Research on equipment financing decision based on three-level mechanism

Jingxiong Gao[1, a], Xiaobo Su[2, 3, b, *], Qi Gao[2, b]

[1]Technology Innovation Center of Army Research Institute, Beijing, China

[2]Shijiazhuang Campus of Army Engineering University, Shijiazhuang, China

[3]Shijiazhuang Division of PLAA Infantry College, Shijiazhuang, China

*Corresponding author e-mail: giantsu030700@sina.com, [a]gao900807@126.com

Abstract. Based on the analysis of the advantages and disadvantages of three-level financing mechanism, the equipment financing cost is divided into three parts: financing cost, storage cost and supply cost, and the average cost model of equipment financing is established. The equipment financing time is divided into three parts: financing time, storage time and supply time, and the average time model of equipment raising is established. Based on the time and cost of equipment raising, a model of equipment raising efficiency is established. By comparing the average cost, average time and efficiency of financing at all levels, we can determine the main responsibility of equipment financing.

Keywords: Equipment financing, Decision, Three-level mechanism.

1. Introduction

1.1 Three-level financing mechanism

The three-level financing mechanism is to divide equipment financing management organization into the top level, the middle level and the primary level according to their authorities. Different types of equipment are financed by the three levels according to difference of equipment financing cost, financing time, transportation and storage.

(1) Top level financing is the highest level for equipment financing. Advantages: high-level, comprehensive, rich in resources and strong ability of overall coordination. Shortage: less staff, heavy security tasks and long security cycle.

(2) Middle level financing is the middle level for equipment financing. Advantages: higher level, master certain resources, and have certain overall coordination ability. Shortage: fewer staff, heavy tasks, long guarantee period, poor interoperability.

(3) Primary financing is the grass root level for equipment financing. Advantages: high matching for equipment demand, short guarantee time, high positive. Shortage: limited coordination, poor integrity, difficulty for price review, contract supervision and quality acceptance, poor security, disorderly activities.

1.2 Problem of equipment financing decision

Equipment financing decision is to selecting and determining action paths and opportunities for equipment financing business according to external environment and internal conditions. In another word it is process to determine the channels, forms and responsible subjects for ordering, purchasing, producing, storing [1].

Through the analysis above each level of equipment financing has its own advantages and disadvantages. The problem in equipment financing decision is to realize the optimization of the overall financing by balancing the advantages and disadvantages and determining the financing according to the division of labor at different levels.

2. Three-level financing model

2.1. Assumptions and symbols

2.1.1. Assumptions

①The quantity of equipment financed is equal to the demand. ④There is no need for equipment at their own level of the top level and the middle level. ⑤Equipment production enterprise is fixed.

2.1.2. Symbols

D: Unit price of equipment. f_1: Cost of one order. f_2: One year storage cost of single equipment. f_3: Transportation cost rate of single equipment in unit distance. f_4: Transportation time of single equipment in unit distance. e_0: Order and production time. e_{0i}: Average supply time from top level to the i th middle level. e_{ij}: Average supply time from i th middle level to the j th primary level. X_{ij}: Equipment demand of the j th primary level of the i th middle level. D_{0i}: Average distance from the top level to the i th middle level. D_{ij}: Average distance from the i th middle level to the j th primary level.

2.2. Top level model

2.2.1 Average cost model. The cost in top level includes financing cost, storage cost and supply cost.

(1) Financing cost is as follows.

$$C_{11} = D\sum_i \sum_j X_{ij} + f_1 \tag{1}$$

(2) Equipment financed at top level generally need to be stored at all levels for 0.5 years. Storage cost is as follows.

$$C_{12} = 3\times 0.5 f_2 \sum_i \sum_j X_{ij} \tag{2}$$

(3) Equipment financed at top level need to be supplied to the middle level first, and then to the primary level from the middle level. The supply cost is as follows.

$$C_{13} = Df_3 \sum_i \sum_j D_{ij} X_{ij} + Df_3 \sum_i D_{0i} \sum_j X_{ij} \tag{3}$$

