CHAPTER 7 - Strategic options generation

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7.9 Life Cycle Costing

Active reading. Note why life cycle costing has become more relevant in today's business environment. Think about what drives its use. Is it the changing business environment, the increased focus on sustainability that includes disposal and recycling in a product life cycle, or the need to recover the investment in developing new products?

7.9.1 Why life cycle costing?

One of the key strategic options available to organizations to sustain a competitive advantage is product development. It can encompass modifications to existing products, for example, adding cameras to cell phones, as well as developing entirely new products. The speed of developments in technology, an increased degree of competition, changing consumer demands, and a heightened awareness of sustainability means that product development is becoming an essential aspect of business strategy. The implication being that resources need to be allocated to activities such as research and development, design, and marketing research. These activities can often be viewed as separate and devoiced from the manufacturing and selling process, and the associated costs become lost in the accounting period in which they are incurred.

Accounting systems are good at recording revenues and costs during the normal operating cycle of a business. Costs are typically assigned when they are incurred and reported in periods, such as monthly, quarterly, or annually. These are usually reported against the revenue generated from the sale of products or provision of the services, within the same period. The primary purpose is to identify the profit or loss.

This practice establishes a relationship between the cost of sales, or service provision, and revenue generation. There is a danger that the costs of initial development, design, pre-production, and costs of disposal at the end of a product's useful life are either forgotten, not considered, or at best marginalized in consideration of the profit or loss generated by the product. When making pricing decisions, it is easy to identify the direct product costs in production, traditionally materials, labor, and machine time, then add on an element for overheads, perhaps via activity-based costing methods, and determine a selling price. Many of the decisions, however, that impact on the product costs during manufacture, distribution, and servicing of a product are made before the production stage.

When considering the overall success of a product, however, it is common to look for a return on investment, where the investment does indeed include the initial development, design, and pre-production costs. These costs are becoming more significant for many businesses as product life cycles are shortening due to the speed of developments in technology and the increased degree of competition. Shorter product life cycles make constant innovation and product development a critical success factor in many business sectors. The concept of life cycle costing suggests that considering the costs of the complete product life cycle from the cradle to the grave, or cradle to cradle, if we consider recycling after use, can provide additional benefits to the organization, particularly in the activities of new product development, affordability studies, source selection, and repair or replace decisions.

7.9.2 What is life cycle costing?

Active reading. Note the cradle to cradle concept. Think about how life cycle costing and target costing can work together, and at which points in the product life cycle costs can be controlled.

Life cycle costing is not a new concept. A definition was provided in 1976 that suggested: "the life cycle cost of an item is the sum of all funds expended in support of the item from its conception and fabrication through its operation to the end of its useful life" (White and Ostwald, 1976: 39). We could extend this definition to explicitly include the cost of recycling materials from the product following the end of its useful life. The typical stages are illustrated in Figure 7.5.

