CHAPTER 4

Case Studies, Results and Analysis

4.1 Chapter Overview

In previous chapters, the high level concept of the proposed IT investment framework based on the learning model in asset management is given. As explained earlier, the learning model of the university in asset management is constructed by applying the KE methodology. It contains experiences of the experts on "how to" and "why" associating with costs and risks when managing the IT asset across its life cycle. Together with the service performance model, the knowledge concepts from this learning model can be used in the balancing mechanism of the proposed IT investment framework to determine the most suitable investment option.

This chapter then discusses case studies and results from applying the proposed IT investment framework. Please note here that although in CAMT the IT assets covers software, server, printer, personal computer, network, motion and CAD/CAM, only the personal computer is selected to verify the validity and practicality of the proposed IT investment framework. This is due to the fact that, in the university context, the personal computer represents the majority of the investment budget, and least obvious direct relationships to the organisation revenues.

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4.2 General Description of Case Study

College of Arts, Media and Technology (CAMT) within the Chiang Mai University is used as the case study. CAMT was established in July 2006 to strategically support the country development outside the capital including IT city, e-Handicraft and e-Tourism. It received the huge initial endowment from the central and local government agencies to cover building infrastructure and research/academic supporting facilities. This

endowment totalled approximately 240 million bahts which included 80.5 million bahts for the initial IT investment. Another 2 endowments for IT related activities were provided in year 2007-2008 at 10 and 7 million bahts respectively. The categorisation of the initial IT investment for CAMT can be illustrated as shown in Figure 4.1.

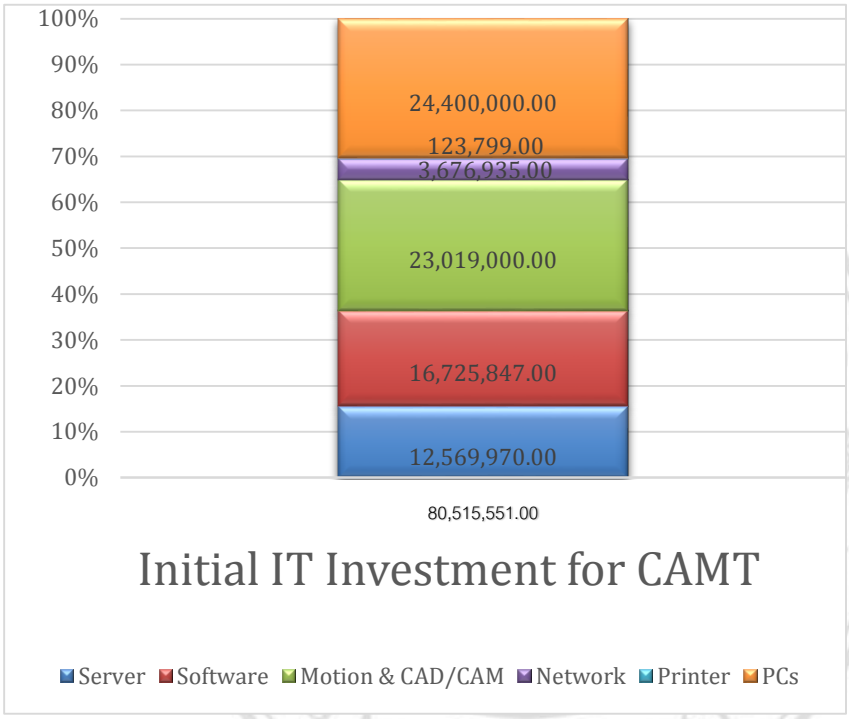

Figure 4.1 Categorisation of the Initial IT Investment for CAMT

Figure 4.1 shows the categorization of the IT assets for CAMT with the initial investment budget in 2006. It can be seen that to fulfil and support the mandate of CAMT the initial investment in IT assets and infrastructure included software, server, printer, personal computer, network infrastructure and motion capture equipment with CAD/CAM.As mentioned previously, only the personal computer is selected to verify the advantages of the proposed IT investment framework. In more details, the initial investment budget for the personal computer in CAMT can be classified into 3 different duties based on academic support in CAMT. These are the personal computer as the academic support for the animation department, the software engineering department,

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and the modern management and information technology department with different expected duties or functions from the personal computers invested.

