Chapter 10
Asset Continuity Planning

Abstract The aim of this chapter is to describe how to plan for the provision of assets which are required to meet an ongoing need. This is a very common situation, in which demand for a type of asset continues into the future, but older items require replacement and variations occur, due to the changes in demand levels and to market and technical developments. *Outcomes* After reading this chapter you will have learnt how to plan the purchase of items to sustain an ongoing capability requirement, by calculating the preplan capability gap and then working toward the planning horizon calculating the purchase needs year by year and making suitable purchase decisions. You will become familiar with a spreadsheet-based method for carrying out the necessary calculations and for graphically illustrating the gap analysis and the acquisition costs.

10.1 Asset Continuity

Asset continuity refers to the common situation where the requirement for the services delivered by a given type of asset is ongoing. Most asset management situations involve planning for the continuity of an existing system of assets, the role of which will continue on into the future. Each asset will have its own life cycle, but the overall situation is more complex than might be suggested by a focus on the life cycles of individual assets or of particular asset types alone. The "inputs to capability" of ranges of major asset types frequently overlap, as do the requirements for supporting asset systems and facilities.

An example is a trucking business, where continuity is required in meeting the demands of the business, so that disposal of old trucks at the end of their useful life is matched by acquisition of new trucks, with variations as necessary to reflect business and technical developments. At the same time, the support facilities such as maintenance personnel and facilities, and asset information systems, will need to continue, but also with developments as necessary to follow the changes in the assets themselves and in the related technology.

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10.1.1 Factors in Continuity Planning

10.1.1.1 Financial

To maintain continuity in an asset fleet it is necessary to make financial provision for the purchase of new items as the fleet ages. If the fleet has an even spread of ages, disposals and acquisitions can occur at roughly even rates to keep the fleet size in balance. It is more likely, however, that most of the items in a fleet will have similar ages, and in this case we must make financial provision against the time when many replacements are due. The numbers purchased at any one time may involve considerations of available capital and economies of scale.

Ideally, we would like to know how much longer individual items will last before we need to replace them. But at the overall budgeting stage we need a process which will ensure that we have, at an aggregate level, the funding to provide the equipment that we need when we need it. In practice, we will take into account individual asset condition and service requirements when making a specific replacement decision.

10.1.1.2 Uniformity

There are advantages in having uniform fleets, so that we may wish to retire a particular equipment type all together and bring in the replacement type. This simplifies issues such as operations, training, spare parts provision, and technical support. We may also wish to use preferred suppliers so as to avoid too wide a spread of types for logistic support.

10.2 Asset Data

For planning purposes, data will be required. This will be held in an *Asset Register* and will be along the following lines:

- The types of assets in the fleet;
- The quantity of each type;
- Date of acquisition of each asset.

Also, we need an estimate of the useful life of each asset type. Ideally, this will be contained in the life cycle asset management plan for the asset. We may also take account of utilization data such as service hours of operation, or kilometers run in the case of vehicles.

10.3 Planning Terminology

The following terms are useful in the planning process. These are illustrated in Fig. 10.1.

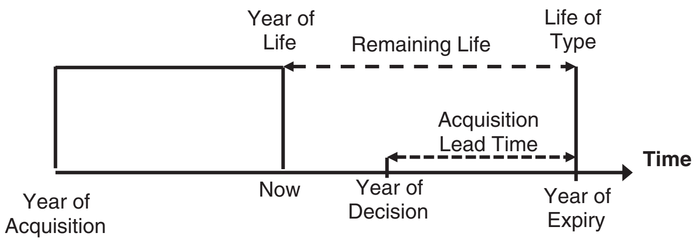


Fig. 10.1 Terms used in asset continuity planning

- *Year of Acquisition* is the year when the asset is acquired, usually also assumed to be the year when it starts its operational life. This should be recorded in the asset database.
- *Age or Year of Life* Measures of the age of an asset. Year of life is the age +1. Thus the first year of life is year 1, the second year is year 2, and so on.