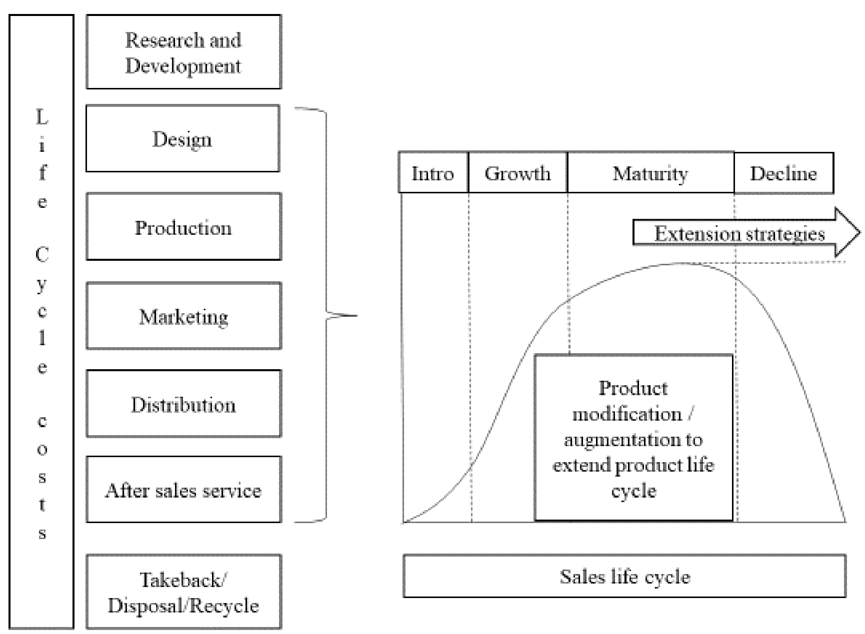

Figure 7.5 Life cycle costs

The life cycle costs include all costs incurred from the initial concept emerging from the research and development process to the recycling of materials at the end of the product's useful life. The diagram in Figure 7.5 also illustrates that modifications may be made to the initial design during a product's life. These modifications often take place during the mature phase of the sales life cycle as competition moves away from price towards product features, and companies adopt extension strategies to prolong the product and sales life cycle. It may not be possible to anticipate the additional functionality and modifications at the initial design phase. Still, there needs to be a recognition that the concept of life cycle costing should be considered when making product modifications, just as much as at the initial new product development stage.

The key phases where costs are incurred in the development of the product and its sales life cycle are illustrated in Figure 7.6. The duration, timing, and degree of overlap of these are dependent on the actual product or modification being developed, but they are useful headings under which to categorize the costs for planning and monitoring purposes. There may even be an element of ongoing consumable costs beyond the initial purchase. For example, a coffee maker such as the Nespresso machine where consumers purchase the machine, then purchase the consumable coffee capsules, which can be returned to a Nespresso recycling point after use. This creates an ongoing recycling cost as well as production costs.

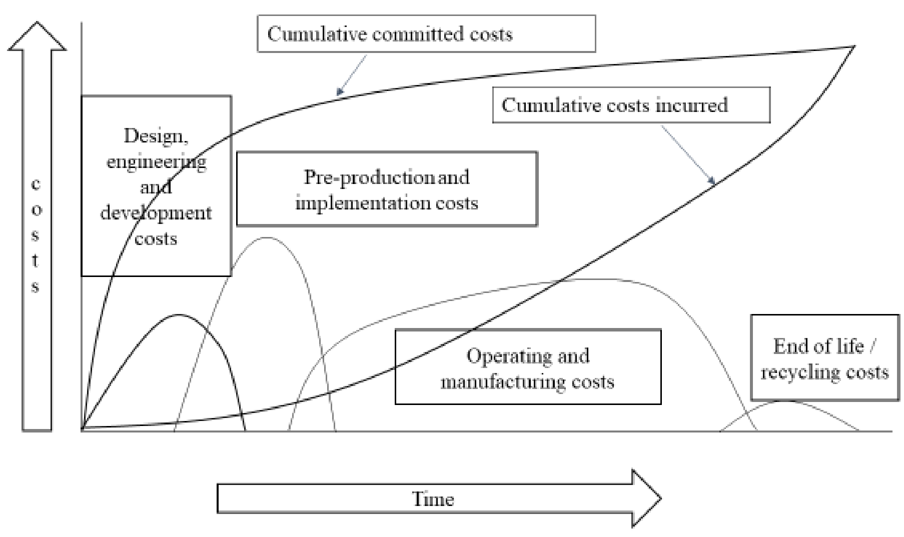

Figure 7.6 Stages in the life cycle costs

Recognizing the different categories of costs allows a trade-off between costs to be considered, for example, between design and manufacture. This categorization of costs also considers the fact that many costs are committed before they are incurred, for example, decisions about materials, the production process, product features, and so on, are made before commencement of manufacture. These costs can be up to 70-90 percent of the total product costs (Bescherer, 2005). The point here is that these costs are typically recorded and reported during the manufacturing phase, and therefore unless considered beforehand, can create surprises for management. The need to be aware of future costs is also relevant for the end of life costs, which are now becoming a key part of product development due to the increased awareness of sustainability issues.

Life cycle costing is connected to other concepts and techniques, for example, the use of target costing. Once the target cost is identified, which is derived from deducting the desired profit from the selling price (Garret, 2018), all phases of the life cycle can be considered in achieving the target cost. The concept is also widely used in the building and construction industry and found in the defense industry and the state sector (Woodward, 1997).