In the animation department, the personal computer needs high specifications with very fast computer processing unit in order to compute 2 dimension graphic, 3 dimension graphic and rendering. Additional to the very fast computer processing unit, the very fast VGA card and large amount of RAM are also needed, as well as the high speed SSD hard disk.

In the software engineering department, the personal computer needs high specification with very fast computer processing unit to support the activities in the software development and programming. Additionally, the large amount of RAM and high speed SSD hard disk are also needed.

In the modern management and information technology department, only the normal personal computer with average speed computer processing unit is required. This personal computer is for the administrative functions in the office and general administrative software. Additionally, regular RAM and high speed hard disk are needed.

In summary, the classification of the personal computer invested in CAMT and its different duties and functions in each department is presented in Table 4.1. Please note here that this classification is essential in this research for the purpose of predetermining the expected quality of the investment option. Then, the investment option can be decided accordingly. This is different from other evaluation methods where the future quality of the investment option is unknown.

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Table 4.1. Classification of the Personal Computer with Different Functions across Departments

Duty/Function	CPU	GPU	RAM	Disk Space/Speed	Total function
ANI	10	10	10	10	40
SE	8	0	10	8	28
MMIT	6	0	6	6	18

Ideally, with no constrains on the financial investment budget, all relevant assets could be replaced by the new assets when the performance drops from the accepted level. However practically, this is not always the case, and replacement usually occurs when their life cycles is reached as shown in Figure 4.2. Note here that, in this research, the life cycle of the IT assets within CAMT is designed to be 3 years. This scenario can be seen as the representation of the investment strategy typically used within university (CAMT included).

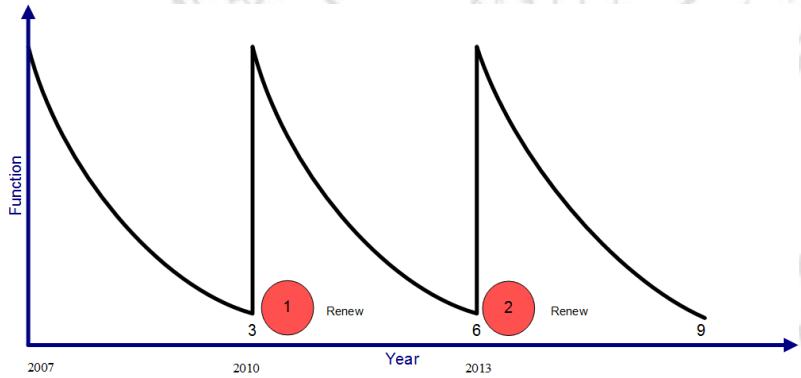

Figure 4.2. Typical Investment Option at the End of the Asset Life Cycle

Figure 4.2 shows the typical investment option used in CAMT and within the university in general. As mentioned previously, since the life cycle of the IT asset is designed at 3 years in this research, the replacement point of the new IT assets (investment) is then at 3 years (or at the end of its life cycle). Although this investment method is simple, it represents the conventional view of the IT asset as the cost center within CAMT.

However practically, this does not always presents the most suitable investment option since the function of the IT asset reduces over its life cycle as well. Moreover, the budgeting usually tends to drop every year. As a result, CAMT needs an alternative investment framework to balance both economic and service aspects. In this research, the investment framework utilizes the learning model of experts in asset management.

In the following subsections, test beds are presented as a case study to validate the advantages and applicability of the proposed investment framework. In another words, these test beds represent different investment scenarios/options.

4.3 Test Bed 1: Based Case

4.3.1 General Description of Test Bed 1

In this research, the test bed 1 represents the conventional view where the investment occurs at the end of the life cycle. In this research, it is designed at 3 years. Furthermore, since the personal computer is classified according to each department based on its functions/duties, the replacement of the new personal computer is then purchased into 3 groups. These are the personal computer for the animation department, the personal computer for the software engineering department and the personal computer for the modern management and information technology. Additionally, with this investment option, the costs for operation and maintenance need to be included. The investment pattern of the test bed 1 can be illustrated in Figure 4.3.