(4)The total cost is as follows.

$$C_{10} = C_{11} + C_{12} + C_{13} \tag{4}$$

2.2.2 Average time model. The total time includes average financing time, average storage time and average supply time.

(1) Average financing time is as follows.

$$U_{11} = e_0 \tag{5}$$

(2) Equipment financed at the top level shall be stored at all levels for 0.5 years. So average storage time is as follows.

$$U_{12} = 0.5 + \sum_i 0.5 + \sum_i \sum_j 0.5 \tag{6}$$

(3) The equipment financed at the top level shall be supplied to the middle level first, and then to the required units from the middle level. The average supply time is as follows.

$$U_{13} = \sum_i e_{0i} + f_4 \sum_i D_{0i} \sum_j X_{ij} + \sum_i \sum_j e_{ij} + f_4 \sum_i \sum_j X_{ij} D_{ij} \tag{7}$$

(4) The total time is as follows.

$$U_{10} = U_{11} + U_{12} + U_{13} \tag{8}$$

2.3. Middle level model

2.3.1. Average cost model

(1) Financing cost

$$C_{21} = D \sum_i \sum_j X_{ij} + \sum_i f_1 \tag{9}$$

(2) Equipment financed at middle level generally need to be stored at the middle level and primary level for 0.5 years. Storage cost is as follows.

$$C_{22} = 2 \times 0.5 f_2 \sum_i \sum_j X_{ij} \tag{10}$$

(3) The equipment financed by the middle level is supplied to primary levels, and the cost can be calculated as follows

$$C_{23} = D f_3 \sum_i \sum_j D_{ij} X_{ij} \tag{11}$$

(4) The total cost is as follows.

$$C_{20} = C_{21} + C_{22} + C_{23} \tag{12}$$

2.3.2. Average time model

(1) The average financing time is as follows.

$$U_{21} = \sum_i e_0 \tag{13}$$

(2) The average storage time is as follows.

$$U_{22} = \sum_i 0.5 + \sum_i \sum_j 0.5 \tag{14}$$

(3) The average supply time is as follows.

$$U_{23} = \sum_i \sum_j e_{ij} + f_4 \sum_i \sum_j X_{ij} D_{ij} \tag{15}$$

(4) The total time is as follows.

$$U_{20} = U_{21} + U_{22} + U_{23} \tag{16}$$

2.4. Primary level model

2.4.1. Average cost model

(1) Financing cost is as follows.

$$C_{31} = \sum_i \sum_j \left(DX_{ij} + f_1 \right) \tag{17}$$

(2) The equipment financed shall be stored for 0.5 years. The cost is as follows.

$$C_{32} = 0.5 f_2 \sum_i \sum_j X_{ij} \tag{18}$$

(3) The equipment financed at primary level can be used when demand, and the supply cost can be ignored

(4) The total cost is as follows.

$$C_{30} = C_{31} + C_{32} \tag{19}$$

2.4.2. Average time model

(1) Financing time

$$U_{31} = \sum_i \sum_j e_0 \tag{20}$$

(2) Storage time

$$U_{32} = \sum_i \sum_j 0.5 \tag{21}$$

(3) The supply time can be ignored.

(4) The total time is as follows.

$$U_{30} = U_{31} + U_{32} \tag{22}$$

3. Decision model

3.1. Cost decision model

Determine the financing division according to the minimum total cost as follows.

$$C = \min_i \left(C_{i0} \right) \tag{23}$$

3.2. Time decision model

Determine the financing division according to the minimum total time as follows.

$$U = \min_i \left(U_{i0} \right) \tag{24}$$

3.3. Efficiency decision model

The minimum cost and the shortest time are combined to determine the financing division as follows.

$$E = \min_i \left(C_{i0} \cdot U_{i0} \right) \tag{25}$$

In financing decision models above, when i =1,2,3, Equipment financing is respectively implemented by top level, middle level and primary level.

