CHAPTER 12

Making Relevant Financial Decisions about Technology in Education

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INTRODUCTION

This chapter shows how *relevant costs* can be used by managers in educational institutions like universities, or related sub-units like computer services, to make more informed financial decisions about the use of technology. *Fixed* and *variable* cost behaviours are described, as well as the nature of *cost-volume-profit analysis* and how it is used to predict net revenue for a given level of services or production. *Time value of money* (present value) concepts and the effect of time horizons on planning and investment decisions are introduced. Finally, the means to cost services through *time-driven, activity-based costing* is described.

DIRECT AND INDIRECT COSTS

Cost objects are items for which a separate measurement of costs is desired. They are usually measured in a currency like dollars. In an online learning environment, cost objects can be courses, registration services, projects, students, departments, or academic programs.

Direct costs can be associated with a cost object in a cost-effective manner. They are generally material in amount, linked to a specific area or responsibility, or related to a particular cost object by *contractual* requirements. Let's assume that the cost object is an academic program at an institution. Direct costs would include the salary for the program coordinator, salaries of contracted faculty who teach only in the program, and the cost of a learning software system used exclusively to deliver the program of study. A rule of thumb to determine a direct cost is to consider whether the cost would disappear if the cost object was eliminated. In the example above, the salaries of the program coordinator and faculty, and the software system costs would cease if the program was discontinued, so they are direct costs.

Indirect costs do not bear a discernible relationship to a particular cost object, or cannot be determined in a cost-effective manner. So, if the cost of an online program is the cost object, insurance for the entire institution would be an indirect cost of operating this program. It is required for the institution to function, but would not be affected if a particular online program was discontinued. The means to allocate these indirect costs to cost objects is discussed later in this chapter.

Classifying costs as direct or indirect is often determined by the particular cost object. For example, building maintenance costs might be relatively immaterial when calculating the costs of several online courses, and thus be an indirect cost. The same maintenance costs would be important direct costs if the cost object was a particular campus building.

FIXED AND VARIABLE COSTS

Variable costs change as the activity level of a cost object changes. For example, if an institution provides all textbooks for online students, these costs vary in direct proportion to the number of students registered in a program. *Fixed costs* remain unchanged over a given period of time – for example, salaries for tenured faculty members would be fixed costs if the objective was to forecast the costs of operating Faculty of Medicine programs. All costs tend to be variable over time or a wide range of activity. For instance, faculty salaries may be fixed for a particular year, but will vary as long-term registration levels fluctuate. They may be fixed if a 2% increase in registrations levels is forecast in the next year, but not for a 20% increase. Thus, determining the *relevant range* is necessary when categorizing costs as fixed or variable.

The distinction between fixed and variable cost behaviours is important. Unit costs can misinform if they contain elements of fixed costs. For example, if you are a bookstore manager and have a choice between a) buying textbooks from a supplier for $600 per year for a class of students (with15 students presently registered); or b) buying texts for $30 per student; what choice would you make? At 15 students, the per unit cost under the first option is $40 per student ($600/15). This comparison suggests that paying the variable rate of $30 per student under the second option would be preferable. However, if registrations turn out to be for 20 students, the average cost per student under the fixed level is the same as under the variable (per student) option ($600/20 = $30). If registration levels exceed 20 students, then the flat purchase price of $600 should be chosen, all other factors remaining constant.

Though this is a simple example, the point is that making financial decisions based on per unit costs which include a fixed cost component can produce incorrect decisions. This error often occurs when calculating relative costs of online versus traditional classroom delivery, because each of these modes has a fundamentally different cost structure. Most forms of online course delivery have a significantly greater fixed-cost component than classroom instruction; there may be a need to invest in computers, communication equipment, and production staff, for instance. Because of the different behaviours of fixed and variable costs over a certain level of activities, when comparing costs among alternative modes of delivery, it is necessary to identify both the fixed and variable components. Using *cost-volume-profit* analysis more accurately predicts total costs over a range of activity levels, once costs have been classified into variable- and fixed-cost categories.

COST-VOLUME-PROFIT RELATIONSHIPS

Multiple revenue and cost drivers (causal factors) can be used to predict total revenues and costs over a range of activity. It is often useful, however, to focus on only one such causal factor and study how variations in this factor affect revenues and costs. CVP analysis does this by first calculating the *total contribution margin* (total revenue less total variable costs), then the *net revenue* (total contribution margin less fixed costs). In other words,

	Measure:	*Calculated as*:
	Total Revenue	Units of output times selling price per unit
Less	Total Variable Costs	Units of output times variable cost per unit
Equals	Total Contribution Margin	
Less	Total Fixed Costs	
Equals	Net Revenue	

CVP analysis assumes that

1. total costs can be divided into fixed and variable components;
2. the behaviour of total revenues and total costs is linear in relation to units of output, within the range of output under consideration (for example, no per unit cost savings result from purchasing large volumes of instructional material);
3. selling price and variable costs of one unit of output are known;
4. time value of money is ignored. This assumption will be relaxed later.