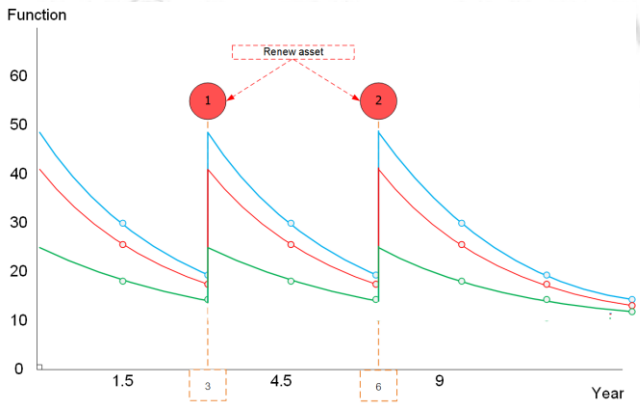

Figure 4.3 Investment Pattern of the Test Bed 1

4.3.2 Results of Test Bed 1

Table 4.2 Results of the Test Bed 1

Cash flow Year	Detail	ANI			SE			MMIT			Grand Total
		Price	Qua.	Total	Price	Qua.	Total	Price	Qua.	Total	
1	initial Cost	99,000	100	9,900,000	80,000	100	8,000,000	65,000	100	6,500,000	24,400,000
2	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
3	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
4	Renew PCs	70,000	100	7,000,000	60,000	100	6,000,000	50,000	100	5,000,000	18,000,000
	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
5	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
6	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
7	Renew PCs	60,000	100	6,000,000	50,000	100	5,000,000	40,000	100	4,000,000	15,000,000
	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
8	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
9	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000

Table 4.2 shows the results of the test bed 1 where replacement of the new personal computer is invested differently for each department, and it occurs every 3 years (or at the end of the life cycle). It can be seen from Table 4.2 that the total costs of investment across 9 years (3 life cycles) is at 61,720,000 bahts. This can be divided into 25,480,000 bahts for initial investment at year 1, 19,620,000 bahts as an investment for the second life cycle, and 16,620,000 bahts as an investment for the third life cycle respectively.

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4.4 Test Bed 2

4.4.1 General Description of Test Bed 2

In this research, the test bed 2 still represents the conventional view where the investment occurs at the end of the life cycle. Again, in this research, it is designed at 3 years. However, instead of replacing the new personal computer to fit different duties/functions for each department, in this test bed, the personal computer with lowest specification (for the modern management and information technology department) is purchased, and then perform additional upgrade to fit requirements of other departments appropriately. This represents the view of the organisation to keep the budget as low as possible while satisfying the functionality/reliability to a certain degree.

In more details, the replacement (or the new investment) in the test bed 2 focuses on purchasing the personal computer with the specification of the modern management and information technology. However, some of them are then upgraded with VGA card, RAM and SSD to match with the requirement of the animation department. Some of them are then upgraded with RAM and SSD to match with the requirement of the software engineering department. This investment scenario occurs every 3 years or at the end of the life cycle. Additionally, with this investment option, the costs for operation and maintenance as well as the costs of the upgrade need to be included.

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4.4.2 Results of Test Bed 2

Table 4.3 Results of the Test Bed 2

Cash flow Year	Detail	ANI			SE			MMIT			Grand Total
		Price	Qua.	Total	Price	Qua.	Total	Price	Qua.	Total	
1	initial Cost	99,000	100	9,900,000	80,000	100	8,000,000	65,000	100	6,500,000	24,400,000
2	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
3	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
4	Renew PCs	50,000	100	5,000,000	50,000	100	5,000,000	50,000	100	5,000,000	15,000,000
	Upgrade	15,000	100	1,500,000	5,000	100	500,000	-	-	-	2,000,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
5	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
6	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
7	Renew PCs	40,000	100	4,000,000	40,000	100	4,000,000	40,000	100	4,000,000	12,000,000
	Upgrade	12,000	100	1,200,000	4,000	100	400,000	-	-	-	1,600,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
8	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
9	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000

Table 4.3 shows the results of the test bed 2 where the personal computer with the lowest specification (for the modern management and information technology department) is purchased with additional upgrade for other departments. Similarly, it occurs every 3 years (or at the end of the life cycle). It can be seen from Table 4.3 that the total costs of investment across 9 years (3 life cycles) is at 59,320,000 bahts. This can be divided into 25,480,000 bahts for initial investment at year 1, 18,620,000 bahts as an investment for the second life cycle, and 15,220,000 bahts as an investment for the third life cycle respectively.