$$\text{Year of Life} = \text{Current year} - \text{Year of Acquisition} + 1$$

  For some assets, cumulative utilization may be a more effective measure than calendar time.
- *Life of Type* is the number of years for which a given type of item is assumed to last, for planning purposes. An alternative term is Estimated Useful Life. This concept is useful in planning for fleets of similar assets. For major assets, we may base our planning on individually assessed remaining lives. The Life of Type may vary with the application and with the environment. For asset fleets, it is advisable to assign a Life of Type for each type of asset. A guideline is given by the depreciation schedules published by tax authorities. This lists "effective lives" for a whole range of asset types. Decisions on specific item replacement can be made tactically in the short term, but it is unwise to rely on a purely tactical approach, as this may not give an adequate signal of financial requirements.
- *Remaining Life* is the number of years which we expect an asset to last from now.

$$\text{Remaining Life} = \text{Life of Type} - \text{Year of Life}$$

  For major items the remaining life may be assessed individually.
- *Year of Expiry* is the calendar year in which an asset runs out of planned life. This is normally when it reaches its Life of Type.

$$\text{Year of Expiry} = \text{Current year} + \text{Life of Type} - \text{Year of Life}$$

  Or we may estimate the Year of Expiry from the Remaining Life and the current year. It is the current year plus the Remaining Life.

$$\text{Year of Expiry} = \text{Current year} + \text{Remaining Life.}$$

- *Acquisition Lead Time* The time taken to plan and give effect to the acquisition of an item and bring it into service.

- *Year of Decision* The calendar year when an acquisition must be approved in order to make an item available when it is needed.

$$\text{Year of Decision} = \text{Year of Expiry} - \text{Acquisition Lead Time.}$$

10.4 Planning Schedules

In practice, asset continuity planning will involve many types of assets with varying ages and conditions. Planning schedules, usually in a spreadsheet format, can be used to assist in asset planning process. Useful schedules are:

- *Expiry Schedule* This shows how many items of a given range of assets are expected to reach their Year of Expiry by nominated calendar years.
- *Retirement Schedule* This is a schedule of planned retirement dates, which reflects decisions whereby some items retire at dates which differ from the expiry schedule. We should not lightly run over the Year of Expiry, but variations in timing may occur for reasons of cost and operational factors. If every item retired at its expiry date, the expiry and retirement schedules would be the same.
- *Decision Schedule* shows the types and numbers of items on which replacement decisions are needed in each year.
- *Acquisition and Cost Schedule* is derived from the preceding schedules.

10.5 Planning Schedules Example

The spreadsheet shown in Fig. 10.2 in an Excel format relates to an electricity distribution company. The company has a number of transformers of various types. It is planning a capital budget for transformer replacement. The types of transformers are designated H, K, and M in column A. Different numbers of transformers were purchased in different years in the past.

	A	B	C	D	E	F	G
1	Item Type	Year	1	2	3	4	5
2	H				10		
3	H						12
4	K				30		
5	K					24	
6	K						30
7	M			12			

Fig. 10.2 Transformer expiry schedule

10.5.1 Expiry Schedule

Figure 10.2 shows the expiry schedule for various cohorts of transformers. For example Row 2, Column E, shows that 10 transformers of type H will reach their expiry date in year 3 (i.e. 3 years from now). Similar entries are shown for the various cohorts of transformers.

10.5.2 Acquisition and Cost Schedule

The expiry schedule of Fig. 10.2 forms a basis for planning a replacement schedule in which some adjustment of the replacement pattern may take place in order to smooth both the replacement workload and the capital requirements. The smoothing process assumes that there will be some latitude for varying the expiry schedule based on asset condition. Technical knowledge of asset condition will be required to confirm whether this is practical. The replacement schedule is not shown separately, but is incorporated into the acquisition and cost schedule shown in Fig. 10.3.

In Fig. 10.3, Row 1 shows the years ahead, which normally would be shown as calendar years. The "Qty" column for each year shows the number of transformers of a given type which are budgeted for replacement in that year. The replacement quantities were initially derived from an expiry schedule, but the results have been smoothed during the planning process, so that, for example, the plan is to replace 11 type H transformers in each of years 3 and 4, rather than 10 in year 3 and 12 in year 5.

The "Cost" column shows the corresponding capital cost for replacement. For example, cell J3 shows a cost of $8,250,000 to be budgeted for replacement of 11 type H transformers in Year 3. The final result from the acquisition and cost schedule will feed into the overall Capital Expenditure Budget.