4. Model application example

4.1 conditions

The purchase unit price of equipment A, B and C is 1 yuan, 10 yuan and 100 yuan respectively. The average cost to organize once order is 50 yuan. The cost of storing a single equipment for one year is 0.2 yuan, 2 yuan and 20 yuan respectively. The cost of one kilometer transportation of a single equipment is 1 ‰ of the equipment unit price and the transportation time is 1 minute. The equipment's production time is 3 months, 6 months and 12 months respectively. The average supply time of top level to middle level is 6 months, middle level to primary level is 6 months, there are 3 middle levels with equipment demand, each middle level has 3 primary level with equipment demand. Equipment demand is subject to normal distribution as N(10, 2), N(5, 2) and N(2, 1). The transportation distance from top level to middle level is 500km, 1000km and 2000km respectively. The transportation distance from middle level to each primary level is 300km, 400km and 500km respectively. The financing fraction decision is as follows.

4.2 Application of top level model

(1) Average cost

According to equation (1)- (3) cost of Equipment A, B, and C is as follows.

C_{11A} =1×3×3×10+50=140, C_{11B} =10×3×3×5+50=500, C_{11C} =100×3×3×2+50=1850;

C_{12A} =3×0.5×0.2×3×3×10=27, C_{12B} =3×0.5×2×3×3×5=135, C_{12C} =3×0.5×20×3×3×2=540.

C_{13A} =0.001×1×[3×10×(300＋400＋500)＋3×10×(500＋1000＋2000)]=141

C_{13B} =0.001×10×[3×5×(300＋400＋500)＋3×5×(500＋1000＋2000)]=705

C_{13C} =0.001×100×[3×2×(300＋400＋500)＋(500＋1000＋2000)×3×2]=2820

Total cost of equipment A=140+27+141=308;

Total cost of equipment B=500+135+705=1340;

Total cost of equipment C=1850+540+2820=5120.

(2) Average time

According to equation (5)- (7) time of Equipment A, B, and C is as follows.

$U_{11A} = e_0$ =3, $U_{11B} = e_0$ =6, $U_{11C} = e_0$ =12

$U_{12A} = U_{12B} = U_{12C}$ =0.5＋3×0.5＋3×3×0.5=6.5 years=78 months

U_{13A} =3×6 ＋ 1/60×30×(500 ＋ 1000 ＋ 2000)/(24×30) ＋ 3×3×6 ＋ 1/60×10×3(300 ＋ 400 ＋ 500)/(24×30)=18＋2.4＋54＋0.83=75.2

U_{13B} =3×6 ＋ 1/60×15×(500 ＋ 1000 ＋ 2000)/(24×30) ＋ 3×3×6 ＋ 1/60×5×3(300 ＋ 400 ＋ 500)/(24×30)=18＋1.21＋54＋0.42=73.6

U_{13C} =3×6 ＋ 1/60×6×(500 ＋ 1000 ＋ 2000)/(24×30) ＋ 3×3×6 ＋ 1/60×2×3(300 ＋ 400 ＋ 500)/(24×30)=18＋0.87＋54＋0.5=73.4

Total time of equipment A=3＋78＋75.2=156.2

Total time of equipment B=6＋78＋73.6=157.6

Total time of equipment C=12＋78＋73.4=163.4

4.3 Application of middle level model

(1) Average cost

According to equation (9)- (11) cost of Equipment A, B, and C is as follows.

C_{21A} =1×3×3×10＋3×50=240, C_{21B} =10×3×3×5＋3×50=600,

C_{21C} =100×3×3×2＋3×50=1950;

C_{22A} =2×0.5×0.2×3×3×10=18, C_{22B} =2×0.5×2×3×3×5=90, C_{22C} =2×0.5×20×3×3×2=360.