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4.5 Test Bed 3

4.5.1 General Description of Test Bed 3

In this research, the test bed 3 represents different investment option other than the conventional view shown in the test bed 1 and 2. In this test bed 3, rather than

purchasing the personal computer and consider it as assets of the organisation, the rental of the personal computer is preferred. Similar to the test bed 1, the rental of the personal computer is divided into 3 groups to match with requirements from different departments within CAMT as mentioned earlier. Please note here that, with this investment option, the costs of operation and maintenance as well as the costs of upgrade are not included.

4.5.2 Results of Test Bed 3

Table 4.4 Results of the Test Bed 3

Cash flow Year	Detail	ANI			SE			MMIT			Grand Total
		Price	Qua.	Total	Price	Qua.	Total	Price	Qua.	Total	
1	initial Cost	99,000	100	9,900,000	80,000	100	8,000,000	65,000	100	6,500,000	24,400,000
2	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
3	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
4	Renew PCs/Rent	70,000	100	7,000,000	60,000	100	6,000,000	50,000	100	5,000,000	7,440,000
	O&M	-	-	-	-	-	-	-	-	-	-
5	Rent	-	-	-	-	-	-	-	-	-	7,440,000
	O&M	-	-	-	-	-	-	-	-	-	-
6	Rent	-	-	-	-	-	-	-	-	-	7,440,000
	O&M	-	-	-	-	-	-	-	-	-	-
7	Renew PCs	60,000	100	6,000,000	50,000	100	5,000,000	40,000	100	4,000,000	6,200,000
	O&M	-	-	-	-	-	-	-	-	-	-
8	Rent	-	-	-	-	-	-	-	-	-	6,200,000
	O&M	-	-	-	-	-	-	-	-	-	-
9	Rent	-	-	-	-	-	-	-	-	-	6,200,000
	O&M	-	-	-	-	-	-	-	-	-	-

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Table 4.4 shows the results of the test bed 3 where the rental of the personal computer for different department is preferred. Similar to other test beds, it occurs every 3 years (or at the end of the life cycle). It can be seen from Table 4.4 that the total costs of investment across 9 years (3 life cycles) is at 66,400,000 bahts. This can be divided into 25,480,000 bahts for initial investment at year 1, 22,320,000 bahts as an investment for the second life cycle, and 18,600,000 bahts as an investment for the third life cycle respectively.

4.6 Test Bed 4

4.6.1 General Description of Test Bed 4

In this research, the test bed 4 represents the investment scenarios of the proposed IT investment framework based on the university learning model in asset management. Still, this investment follows the designed life cycle of the IT asset set at 3 years. Furthermore, the costs of the operation and maintenance as well as the costs of the upgrade are included. When deciding on the investment option, this test bed utilizes the knowledge/experiences of the experts in the learning model as shown in previous chapter.

Firstly, experiences from the corrective maintenance are explicated. These are experiences from the corrective actions performed during the operation and maintenance activities in the first year. These corrective actions include analysing and fixing of the personal computer related problems when the complaints occur (CAMT incident system). Knowledge on "how-to" and "why" relating to the corrective actions is exchanged and transferred among IT staff (knowledge users) to develop the best practice. With the knowledge on the corrective actions, the IT staff can then develop the most suitable plan to prevent the similar incidents from occurring again. In another word, the knowledge is elevated from the corrective maintenance to the preventive maintenance.

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With the preventive maintenance, the functions/duties of the personal computer are maintained above or at least at the accepted level. Hence, the knowledge on "how to upgrade" is performed at the second year as part of the maintenance actions to maintain the functionality of the existing personal computers. Based on experiences from the preventive actions accumulated, the knowledge on prediction and assessment of the possible risks can then be developed to regularly monitor the status of the personal computer and take actions to mitigate the consequences of the incidents respectively. In another word, the knowledge is then enhanced from the preventive actions to predictive and proactive maintenances. The relocation of the personal computer is conducted when the risks of it performing the existing duties are assessed.

This is to relocate the personal computer from its existing service functions to lower service functions (change functions) while reducing the risks and the consequences.

In summary, with the knowledge developed and experiences accumulated as the learning model in asset management, the corrective and preventive actions are performed during the first year. Then, upgrade actions for the personal computer of the animation and software engineering departments is performed during the second year of the investment. This is to maintain the service functions of the personal computer to still perform the acceptable level of the animation and software engineering departments. Then, at the end of the life cycle (year 3), only the personal computer of the animation department is replaced by new investment. The existing personal computer of the animation department (already upgraded) is relocated to the software engineering department. Similarly, the existing personal computer of the software engineering department (already upgraded) is then relocated to the modern management and information technology department. The investment pattern of the test bed 4 is shown in Figure 4.4.