Life cycle costing is not confined to the design and development of new products, but include affordability studies, for example investigating the cost of acquiring and operating a building; source selection studies, for example, between different vendors or products; evaluating alternative operational decisions, such as whether to take out an extended warranty or simply repair or replace.

These uses recognize that life cycle costing can be used from different perspectives. For example, in new product development, it is being used from the perspective of the manufacturer, but in the selection of alternative suppliers and purchase options, it is being used from the perspective of the client.

7.9.3 Life cycle costing and new product development

Active reading. Think about the functions that need to work together to develop and successfully launch new products.

The new product development process is shown in Figure 7.7. This process illustrates that there are many costs and activities, other than product costs, that go into developing a commercially successful product or service.

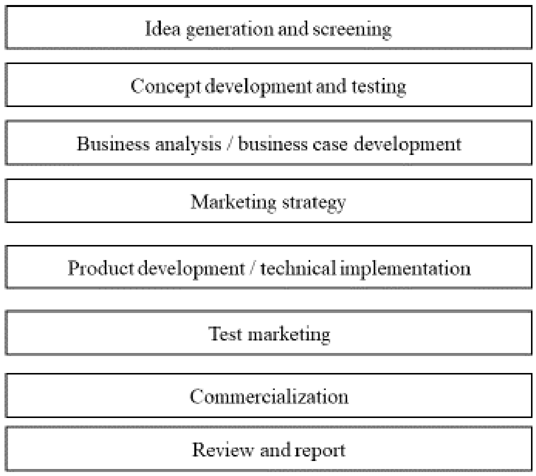

Figure 7.7 New product development phases

The life cycle costs begin during the idea generation and screening stage. It is worth taking a few moments to consider the activity of research and development. The accounting treatment of research and development costs is dealt with under the accounting standards. IAS 38 – Intangible assets. The standard defines the parameters for when development costs may be capitalized and written off over the expected commercial life of the asset. For the purposes of life cycle costing, we should recognize that organizations, such as pharmaceutical companies, may undertake two basic types of research – pure and applied research.

Pure research could be described as research that is undertaken with no real commercial product in mind but is undertaken to further knowledge and understanding. This research may or may not generate future revenue. It is usual practice to write this off in the year in which it is incurred. Applied research, however, is closer to development costs in that it seeks to solve a specific problem. The development costs include, for example, where a car manufacturer undertakes design, development, construction of a prototype, testing, and pre-production activities. These should all be treated as part of the life cycle costs and, if within the scope of IAS 38, could be written off over the commercial life of the product.

Consideration of the life cycle costs becomes highly significant during the development of the business case, marketing strategy, and commercialization of the product. Marketing research is required to establish whether there is a potential market of the product, what features and functionality consumers desire, and the price they would be prepared to pay for such a product.

Other techniques, such as target costing, may also be highly relevant. Target costing is where the market price, or the price at which consumers would be prepared to purchase the product, is established, and the required profit deducted, which derives the target cost. The derived cost then has implications for product design, development, manufacture, logistics, and takeback/recycling, to be able to develop a viable product that will sell in the market.

When determining where savings in cost can be made, the whole of the life cycle costs can be considered. In fact, the whole of the supply chain may need to be considered. For example, to encourage retailers to stock a particular product, they need to know that an acceptable level of profit per square centimeter can be achieved. This requirement has implications for product size, packing, ease of handling, transportation, storage, and so on. All these factors need to be considered, as well as the wants and needs of the end consumer.

The principle behind target costing is that the starting point is the price to the end consumer. If the old approach of making a product and adding a profit mark-up to the cost is adopted, this may mean that the initial price is too high to attract consumers. Even for new innovative products that are breaking new ground, creating a product that presents an attractive market proposition to consumers is a critical element of a product's success. As the new product increases in sales volume, the average cost per unit will reduce. Therefore, target costing is as much about establishing a price that will be profitable when a certain volume is reached, which considers economies of scale and the effects of the experience curve. Where products are manufactured by a company that then sells to intermediaries, who then sell to end retailers, this means that the costs throughout the whole of the supply chain need to be considered, and are of course, open to consideration in achieving the target price.

