Life Cycle Costing

Introduction

One of the key strategic options available to organisations to sustain a competitive advantage is product development. This can encompass modifications to existing products, for example, adding cameras to cell phones, as well as developing completely 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 a key 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 time 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 main purpose being 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 products useful life are either forgotten, not considered, or at best marginalised 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, labour, and machine time, 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 during use, are made prior to 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 aforementioned speed of developments in technology and the increased degree of competition, making 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 cradle to grave, or cradle to cradle, if we consider the recycling after use, can provide additional benefits to the organisation, particularly in the activities of new product development, affordability studies, source selection, and repair or replace decisions.

Life cycle costing – a definition

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, p.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 1.

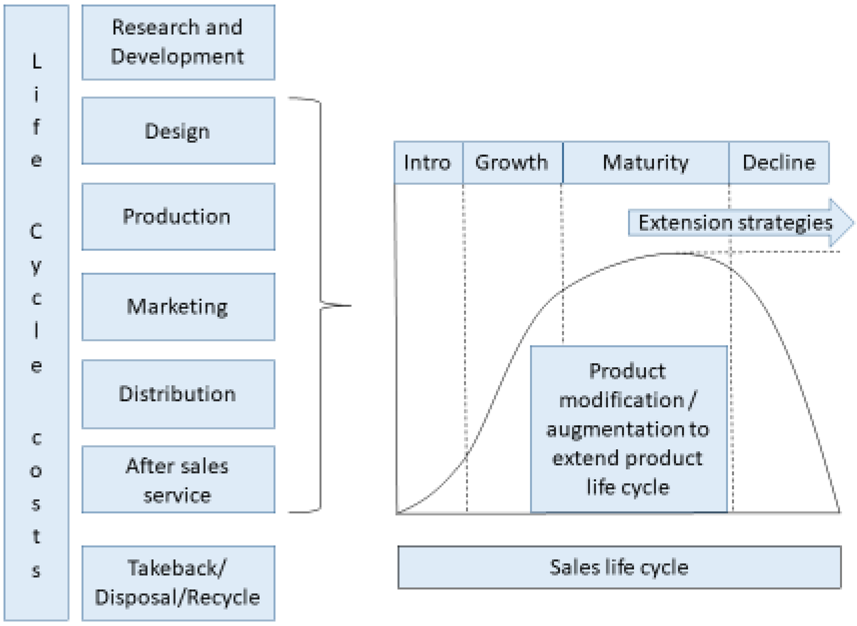

Figure 1 – Life cycle costs

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 products useful life. The diagram in Figure 1 also illustrates that modifications may be made to the initial design during a products life. This often takes 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. Consider, for example, how the mobile cell phone has developed from a device that made telephone calls to be the product it is today, and the business sectors that have developed because of the device. It may not be possible to anticipate the additional functionality and modifications at the initial design phase, but 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 2. 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 categorise 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 cost.

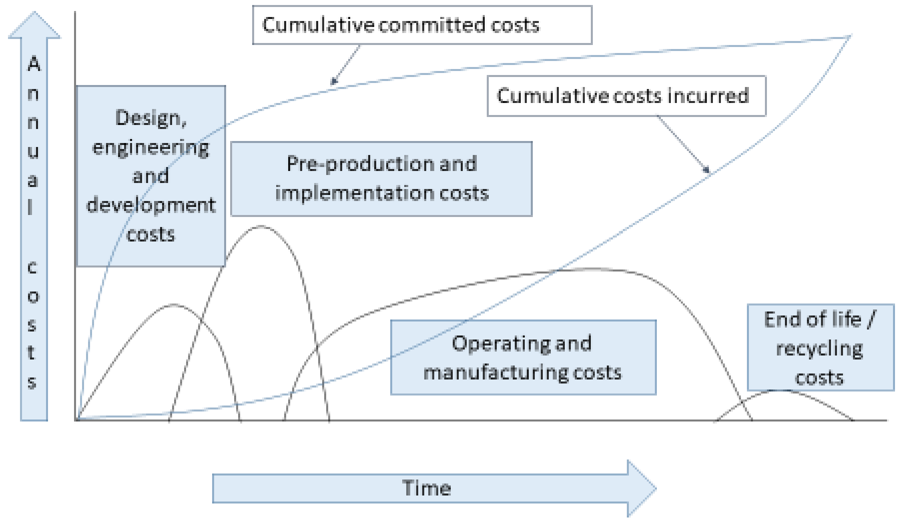

Figure 2 – Stages in life cycle costs

Recognising the different categories of costs allows trade off between costs to be considered. For example, between design and manufacture. This also takes into account 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 prior to commencement of manufacture. This 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. This is also true of 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 (Garrett, 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 also found in the defence industry and state sector (Woodward, 1997). Life cycle costing is not confined to the design and development of new products, but include uses in 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 recognise 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.

New product development

The new product development process is shown in Figure 3. This illustrates that there are many costs and activities, other than product costs, that go into developing a commercially successful product or service.