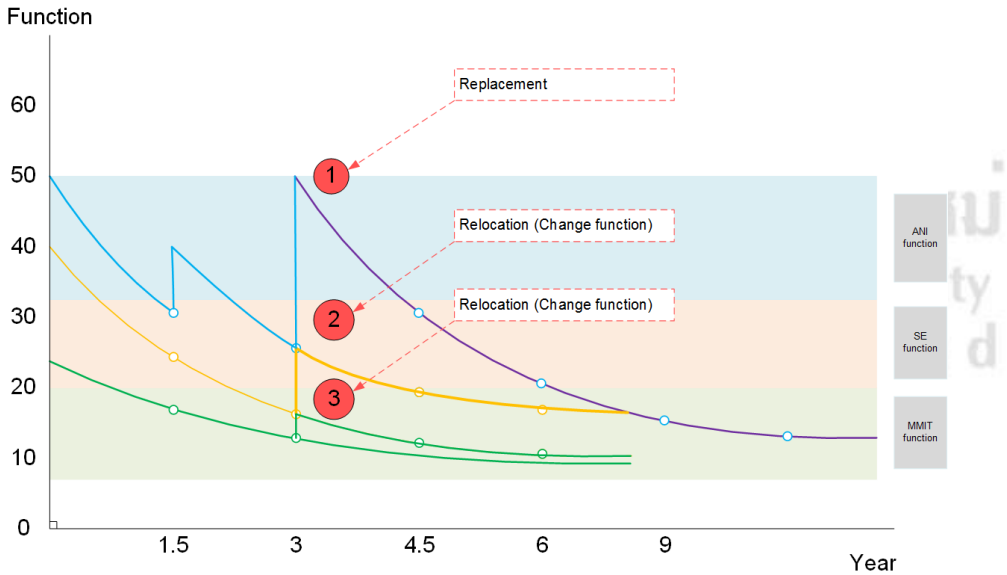

Figure 4.4 Investment Pattern of the Test Bed 4

By following this investment option from the proposed alternative investment framework based on the university learning model in asset management, the costs of investment can be reduced while satisfying all relevant stakeholders as well as maintaining the functionality and reliability of the assets. Hence, in year 2, the relevant costs are 1,400,000 bahts for the upgrade actions, and 540,000 bahts for the operation and maintenance actions. In total, the costs associated in year 2 are 1,940,000 bahts. In year 3, the relevant costs are 7,000,000 bahts for the new investment of animation department, and 540,000 bahts for the operation and maintenance actions. In total, the costs associated in year 3 are 7,540,000 bahts.

4.6.2 Results of Test Bed 4

The results of the test bed 4 can be seen in Table 4.5.

Table 4.5 Results of the Test Bed 4

Cash flow Year	Detail	ANI			SE			MMIT			Grand Total
		Price	Qua.	Total	Price	Qua.	Total	Price	Qua.	Total	
1	initial Cost	99,000	100	9,900,000	80,000	100	8,000,000	65,000	100	6,500,000	24,400,000
2	Upgrade	-	-	-	-	-	-	-	-	-	-
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
3	Upgrade	8,000	100	800,000	6,000	100	600,000	-	-	-	1,400,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
4	Renew PCs	70,000	100	7,000,000	-	-	-	-	-	-	7,000,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
5	Renew PCs	55,000	100	5,500,000	-	-	-	-	-	-	5,500,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
6	Renew PCs	50,000	100	5,000,000	-	-	-	-	-	-	5,000,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
7	Renew PCs	45,000	100	4,500,000	-	-	-	-	-	-	4,500,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
8	Renew PCs	40,000	100	4,000,000	-	-	-	-	-	-	4,000,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000
9	Renew PCs	37,500	100	3,750,000	-	-	-	-	-	-	3,750,000
	O&M	180,000	1	180,000	180,000	1	180,000	180,000	1	180,000	540,000

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From table 4.5 shows the results of the investment option which follows the learning model on asset management proposed in this research. It can be seen that with this alternative investment framework the investment is spread across the asset's life cycle. The actions include an upgrade to the existing personal computers, new purchase of the personal computer with highest specification required, and relocation of existing personal computers to other departments with reduced requirements. Please note here that these actions are performed repeatedly across the whole life cycle and every life cycle. It can be seen from Table 4.5 that the total costs of investment across 9 years (3 life cycles) is at 58,470,000 bahts. This can be divided into 25,480,000 bahts for initial investment at year 1, 19,120,000 bahts as an investment for the second life cycle, and 13,870,000 bahts as an investment for the third life cycle respectively

4.7 Analysis and Discussion

In the previous subsections, the case study is presented to validate the advantages and applicability of the proposed investment framework in the form of different test beds. This subsection then analyses the results and provides discussion on the proposed investment framework when comparing to the existing conventional investment methods based on financial evaluation techniques.