10.5.3 Application of the Acquisition and Cost Schedule

The resulting acquisition and cost schedule forms a basis for budgeting and acquisition planning. The actual numbers of replacements may in practice vary from

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Item Type	Quantity	Renewal Cost,$k	Year	1	1	2	2	3	3	4	4	5	5	Total
2					Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost	
3	H	10	750		0	0		0	11	8250		0		0	
4	H	12	750		0	0		0		0	11	8250	0	0	
5	K	30	345		0	0		0	28	9660		0		0	
6	K	24	345		0	0		0		0	28	9660		0	
7	K	30	345		0	0		0		0		0	28	9660	
8	M	12	1,250		0	0	12	15000		0		0		0	
9	Totals				0			15000		17910		17910		9660	60480

Fig. 10.3 Acquisition and cost schedule

those planned, but if estimates have been based on sound experience and judgement, the overall numbers of replacements will be approximately correct. The result will be effective management of the assets, which might otherwise have been allowed to run to failure with resulting loss of system reliability and safety.

10.6 Planning Example with Varying Needs

In the previous example, replacements were planned on a one-for-one basis, but in practice there may be variations as changes in capacity requirements result in the population being increased or decreased through time. The following example illustrates this.

A transportation company maintains a vehicle fleet.

Figure 10.4 shows data relating to a particular range of vehicles, for which the unit acquisition cost is $800,000 and the unit disposal cost is $100,000. These unit costs are shown in Row 2. The number of units needed in-service over the next 6 years is shown as “In-Service Need” in Row 4. This number includes a provision for local contingency holdings to cover emergencies. Initially there are 108 vehicles in-service including contingency, and 10 vehicles acquired but not currently deployed, giving a total of 118, shown as the year 1 “Un-augmented qty” at cell B6. Senior management has stated that the number of non-deployed vehicles is to be reduced.

The number of disposals of vehicles over the planning period has been estimated, allowing for aging and condition of the existing items. This is shown in Row 5 as “Disposals end of year”. The problem is to plan the purchase of new vehicles over the 7-year planning period and to estimate the financial capital requirements.

10.6.1 Preplan Gap Analysis

The first step is to carry out a preplan gap analysis. A preplan gap analysis is an analysis of the situation before we plan any acquisitions or other changes. It represents how the situation would unfold if we do nothing. In the example, the gap

	A	B	C	D	E	F	G	H
1	Capacity Planning Example - DATA							
2	Unit Costs $M		Acquisition	0.8		Disposal	0.1	
3	Year	1	2	3	4	5	6	7
4	In-Service Need	108	108	110	112	114	117	120
5	Disposals end of year	2	12	14	10	5	1	1
6	Un-augmented qty	118						

Fig. 10.4 Vehicle planning data

	A	B	C	D	E	F	G	H
1	Capacity Planning Example - PRE-PLAN GAP ANALYSIS							
2	Unit Costs $M	Acquisition		0.8	Disposal		0.1	
3	Year	1	2	3	4	5	6	7
4	In-Service Need	108	108	110	112	114	117	120
5	Disposals end of year	2	12	14	10	5	1	1
6	Un-augmented qty	118	116	104	90	80	75	74
7	Pre-plan Gap	-10	-8	6	22	34	42	46

Fig. 10.5 Gap analysis calculation

between the in-service need and the quantity available after disposals is the *pre-plan gap* this represents the situation before we plan any acquisitions.

The calculations are shown in Fig. 10.5. We first calculate the un-augmented capacity by subtracting the disposals (Row 5) progressively from the initial quantity available (cell B6).

Figure 10.5 Row 6 shows the result. We then calculate the preplan gap by subtracting the un-augmented capacity (Row 6) from the need (Row 4). Row 7 shows the result.