Manufacturers need to think in terms of the costs from the cradle to the grave rather than just cradle to gate, where traditionally, once the product had left the factory gate, it became someone else's problem. The cost incurred in transportation, storage, and handling through the supply chain by all intermediaries needs to be considered. Indeed, with sustainability in mind, the concept of carbon miles in transporting the product, and the importance of being able to recycle a high proportion of the products materials after use, indicate that the consideration of costs should be from cradle to cradle.

Table 7.1 provides an example of a life cycle cost report for the introduction of a new vacuum cleaner. This example is the case of a manufacturer that sells direct to the public.

Table 7.1 Life cycle cost calculation for a vacuum cleaner

Sales quantity in units	5,000	7,500	10,000	7,250
Probability	0.3	0.5	0.2	most likely
	$	$	$	$
Selling price per unit	300	280	250	280
Cost information per unit				
Direct product costs	100	100	100	100
Distribution costs	20	20	20	20
Customer service costs	50	50	50	50
Takeback and recycling costs	10	10	10	10

	$	$	$	$
Life cycle revenues	1,500,000	2,100,000	2,500,000	2,030,000
Life cycle costs				
R & D costs	200,000	200,000	200,000	200,000
Design costs	80,000	80,000	80,000	80,000
Pre-production costs	100,000	100,000	100,000	100,000
Direct costs of production	500,000	750,000	1,000,000	725,000
Fixed costs of production	250,000	250,000	250,000	250,000
Distribution costs	100,000	150,000	200,000	145,000
Customer service costs	250,000	375,000	500,000	362,500
Takeback and recycling costs	50,000	75,000	100,000	72,500
Total life cycle costs	1,530,000	1,980,000	2,430,000	1,935,000
Life cycle profit/(loss)	(30,000)	120,000	70,000	95,000
% of sales revenue	(2.0%)	5.7%	2.8%	4.7%
Life cycle cost per unit	$306	$264	$243	$267

The above example does not take account of the time value of money. The analysis could be undertaken using the net present value technique of discounting the cash flows in each year by a suitable discount factor. Other factors, such as inflation, can also be considered. It does take account of the volume effect on fixed cost recovery but does not take account of a learning curve effect, where some costs of manufacture may reduce per unit, as experience of the manufacturing process is built up.

Additional levels of sophistication can be added to the basic model, such as introducing probabilities to the cost estimates. For example, likely repair costs could be estimated based on the experience of failure rates. Each category of cost can be broken down into more elements than is shown in the example.

7.9.4 Life cycle costing and building and construction projects

Active reading. Think of industry sectors where life cycle costs relating to buildings might be appropriate. For example, supermarkets develop new sites and buildings; universities create new facilities on their campuses; football clubs build sports stadia.

Life cycle costing is used in the building and construction industry. The costs of a building are more than just the construction costs but include the operating or running costs. Energy is a significant element of the running costs, so decisions about energy usage over the life of the project can add significantly to the life cycle costs of a building. Similarly, aspects such as the need for, and ease of maintenance and repair, over the building's life can have an impact on the overall cost. Trade-offs in the cost of materials and maintenance and repair costs are important considerations at the design stage in determining life cycle costs.

Life cycle costing is useful in real estate management when considering alternative buildings. It is highly effective in determining the costs of facility ownership (Fuller and Petersen, 1995). Figure 7.8 illustrates the typical cost categories that should be considered.

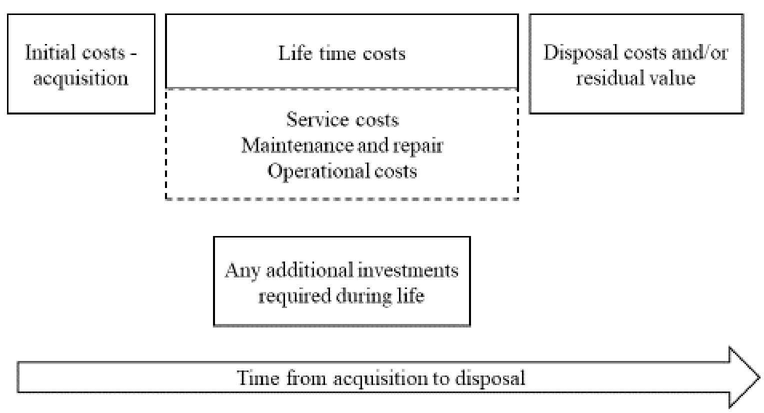

Figure 7.8 Affordability of building decision costs

7.9.5 Life cycle costing and comparison and affordability studies

Active reading. Manufacturing organizations frequently invest in plant and equipment where there is a choice of alternative suppliers. Why is it important that the investment appraisal is undertaken using the principles of life cycle costing?