4.7.1 Actual Investment Costs of Each Test Bed

The actual investment costs of each test bed is given in Table 4.6. Please note here that the actual costs of investment include the costs of new investment, the costs of upgrade, and the costs of operation and maintenance actions. Furthermore, the actual costs of investment cover the full 3 life cycles of the IT asset (the personal computer in this research).

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Table 4.6. The Actual Investment Costs of Each Test Bed

Actual Cost	Initial Cost Cycle1	Actual Cost Cycle12	Actual Cost Cycle 3	Actual Cost (Year 0-8)
Alternative A	25,480,000	19,620,000	16,620,000	61,720,000
Alternative B	25,480,000	18,620,000	15,220,000	59,320,000
Alternative C	25,480,000	22,320,000	18,600,000	66,400,000
Alternative D	25,480,000	19,120,000	13,870,000	58,470,000

Table 4.6 shows the actual investment costs of each test bed. It can be seen that if the evaluation technique is solely based on the conventional financial evaluation (capital budgeting) and excluding the results from the investment framework proposed in this paper (Alternative D), an investment option shown in the test bed 2 will be selected. This is because it presents the cheapest investment costs including upgrade when comparing it with other investment options. This is due to the fact that this investment option chooses to purchase the lowest quality personal computer which is surely cheapest, then upgrade some of them accordingly to fit the requirements of other departments. However, this investment option also increases risks and reduces reliability of the service performance during year 2 and 3. This is evident from more complaints for the corrective actions in the test bed 2 compared to others. With the proposed investment framework considered, an alternative D indicates the cheapest actual investment costs in long term, and performs better than others. This is also confirmed in the present value analysis given in the following sub sections.

4.7.2 Present Value Analysis

In the previous subsection, the analysis and discussion on the actual costs are given. Although this financial evaluation method is typically used in CAMT (and other faculties within the university) due to its simplicity, the investment decision focusing solely on the actual costs of the investment could be misleading. This can be seen from the results shown in Table 4.6 where the investment option indicated presents greater risks and reduced service reliability. This subsection then illustrates the investment decision by analysing the present values of costs and benefits of each investment options.

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As reviewed in the literatures, the present value is also one of the common financial evaluation techniques used when analysing different investment options. The equations for the present values of costs and benefits used in this research are given in equation (3).

$$PV = \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \cdots + \frac{C_n}{(1+r)^n}$$

$$NPV = C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \cdots + \frac{C_n}{(1+r)^n} \quad \text{..... (3)}$$

Please note here that the benefits in this research is measured by the satisfaction of students from the personal computers invested as a proportion to the tuition fees paid. The results of the present values of costs and benefits from each test bed can be seen in Table 4.7.

Table 4.7. Present Values of Costs and Benefits from Each Investment Scenario

Present value	PV of benefit - PV of cost Year 0-11	PV of benefit - PV of cost Year 3-11	PV of benefit - PV of cost Year 6-11
Alternative A	-11,393,634.38	-5,086,213.02	-3,449,686.44
Alternative B	-15,562,775.75	-9,921,486.43	-5,316,347.28
Alternative C	-13,111,608.24	-7,190,804.88	-4,343,069.26

In Table 4.6 the investment decision based on the actual costs would indicate that the investment option in the test bed 2 is preferable since it presents the cheapest of all. However, when considering the present value of costs and benefits as shown in Table 4.7, this is not the case and it is actually the worst investment option compared to others. Furthermore, the investment option in the test bed 3 (rental) presents the highest amount of costs since interests and premiums are included and spread throughout the rental period. This investment option is suitable for the organisation with limited annual investment budget. With the present values analysis, the investment option in the test bed 1 is the most preferable while still maintain the service performance within the acceptable limit.