Figure 10.6 shows the preplan gap as a graph, based on the needs (Row 4) and the un-augmented qty available (Row 6). The space between the two lines is the gap, and can be negative (representing a surplus) or positive (representing a shortage). The preplan gap result can assist with acquisition planning. In the example, the minimum total number of vehicles to be acquired over the planning horizon is 46, given in cell H7 of Fig. 10.5. This result can assist us in deciding on an acquisition strategy, for example, we may decide to develop a purchase plan covering all 46 vehicles, from our preferred potential suppliers. We also see that there will not be a positive gap until year 3, and this tells us that we have some lead time in hand.

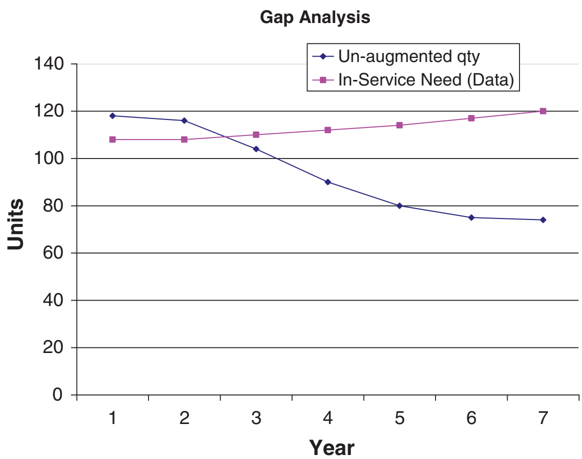


Fig. 10.6 Gap analysis graph

10.6.2 Creating the Purchase Plan

The process for creating the purchase plan for each year across the horizon is as follows. The process is illustrated in Fig. 10.7 and summarized algebraically at the end of this section.

a. Calculate the quantity-before-purchase, that is, the fleet quantity available in the current year before more items are purchased (Row 9 and Eq. 8.3);
b. Calculate the gap-before-purchase, this gives the minimum number to be purchased to cover the gap (Row 10 and Eq. 8.4);
c. Create a purchase plan quantity (Row 11, BOY = Beginning of Year) which may vary from the minimum purchases;
d. Calculate the fleet quantity-after-purchase, (Row 12 and Eq. 8.5);
e. Calculate the cost (Row 17).

10.6.2.1 Planning Steps

The steps in the example are as follows: For year 1 we calculate the quantity-before-purchase and the gap-before-purchase. In year 1, the gap-before-purchase is negative so we decide to make no purchases. In year 2, the gap is also negative so again we make no purchases. In year 3, the quantity-before purchase, is 104 but the In-Service Need is 110, so we get a gap-before-purchase of 6. These vehicles are normally purchased in multiple quantities of about 10. The reason behind the minimum lot size is that we want to avoid having too fragmented a set of assets and also to achieve economies of scale in purchasing. Since our policy is to

	A	B	C	D	E	F	G	H
1	Capacity Planning Example PLANNING: ROWS 9 to 17							
2	Unit Costs $M		Acquisition	0.8		Disposal	-0.1	
3	Year	1	2	3	4	5	6	7
4	In-Service Need	108	108	110	112	114	117	120
5	Disposals end of year	2	12	14	10	5	1	1
6	Un-augmented qty	118	116	104	90	80	75	74
7	Pre-plan Gap	-10	-8	6	22	34	42	46
8								
9	Qty before purchase	118	116	104	100	102	109	118
10	Gap before purchase	-10	-8	6	12	12	8	2
11	Purchase Plan BOY	0	0	10	12	12	10	10
12	Qty after purchase	118	116	114	112	114	119	128
13								
14	Cumul Purchased	0	0	10	22	34	44	54
15	Planned excess	10	8	4	0	0	2	8
16								
17	Capital Reqt $M		0.2	9.2	11	10.6	8.5	8.1

Fig. 10.7 Asset purchase planning

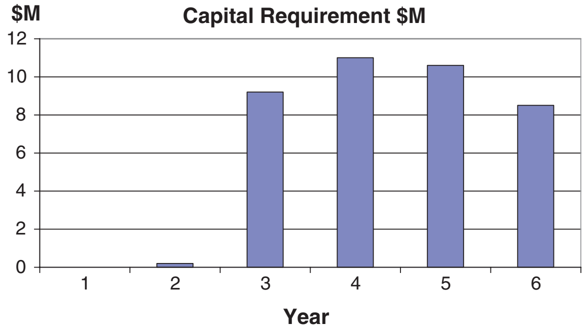


Fig. 10.8 Vehicle purchase capital requirements graph

purchase in lots of at least 10, we plan to purchase 10. The quantity-after-purchase then becomes 114, shown at cell D12.