Life cycle costing is also a useful tool when comparing products and vendors, for example, where a company has a choice between two different machines that can be used to manufacture its products. The comparison should be undertaken using the principles of life cycle costing, considering running costs, and repair and maintenance costs. This concept is easy to envisage when considering fleet management costs for a delivery company. Not only is there the buy or lease decision and the capacity of logistical space (that is the size of the vehicles), but within that, the running costs, estimated residual values, annual mileage, and replacement policy.

Tables 7.2 – 7.4 illustrates the comparison of a choice between two machines. Machine A can be purchased in the U.K., but a less expensive version can be bought from Asia. The costs of delivery and installation are higher for the machine sourced from Asia. However, the purchase price and delivery and installation in total are still less than the U.K. option. The following information has been gathered about both machines by consulting internal data and the technical specification provided by the manufacturers.

Table 7.2 – Basic data for machine comparison

	Machine A	Machine B
Cost item		
Product price	$210,000	$200,000
Equipment life	3 years	3 years
Delivery and Installation cost	$2,000	$6,500
Operating labor requirement	1 man	1 man
Labor hour rate	$10/hr	$10/hr
Operating hours per day	8	8
Annual operating days	200	200
Preventative maintenance cycle time	500 hrs	100 hrs
Preventative maintenance downtime	2 hrs	3 hrs
Average time between failures	1,500 hrs	500 hrs
Average time to repair	8 hours	36 hours
Maintenance labor rate	$15/hr	$15/hr
Parts and supplies cost	1% of purchase price	1.5% of purchase price
Power requirement per hour	9.0 kwh	12 kwh
Cost per kwh	$0.15	$0.15

Table 7.3 Workings of running costs

Workings		
Operating labor costs (200 days x 8 hrs x 1 man x £10 per hr x 3 years)	**$48,000.00**	**$48,000.00**
Total operating hours	4,800.00	4,800.00
Preventative maintenance cycle	500.00	100.00
Number of cycles	9.60	48.00
Preventative maintenance hours	19.20	144.00
Cost per hour $	15.00	15.00
Cost of preventative maintenance	**$288.00**	**$2,160.00**
Total operating hours	4,800.00	4,800.00
Corrective maintenance cycle	1,500.00	500.00
Number of cycles	3.20	9.60
Corrective maintenance hours	25.60	345.60
Cost per hour $	15.00	15.00
Cost of corrective maintenance	**$384.00**	**$5,184.00**
Power		
Operating hours	4,800.00	4,800.00
Kw per hour	9.00	12.00
Number of kwh	43,200.00	57,600.00
Cost per kwh $	0.15	0.15
Cost of power	**$6,480.00**	**$8,640.00**

Table 7.4 Comparison of machines

	$	$
Product price	210,000	200,000
Installation cost	2,000	6,500
Operating labor costs	48,000	48,000
Preventative maintenance	288	2,160
Corrective maintenance	384	5,184
Power requirements	6,480	8,640
Parts and supplies cost	2,100	3,000
Total life cycle cost	269,252	273,484

The total cost of the machines can be compared. Over the three-year life cycle, the cost of the machine from Asia is slightly more expensive. As with the example in Table 7.1, the costs involved could be undertaken using a net present value approach if the timing of cash flows is significantly different between the two options. The closeness of the comparison illustrates that the overall financial aspect is only one element of vendor selection.

7.9.6 Methods of determining life cycle costs

Active reading. Note that life cycle costs deal with costs into the future, and therefore, a degree of estimation is required. Also, note that organizations that have a program of developing new products will gain experience and become better at forecasting and estimating costs. The use of sensitivity analysis is always good practice.

