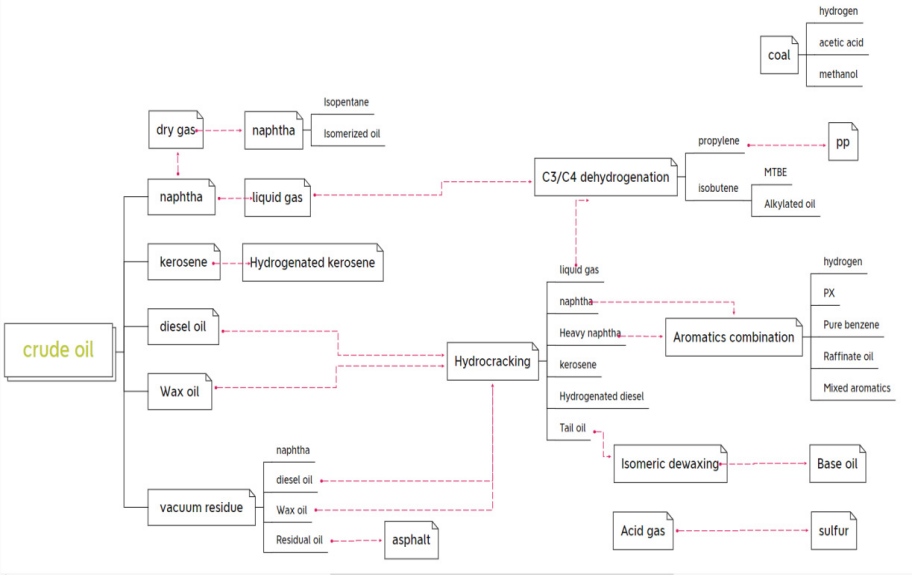

Figure 3. Refining and chemical project of Hengli Petrochemical Comp [8]

5. THE CASE OF SHANGHAI ELECTRIC GROUP CO LTD

5.1 Company overview

Shanghai Electric Group Co Ltd (Shanghai Electric) is a world-class high-end equipment manufacturer dedicated to offering green and smart industrial system solutions for energy and intelligent manufacturing. The main businesses are divided into three parts: energy equipment, industrial equipment, and integration services. The goal is to build an "industrial ecosystem" featuring smart equipment, the Industrial Internet, and smart supply chains and to contribute to the sustainable development of both mankind and the whole of society [9].

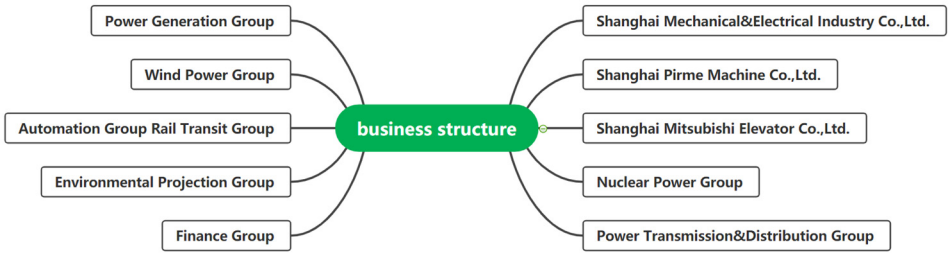

Figure 4. The business structure of Shanghai Electric [10]

5.2 Financial situation

The company realized a total operating income of RMB 137.285 billion during this financial period, increasing by 7.67%. Specifically, the energy equipment sector achieved an operating income of RMB 5.96 billion, increasing by 21.8% from the previous year due to the rapid growth of the wind power business. The operating income of the industrial equipment sector reached RMB 42.177 billion, down by 9.1%. Affected by the epidemic, basic industrial parts and intelligent manufacturing equipment in sectors decreased differently. Furthermore, the integration service sector reached RMB 52.232 billion, up 17.9% from the previous year [9].