For year 4, the quantity-before-purchase is found by subtracting the disposals at the end of year 3, and the gap-before-purchase is calculated. This is 12 as shown at cell E10. We then make a purchase plan decision for year 4, and in the example this is for 12 items. The calculations then continue in the same way, with purchase plan decisions being made for each year. As we proceed, the spreadsheet calculates the capital requirement based on the numbers of purchases and disposals and their costs. A graph of the capital requirements year by year is shown in Fig. 10.8.

The spreadsheet format allows us to model a range of data assumptions and plans and to present the corresponding tabular and graphical results.

10.6.2.2 Planning Formulas

The planning process is summarized algebraically as follows.

Let

i year number
N in-service need (Row 4)
D disposal quantity at end of year (Row 5)
$U(i)$ un-augmented quantity (Row 6)
$X(i)$ preplan gap (Row 7)
Q fleet quantity-before-purchase (Row 9)
G gap-before-purchase (Row 10)
P purchase quantity (Row 11)
R fleet quantity-after-purchase (Row 12)

Then for the preplan gap analysis:

$$U(i) = U(i-1) - D(i) \tag{10.1}$$

$$X(i) = N(i) - U(i) \tag{10.2}$$

And for the purchase planning stage:

$$Q(i) = Q(i-1) + P(i-1) - D(i-1) \tag{10.3}$$

$$G(i) = N(i) - Q(i) \tag{10.4}$$

$$R(i) = Q(i) + P(i) \tag{10.5}$$

10.7 Capability Continuity Planning

The process described in this chapter represents a basic approach to the planning of prime equipment requirements and in practice additional work will be required in planning for the continuity of the total capability involved in the sustainment of the assets. Having established the prime asset requirement we continue to plan for the related elements of the capability, and this may cause feedback into the prime equipment plan. In practice, a number of interrelated spreadsheets or similar planning systems will be needed.

10.8 Columnar Format

The analysis can also be carried out in the style indicated by Fig. 10.9. This lists the assets by type and age, and shows the *life of type* or estimated useful life of each group. From this the *year of expiry*, that is, the year by which replacement is needed, can be calculated. In Fig. 10.9 this is shown in relation to "Now" but in practice an actual calendar year would be shown. The acquisition lead time is then entered and we then calculate the year of decision. The *year of decision* is the year in which we must make a decision about replacing the assets in order to acquire their replacements by their year of expiry. The year-of-decision calculation gives an indication of the urgency of the development process.

The analysis proceeds to an asset retirement schedule as illustrated in Fig. 10.10.

Item Type (1)	Qty (2)	Year of Life, (3)	Life of Type, (4)	Year of Expiry, (5)=Now+(4)-(3)	Acquisition Lead Time, years (6)	Year of Decision (7)=(5)-(6)
A	10	13	15	Now+2	2	Now
A	12	11	15	Now+4	2	Now+2
B	30	7	10	Now+3	3	Now
C	24	37	40	Now+3	3	Now
C	30	36	40	Now+4	3	Now+1
D	12	15	15	Now	2	Now-2

Fig. 10.9 Determining year of expiry and year of decision

Item Type	Now	Now+1	Now+2	Now+3	Now+4
A	0	0	10	0	12
B	0	0	0	30	0
C	0	0	0	24	30
D	12	0	0	0	0
E	0	3	15	0	6
F	2	7	3	2	0

Fig. 10.10 Retirement schedule, numbers retiring each year

10.9 Exercises

10.9.1 Continuity Planning

A fleet of five specialized vehicles used in road maintenance was purchased 4 years ago. Their Life of Type is 10 years. Because they are imported and then adapted to local conditions, their acquisition lead time is 2 years. Calculate the following:

a. The year of life of the fleet;
b. Their remaining life;
c. Their year of expiry;
d. Their year of decision;
e. The capital expenditure plan for continuity of the fleet, given a cost of $700,000 2 years prior to entry into service and $300,000 1 year prior to entry into service.