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4.7.3 Present Value Analysis with Proposed Investment framework

In this subsection, the investment option in the test bed 4 is included in the present value analysis. This investment option in the test bed 4 utilises the knowledge from the learning model in asset management and translates this knowledge into effective maintenance actions to reduce costs and risks, and maintain the performance and benefits. The results of the present value with the investment option in the test bed 4 is given and compared in Table 4.8

Table 4.8 Present Values of Costs and Benefits from Each Investment Scenario

Present value	PV of benefit - PV of cost Year 0-11	PV of benefit - PV of cost Year 3-11	PV of benefit - PV of cost Year 6-11
Alternative A	-11,393,634.38	-5,086,213.02	-3,449,686.44
Alternative B	-15,562,775.75	-9,921,486.43	-5,316,347.28
Alternative C	-13,111,608.24	-7,190,804.88	-4,343,069.26
Alternative D	-3,726,161.00	4,141,472.85	1,434,102.54

It can be seen from Table 4.8 that the investment option in the test bed 4 shows the best possible investment decision comparing to others. Not only the investment costs are relatively low, the benefits are also high. Instead of performing the corrective actions when the service performance drops, this proposed investment framework classifies and sets the service performance requirements of each department. Then, it constructs maintenance actions from accumulated experiences to perform upgrades, relocation and replacement when needed. The results given in Table 4.8 can also be illustrated as in Figure 4.5

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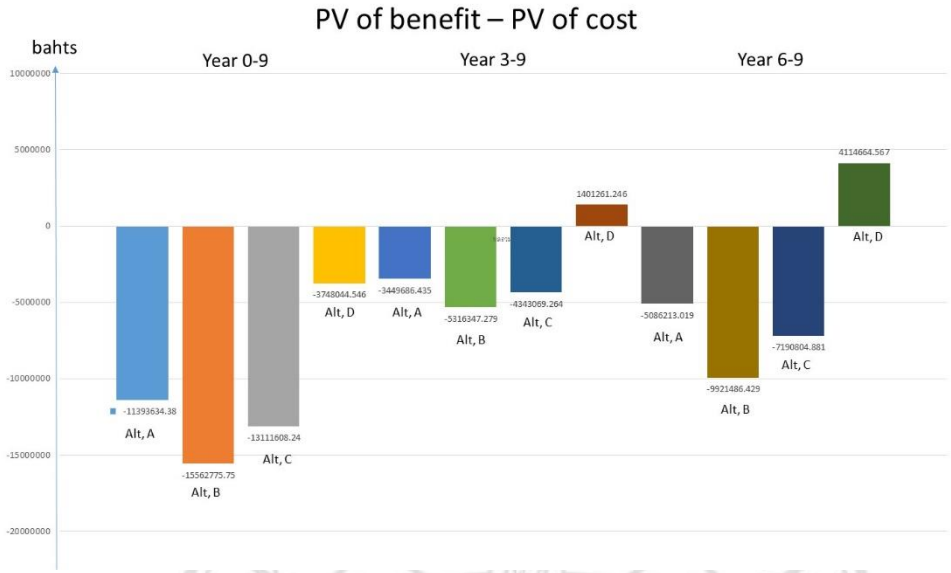

Figure 4.5 Comparisons of Present Values of Each Investment Options

Figure 4.5 shows the comparisons of the present values from each investment scenario. It can be seen that in most cases the investment costs are usually greater than benefits. This is due to the fact that the IT investment in the university does not relate directly to the revenues or financial productivity. However, university has no choice, but to keep spending to support the academic activities. Hence, this proposed investment framework can assist the university in the most suitable investment decision/actions and make the most of its investment budgets.

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4.8 Chapter Summary

In this chapter, the results from applying the alternative IT asset management framework proposed in this thesis are presented. Different scenarios are developed into 4 test beds. These developed test beds cover the decision and maintenance actions from "similar investment (existing investment pattern)", "cheapest investment", "rental" and "investment option based on asset management". The results have shown that the knowledge engineering methodology can be applied to construct the learning curve which represents the organisational learning model of CAMT in operation and

maintenance. This organisational learning model represents the economic model of the proposed IT asset management framework. This economic model contains expert knowledge concepts. These knowledge concepts can then be used in the service performance model as a reasoning guideline together with equation (1). Finally, the analysis and discussion are given, and it shows that with the proposed IT asset management framework, costs, performances and risks can be better managed when compared with the conventional method.

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