TABLE III. DEPRECIATION METHOD [9]

Category	Method	Period	Salvage value rate	Yearly depreciation rate
Building	Straight-line method	10-50years	0-10%	50%
Machinery equipment	Straight-line method	3-20 years	0-10%	15.83-19%
transport machines	Straight-line method	5-12 years	0-10%	9.5-33.3%
Other office equipment	Straight-line method	3-10 years	0-10%	33.3%

Non-current assets of machines and equipment are recognized when the economic benefits associated with them are likely to flow into the Group, and their costs can be measured reliably. The purchase price is measured at the cost of acquisition. During the reconstruction of the company system, the fixed assets invested by the state-owned stock shareholders shall be taken as the book value.

The company mainly applies straight-line depreciation according to Table III, and the depreciation is withdrawn within the expected service life based on its book value minus the estimated residual value in each replacement. The asset is terminated when disposed of, or there is no economic benefit that can be generated through usage.

5.3 Calculation of optimal machine life

The Equivalent annual annuity model will be used to evaluate the optimal replacement year for the machine. The machine may be iterated based on the number of the period, and the option replacement year for each cycle is identical. Therefore, it is a trade-off between marginal profit and salvage value [11]. All the datum comes from the annual financial report of Shanghai Electric.

According to the financial report, between 2018-2020, the purchase of the new machine will cost RMB 520,184, based on Table V. Technically, the machine will last for 3 years. To make the calculation easier, here we assume a flat discount rate of 10%. The cash flow and salvage life are shown in Table. IV.

TABLE IV. CALCULATION OF EAA AND NPV [9]

	T1	T2	T3
CF	1,135,754	1,888,550	1,637,323
Salvage life	12,173	2,501	44,262

TABLE V. CASH FLOW BETWEEN 2018 AND 2020 [9]

CF0	CF1	CF2	CF3	NPV	EAA
-520184	1147927			523386	575725
-520184	1,135,754	1891051		2075171	1195694
-520184	1,135,754	1888550	1681585	3336504	13416578

5.4 Implication

T=3 provides the highest EAA. Hence the machine should just be kept for three years and then be replaced. The replacement chain maximizes the total NPV. The future goal is that the replacements need to meet clean production requirements, and the project production should adopt optimal machine life. Therefore, the operation of the machine may become advanced, mature, safe, and reliable production technology, and then effectively manage the pollution generated and achieve the control of the whole process.

In terms of equipment manufacturing, the industry is greatly affected by non-current asset investment, which is strongly related to national economic growth. The variation

macro-economy and the cyclical fluctuations of the industry will bring many challenges to the sales of the products. Meanwhile, due to the spread of COVID-19 in 2020, it is expected to impact the demand of the company's downstream industry to a certain extent.

6. CONCLUSION

In conclusion, firms purchase assets, and assets support company development, i.e., it is important to figure out when to replace the machine to maximize net profits and minimize cost. The three above examples show the experiences that firms make succeed or fail to use our optimal machine life and depreciation concepts to make profits. Deppon Express Company is regarded as a wonderful case. It started with express business and gradually developed express delivery service. Later, with an increase in business volume on new business, the company reform and upgrade the transit yard. Moreover, the firm uses the straight-line method to calculate the depreciation of fixed assets. From the official annual report, the estimated residual value is the same as the real value. Nevertheless, there is a counterexample. Hengli Petrochemical Company uses crude oil as raw material. However, due to Saudi Arabian unoptimistic condition, an increase in the price of crude oil causes a big loss for the company. Additionally, with P-xylene increase, storage cost leads heavy burden on Hengli Petrochemical. Moreover, Petrochemicals suffer high cash flow losses due to depreciation on p-xylene production units. Thus, we need to achieve ecological modernization by developing cleaner production and an ecological industry. In the meantime, it is necessary to control costs as much as possible. The third case exhibits the way Shanghai Electric Group Co Ltd can learn from others' experiences and get improvement. Owing to the pandemic situation, the basic industrial parts and intelligent manufacturing equipment in sectors got affected the most. Additionally, the company adopts a straight-line method for calculating the depreciation of assets. With the assumption of a 10% constant discount rate, we figure out assets should be replaced every three years. In the future, it should be achieved cleaning production requirement, in order to produce goods and clean up pollution at the same time. Based on the analysis, we should consider not only optimal machine life but also the medication of technology and cost control. However, the analysis only considers optimal machine life, depreciation, and disposal. Overall, these results shed light on improving the facility/asset optimal strategy.

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