10.9.2 Vehicle Fleet Capacity Exercise

A company currently has 10 trucks. Trucks are sold when they become 7-years old. A forecast of the required number of vehicles to be in-service, and of the projected numbers of disposals year by year, is shown in Fig. 10.11.

Year	1	2	3	4	5	6
Vehicles Required In-Service	10	12	10	12	12	13
Disposals end of year	1	0	2	1	2	1

Fig. 10.11 Projected vehicle demand and disposals

New trucks cost $200,000. Old ones are sold for $15,000. The company policy is to own sufficient trucks to cover “base load” requirements. Shortages can be made up by leasing at $50,000 per truck per year. Capital rationing limits purchases to at most three trucks in any year.

Determine a suitable purchasing and hiring plan. Estimate the cost year by year and calculate the net present value of costs.

10.10 Exercise Solutions

10.10.1 Continuity Planning Solution

a. Year of Life = Current Year − Year of Acquisition + 1 = 4 + 1 = 5.
b. Remaining Life = Life of Type − Year of Life = 10 – 5 = 5 years (beyond current year).
c. Year of Expiry = Current Year (say NOW) + Remaining Life = NOW + 5.
d. Year of Decision = Year of Expiry − Acquisition Lead Time = NOW + 5 − 2 = NOW + 3.
e. Assuming entry into service at start of NOW + 6, CAPEX in NOW + 4 is 5 × $700,000 = $3.5 million and in NOW + 5 is 5 × $300,000 = $1.5 million.

10.10.2 Vehicle Fleet Capacity Exercise

The solution can be developed using the template shown in Table 10.1 Vehicle Fleet Planning Template. BOY means Beginning of Year and EOY means End of Year.

Table 10.1 Vehicle fleet planning template

1. Year, i	1	2	3	4	5	6
2. Vehicles reqd BOY	10					
3. Disposals EOY	1					
4. Number owned BOY before purchase = Row 7 (i − 1) − Row 3 (i − 1)	10					
5. BOY shortage (+) or surplus (−) = Row 2 − Row 4	0					
6. Purchase plan BOY	0					
7. Number owned BOY after purchase = Row 4 + Row 6	10					
8. Lease reqt BOY = Row 2 − Row 7						
9. Lease cost = Row 8 × $50 k						
10. Capital cost = Row 6 × $200 k − Row 3 × $15 k	−15					
11. Total $k	−15					

Table 10.2 Vehicle fleet planning solution

1. Year, i	1	2	3	4	5	6
2. Vehicles reqd BOY	10	12	10	12	12	13
3. Disposals EOY	1	0	2	1	2	1
4. Number owned BOY before purchase = Row 7 (i − 1) − Row 3 (i − 1)	10	9	10	8	10	10
5. BOY shortage (+) or surplus (−) Row 2 − Row 4	0	3	0	4	2	3
6. Purchase plan BOY	0	1	0	3	2	2
7. Number owned BOY after purchase = Row 4 + Row 6	10	10	10	11	12	12
8. Lease reqt BOY = Row 2 − Row 7	0	2	0	1	0	1
9. Lease cost = Row 8 × $50 k	0	100	0	50	0	50
10. Capital cost = Row 6 × $200 k − Row 3 × $15 k	−15	200	−30	585	370	385
11. Total cost $k	−15	300	−30	635	370	435

Notes

a. A rolling plan will be reviewed annually

b. Capital costs are smoother if approximately the same number of vehicles bought each year, but this can have the disadvantage that the fleet is made up of many different models

c. Leasing is usually more expensive than owning in terms of costs per vehicle leased, but…