Several methods can be used to determine life cycle costs (Fabrycky and Blanchard, 1991). As with every other decision that potentially has a long-time frame, there is a degree of estimation required, and therefore sensitivity analysis on the estimates should always be carried out. Techniques such as net present value calculations are also highly relevant as future costs and revenues, if appropriate, need to be converted to common values for comparison of alternatives, and present values are a suitable means of doing this.

Deterministic

A deterministic approach is where a detailed analysis is undertaken, and the actual cost of each element is costed. While this might be the most accurate means of conducting the analysis, it is dependent on being able to obtain sufficiently accurate information on which to base the calculation of cost. Collecting the data involves working closely with all the functional staff involved in the life cycle of a product, such as design and production engineers, operations and logistical staff, and marketers, as well as potentially gathering figures from external stakeholders, such as suppliers, intermediaries, and end retailers.

Estimation by analogy

In cases where new products have similar elements to other products which the company has experience of, the cost information of similar products can be used to estimate the likely costs of the new product. This method uses the previous experience of the company and, in some industries where new product development is a key to organizational success, a body of expertise can be built up that provides the basis of reasonable estimates.

Stochastic – probabilistic approach

To account for the risk aspect, and the fact that many costs are estimated, probabilities can be applied to the costs to create expected values. Previous experience can be used to generate statistical analysis. For example, failure rates, learning curve effects, and so on, can be calculated based on past products and used to help the life cycle costs of new products. Also, the degree of accuracy of previous estimates over the actual costs incurred can be monitored to build up experience of the costs of activities involved and be applied to future cost estimates.

7.9.7 Benefits of life cycle costing

Active reading. Think about how decisions involving life costing aid the development and implementation of the strategy.

The key benefits of using life cycle costs include:

Greater transparency of future costs

Life cycle costing forces a consideration of all the costs incurred through the whole of the supply chain at the development and design stages. It provides the opportunity to open the negotiations early in the process to ensure that all parties add value to the consumer and make a profit.

Encourages cooperation through the supply chain

Life cycle costing encourages companies to work together through the supply chain. For example, decisions taken at the design stage can have an impact on the handling costs of retailers and, thus, the end price to the consumer. It provides a much better understanding of the costs and the consequences of decisions made within the supply chain by all parties, and the potential effect on the attractiveness of the sales proposition to the end consumer.

Improved awareness of total costs

Life cycle costing also ensures that there are no surprises later in the product's life cycle. For example, factors such as the expected life of the product components, and the ease and costs of repair need to be considered. The reliability and maintenance issue can influence the length of the manufacturer's guarantee offered and subsequent costs under warranty claims that could emerge a long time after the initial purchase.

Performance versus cost

Life cycle costing, particularly if used in conjunction with target costing, can aid decisions concerning any necessary trade-offs of performance versus cost. It is always important to consider the requirements of the end customer to reduce the danger of taking away features or functions that reduce costs, but also remove the reason why the product is attractive to the end consumer. Therefore, market research is a crucial part of new product development to ensure that the product does what it is supposed to do, and indeed, performs as the consumer expects, so that it remains an attractive sales proposition.

Better forecasting

Life cycle costing provides a better understanding of costs such that future costs can be anticipated, but also, as experience is gained of life cycle costing, estimates can be made based on previous experience, which will, in turn, improve the accuracy of the forecasts.

Ability to plan for future resources

Understanding the stages of the product's life cycle facilitates the planning and provision of the necessary resources and, allied to better forecasting, to plan for the cost of these resources in advance.

Aids pricing decisions

Understanding the life cycle costs aids the pricing decision. Techniques such as activity-based costing are beneficial in the pricing decisions, but only if the total costs are considered. Ideally, for a product to be successful, all parties in the supply chain need to be able to make a profit. Therefore, it is essential that the total costs, including the effect of volume, are taken into account when setting the price. If life cycle costing is used in conjunction with target costing, it means that the whole of the supply chain can be used to look for potential savings in cost. Often the savings are looked for in the design or manufacturer of the product, but considering alternative methods to distribute the product, or reducing handling costs through packaging design, or thinking of the sustainability aspects and reducing the cost of recycling materials at the end of the products life, can all be taken into account.

Sustainable development

Life cycle costing encourages a cradle to cradle approach and ensures that the cost of recycling and end of life costs are considered at the initial phases of a product's life.