Figure 3 – 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, defines the parameters for when development costs may be capitalised and written off over the expected commercial life of the asset. For the purposes of life cycle costing we should recognise that organisations, 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 in order to further knowledge and understanding. This research may or may not generate future revenue. It is normal 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 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 commercialisation of the product. Marketing research is required to establish whether there is a potential market of the product, what features and functionality consumer's desire, and the price they would be prepared to pay for such a product.

Techniques such as target costing may also be highly relevant. This 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. This then has implications for product design, development, manufacture, logistics and takeback/recycling, in order 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 taken into account. In fact, the whole of the supply chain may need to be considered. For example, in order to encourage retailers to stock a certain product they need to know that an acceptable level of profit per square centimetre can be achieved. This 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 key element of a products success. As the new product increases in sales volume the average cost per unit will reduce, and 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 cradle to 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 need 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, indicates that the consideration of costs should be from cradle to cradle.

Table 1 provides an example of a life cycle cost report for the introduction of a new vacuum cleaner. This is the case of a manufacturer that sells direct to the public.

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

Table 1 – Life cycle cost calculation for a vacuum cleaner

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 taken into account.

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 past experience of failure rates. Each category of costs can be broken down in to more constituent parts than is shown in the example, and to take account of fixed and variable elements.

Building and construction life cycle costs

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 high 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 buildings 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 effect in determining the costs of facilities ownership (Fuller and Petersen, 1995). Figure 4 illustrates the typical cost categories that should be considered.

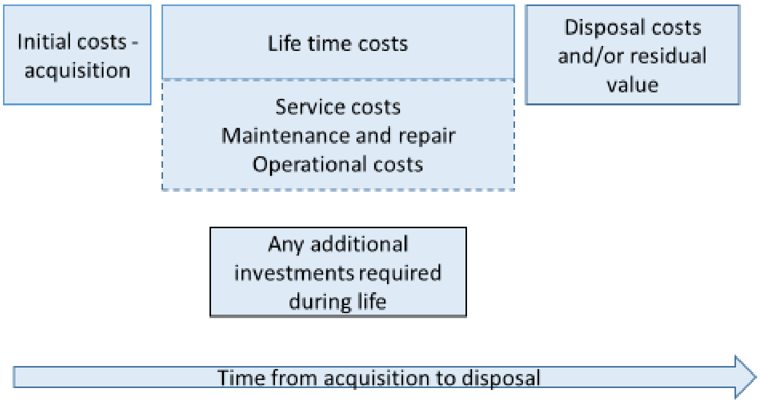

Figure 4 – Affordability of building decision costs

Comparison and affordability studies

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, taking into account 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.

Table 2 illustrates the comparison of a choice between two machines. Machine A can be purchased in the UK, but a less expensive version can be purchased from Asia. The costs of delivery and installation are greater for the machine sourced from Asia, but the purchase price and delivery and installation in total is still less than the UK option. The following information have been gathered about both machines, by consulting internal information and the technical specification provided by the manufacturers.

	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 labour requirement	1 man	1 man
Labour 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 labour rate	£15/hr	£15/hr
Parts and supplies cost	1% of purchase price	1.5% of purchase price
Power requirement per hour	9.0 kw	12 kwh
Cost per kwh	£0.15	£0.15

	£	£
Product price	210,000	200,000
Installation cost	2,000	6,500
Operating labour 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

Table 2 – Comparison of machines

(See appendix A for workings)

It can be seen that 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 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.

Methods

There are several methods that 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 an appropriate means of doing this.

Deterministic

A deterministic approach is where a detailed analysis is undertaken, and the actual cost of each element is costed. Whilst this might be the most accurate means of undertaking the analysis, it is dependent on being able to obtain sufficiently accurate information on which to base the calculation of cost. This 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 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 for which the company has experience, the cost information of similar products can be used to estimate the likely costs of the new product. This utilises the previous experience of the company and, in some industries where new product development is a key to organisational success, a body of experience 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 utilised to generate a statistical analysis. For example, failure rates, learning curve effects, and so on, can be calculated based on previous 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.

Benefits

The key benefits from 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. This 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. This 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. This in turn can influence the length of the manufacturers 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 key 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 to 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 products 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 and therefore it is important that the total costs, including the effect of volume, are taken into account when setting the price. If used in conjunction with target costing using life cycle costing 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 products 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.

Drawbacks

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 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.

Difficulty of estimating demand and hence unit costs. The impact of volume is also difficult to estimate. This places 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 life time can be difficult enough, but also anticipating technology changes that might impact on the costs of production can be almost impossible to forecast. This illustrates 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 now available as e-books, as well as 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.

The implications of using life cycle costing.

Pricing. The life cycle costs will impact on the price, particularly if used in conjunction with target costing. 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.

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 commercialisation 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 estimated the life cycle costs of other future products. It is important that the organisation monitors performance for the purposes of learning 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.

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Appendix A

Workings for table 2 – Machine comparison

Operating labour costs	£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