C_{23A}=0.001×1×3×10×(300＋400＋500)=36

C_{23B}=0.001×10×3×5×(300＋400＋500)=180

C_{23C} =0.001×100×3×2×(300＋400＋500)=720

Total cost of equipment A=240＋18＋36=294,

Total cost of equipment B=600＋90＋180=870,

Total cost of equipment C=1950＋360＋720=3030.

(2) Average time

According to equation (13)- (15) time of Equipment A, B, and C is as follows.

U_{21A} = 3×3＝9, U_{21B} = 3×6=18, U_{21C} = 3×12=36

$U_{22A} = U_{22B} = U_{22C}$ =3×0.5＋3×3×0.5=6 years=720 months

U_{23A} =3×3×6＋1/60×3×10×(300＋400＋500)/(30×24)=54.83

U_{23B} =3×3×6＋1/60×3×5×(300＋400＋500)/(30×24)=54.42

U_{23C} =3×3×6＋1/60×3×2×(300＋400＋500)/(30×24)=54.17

Total time of equipment A=9＋720＋54.83=783.8

Total time of equipment B=18＋720＋54.42=792.4

Total time of equipment C=36＋720＋54.17=810.2

4.4 Application of primary level model

(1) Average cost

According to equation (17)- (18) cost of Equipment A, B, and C is as follows.

C_{31A} =3×3×(1×10＋50)=540, C_{31B} =3×3×(10×5＋50)=900,

C_{31C} =3×3×(100×2＋50)＝2250;

C_{32A} =0.5×0.2×3×3×10=9, C_{32B} =0.5×2×3×3×5=45, C_{32C} =0.5×20×3×3×2=180.

Total cost of equipment A=540＋9=549,

Total cost of equipment B=900＋45=945,

Total cost of equipment C=2250＋180=2430.

(2) Average time

According to equation (20)- (21) time of Equipment A, B, and C is as follows.

U_{31A} = 3×3×3=27, U_{31B} =3×3×6=54, U_{31C} =3×3×12=108

$U_{32A} = U_{32B} = U_{32C}$ =3×3×0.5=4.5 years=54 months

Total time of equipment A=27＋54=81

Total time of equipment B=54＋54=108

Total time of equipment C=108+54=162

4.5 Application of decision model

Table 1 can be got from the calculation results above.

Table 1. Calculation results comparing.

Equipment kinds	Financing subject	Total fee	Total time	Efficiency
A	Primary level	549	81	44469
A	Middle level	294	783.8	230437.2
A	Top level	308	156.2	48109.6
B	Primary level	945	108	102060
B	Middle level	870	792.4	689388
B	Top level	1340	157.6	211184
C	Primary level	2430	162	393660
C	Middle level	3030	810.2	2454906
C	Top level	5210	163.4	851314

(1)Decision according cost

According to table 1, the financing subject of equipment A, B, and C is as follows.

The minimum cost of equipment A is 294 yuan. The financing subject is primary level.

The minimum cost of equipment B is 870 yuan. The financing subject is middle level.

The minimum cost of equipment A is 2430 yuan. The financing subject is primary level.

(2) Decision according to time

According to table 1, the financing subject of equipment A, B, and C is as follows.

The minimum time of equipment A is 81 months. The financing subject is primary level.

The minimum time of equipment B is 108 months. The financing subject is primary level.

The minimum cost of equipment C is 162 months. The financing subject is primary level.

(3) Decision according to efficiency

According to table 1, the financing subject of equipment A, B, and C is as follows.

The best efficiency value of equipment A is 44469. The financing subject is primary level. The best efficiency value of equipment B is 102060. The financing subject is primary level. The best efficiency value of equipment C is 393660. The financing subject is primary level.

5. Concluding remarks

For the selection of three types of models, when the demand of equipment maintenance for equipment is urgent, the time model should be used to determine the subject of equipment financing. When the demand of equipment maintenance for equipment is not urgent, the cost model can be used to determine the subject of equipment financing. When there are requirements for the timeliness and economy of equipment financing, the efficiency model of equipment can be used to determine the subject of equipment financing.

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