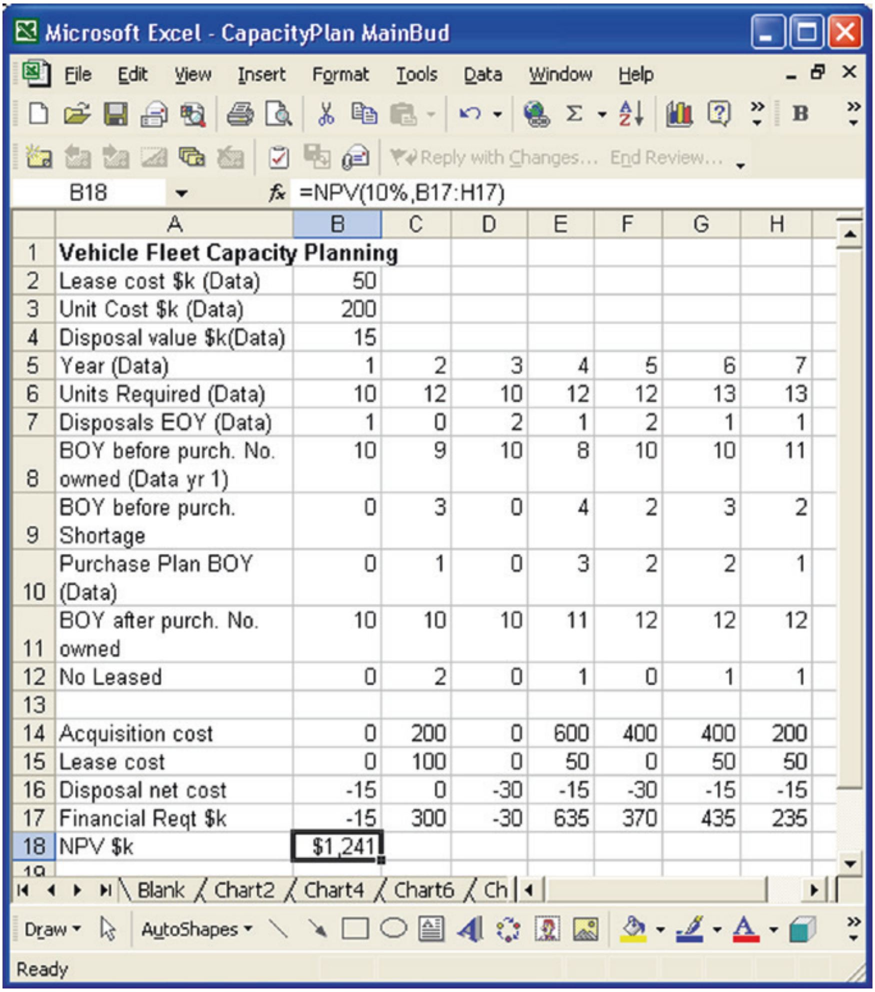
d. Leasing costs are an expense which is tax deductible in the current year

e. Leasing gives more flexibility in responding to changes in demand, particularly downturns; there is more downside liquidity

f. If demand is up, revenue will be up and the extra cost of leasing will be affordable

The analysis can be carried out using the following steps:

1. Calculate the number of vehicles which will be owned at the end of the year after disposals, but before purchases. Row 4.
2. Compare this with the number required next year, to check for a potential shortage. Row 5.
3. Decide how many to buy, if any, make up the rest of any requirement with leasing. Row 6, Row 8.
4. Calculate costs. Rows 9–11.



	A	B	C	D	E	F	G	H
1	**Vehicle Fleet Capacity Planning**							
2	Lease cost $k (Data)	50						
3	Unit Cost $k (Data)	200						
4	Disposal value $k(Data)	15						
5	Year (Data)	1	2	3	4	5	6	7
6	Units Required (Data)	10	12	10	12	12	13	13
7	Disposals EOY (Data)	1	0	2	1	2	1	1
8	BOY before purch. No. owned (Data yr 1)	10	9	10	8	10	10	11
9	BOY before purch. Shortage	0	3	0	4	2	3	2
10	Purchase Plan BOY (Data)	0	1	0	3	2	2	1
11	BOY after purch. No. owned	10	10	10	11	12	12	12
12	No Leased	0	2	0	1	0	1	1
13								
14	Acquisition cost	0	200	0	600	400	400	200
15	Lease cost	0	100	0	50	0	50	50
16	Disposal net cost	-15	0	-30	-15	-30	-15	-15
17	Financial Reqt $k	-15	300	-30	635	370	435	235
18	NPV $k	$1,241						

Fig. 10.12 Vehicle fleet planning—excel solution

The results are shown in Table 10.2 Vehicle fleet planning solution and Fig. 10.12.