Evaluation of competing outcomes

In cases where there are alternative options, life cycle costing provides the basis for a decision to be made based on the total life cycle costs, rather than just an element of costs, such as initial purchase price.

7.9.8 Considerations in implementing life cycle costing

Active reading. Note the practical implications of using techniques such as life cycle costing. Forewarned is forearmed, so think how they can be overcome by the way the technique is implemented.

Time-consuming and resource-intensive

If detailed cost estimates are to be obtained for every stage of the product life cycle, it adds more time to the new product development process, particularly if third parties in the supply chain are to be involved.

Accuracy of data

It is always difficult to estimate future costs, particularly in instances where there is no track record or no similar experience, on which the estimates can be based. This uncertainty means that some form of sensitivity analysis or application of probabilities is required. Estimation by analogy based on previous experience can help to alleviate some of the issues surrounding the accuracy of data.

The difficulty of estimating demand and hence unit costs

The impact of the volume is also difficult to estimate, which puts a high degree of reliance on marketing estimates of the likely demand, particularly in cases where there is a significant impact on costs in terms of economies of scale and experience curve effects.

Technology changes

Estimating costs over the lifetime can be difficult enough, but also anticipating technology changes that might impact on the costs of production can be almost impossible to forecast. Technology changes illustrate why life cycle costs need to be revisited during the product life cycle as changes occur. Consider the case of software products that are invariably now supplied online instead of via a physical disk, or books that are currently available as e-books, as well as a hard copy. In these cases, the technology has changed the delivery method, reduced the need to hold inventory, and impacted on the production costs, and indeed, potentially changed the nature of the product.

Pricing

The life cycle costs can have an impact on the price, for example, the increased demand for sustainability to be designed into products may have implications for pricing as to who pays for the recycling of materials at the end of the products life. The need to sell at a price that covers the costs makes it essential to use target costing in conjunction with life cycle costing as the start point for target costing is the acceptable market price.

Performance management

Understanding the life cycle costs can provide the basis for performance management. Budgets will often be set based on the estimates made at the business case stage of the new product development process and refined at the commercialization stage. Monitoring of the actual costs, growth patterns based on the marketing strategy, and general performance of the product, will not only provide a platform for assessing performance but build up a databank of information on which to draw when estimating the life cycle costs of other future products. The organization must monitor performance to learn how it can improve in the future.

Decision making

Life cycle costs can have implications for decisions other than just new product development. For example, make or buy decisions, purchase or lease, affordability, comparison of products and vendors, can all benefit from the technique of life cycle costing.

Learning activity.
The following information is provided for product X. Calculate the profit or loss for each level of projected sales volume and the most likely outcome.

Sales quantity in units	1,000	2,000	3,000
Probability	0.3	0.5	0.2
Selling price per unit	$200	$180	$150
Cost information per unit	$		
Direct product costs	50		
Distribution costs	10		
Customer service costs	15		
Takeback and recycling costs	5		
R & D costs	10,000		
Design costs	15,000		
Pre-production costs	20,000		
Production overheads	50,000		

Solution

Sales quantity in units	1,000	2,000	3,000	1,900
Probability	0.3	0.5	0.2	most likely
	$	$	$	$
Selling price per unit	200	180	150	180
Cost information per unit				
Direct product costs	50	50	50	50
Distribution costs	10	10	10	10
Customer service costs	15	15	15	15
Takeback and recycling costs	5	5	5	5

	$	$	$	$
Life cycle revenues	200,000	360,000	450,000	342,000
Life cycle costs				
R & D costs	10,000	10,000	10,000	10,000
Design costs	15,000	15,000	15,000	15,000
Pre-production costs	20,000	20,000	20,000	20,000
Direct costs of production	50,000	100,000	150,000	95,000
Production overheads	50,000	50,000	50,000	50,000
Distribution costs	10,000	20,000	30,000	19,000
Customer service costs	15,000	30,000	45,000	28,500
Takeback and recycling costs	5,000	10,000	15,000	9,500
Total life cycle costs	175,000	255,000	335,000	247,000
Life cycle profit/(loss)	25,000	105,000	115,000	95,000
% of sales revenue	12.5%	29.2%	25.6%	27.8%
Life cycle cost per unit	175	128	112	130