Using CVP analysis, the *break-even point* can be determined. This is the point where Total Contribution Margin equals Total Fixed Costs and net revenue is therefore zero. The formula is:

$$\text{Break-even in units} = \frac{\text{Total Fixed Costs}}{\text{Per-unit Contribution Margin}}$$

For instance, a university pays $3,000 to an instructor per online course. Tuition fees are $300 per course. Variable costs for Course A are $100 per student, which represents the cost of the textbook. Fifteen students must be registered for the course to break even, calculated as $3,000/($300–100) = 15 students. An income statement prepared in *contribution margin* format would show the following:

	PER STUDENT	TOTAL
Revenue	$300	$4,500
Variable costs	100	1,500
Contribution margin	$200	3,000
Fixed costs		3,000
Net revenue		$ -0-

TABLE 1. Course A Net Revenue

Now suppose that Course B is offered and the instructor is paid $2,400. Tuition is $280 and the textbook costs $180. Twenty-six students are enrolled. The net revenue at this registration level is:

	PER STUDENT	TOTAL
Revenue	$280	$7,280
Variable costs	180	4,680
Contribution margin	$100	2,600
Fixed costs		2,600
Net revenue		$ -0-

TABLE 2. Course B Net Revenue

Each course is operating at its break-even point, as net revenue is zero in each case. Using the break-even formula, the minimum number of students necessary in each course to cover fixed costs – the break-even point – can also be calculated as follows:

Course A: $3,000/($300–$100)	= 15 students
Course B: $2,600/($280–$180)	= 26 students
Total in A and B	= 41 students

CVP analysis can inform other financial decisions. For instance, if a student is indifferent between choosing Course A or B, which course should be recommended if the institutions wants to maximize net revenue? The answer is Course A, as the contribution margin per student is $200 ($300–100), versus $100 for Course B ($280–180). That is, for every additional student registered in Course A, an extra $200 is contributed to net revenue, as opposed to only $100 for Course B. This assumes, however, that fixed costs will not increase if one more student enrols in either course. At some point, another instructor will need to be hired for Course A. Just prior to that point, students should be directed to Course B, until another instructor needs to be hired for that course.

SEGMENT MARGIN ANALYSIS

Let's assume that Course B is not needed for program requirements. If only 25 students are enrolled, should Course B be offered at all? The operating loss at this level is $100, because there is one student less than the break-even point of 26 students and the contribution margin per student is $100. This question brings up another important point with respect to cost and revenue analysis. In the example above, fixed costs are all assumed to be direct costs. In other words, if either or both Courses A and B were cancelled, the associated fixed costs ($3,000 and $2,400 respectively) would disappear. Fixed costs, however, can also be indirect costs. Some or all of these fixed costs may remain whether or not Course A or B is cancelled. The process of expanding the contribution margin analysis by analyzing the fixed cost components as direct or indirect costs is called *segment margin* analysis.

Using the same example, let's assume that the fixed costs of Courses A and B – $3,000 and $2,600 respectively – are composed of the following:

	Course A	**Course B**
Course-specific costs	$2,000	$1,600
Central administration salaries, allocated equally between Courses A & B	1,000	1,000
Total	$3,000	$2,600

Disclosing direct and indirect costs separately, a segment margin analysis of both courses would show the following:

	Course A		Course B		Combined Total
	Per student	Total	Per student	Total	
Revenue	$300	$6,000	$280	$7,000	$13,000
Variable costs	100	2,000	180	4,500	6,500
Contribution margin	$200	4,000	$100	2,500	6,500
Direct fixed costs		2,000		1,600	3,600
Segment margin		$2,000		$900	2,900
Indirect fixed costs					2,000
Net revenue					$900

Table 3. Segment Margin Analysis – Courses A and B

Based on this analysis, Courses A and B both have positive segment margins ($2,000 and $900 respectively). At the given registrations levels, both courses help to cover central administration salaries. Course B should not be cancelled. If it was, overall net revenue for the institution would decrease by the amount of Course B's segment margin – $900 – to zero. Using segment margin analysis, the recalculated break-even points are as follows:

Course A: $2,000/($300–100)	= 10 students
Course B: $1,600/($280–180)	= 26 students
Total in A and B	= 36 students

Segment margin analysis illustrates the danger of making decisions based on arbitrary allocations of costs. It is important to remember that direct fixed costs only include costs that can be controlled by the organizational unit or activity under consideration, and that would disappear if the unit or activity was discontinued. In the above example, central administration salaries were allocated to Courses A and B as if these were direct fixed costs. When these indirect fixed costs are appropriately segregated, the registration levels at which direct fixed costs are covered are significantly lower, and more accurate financial decisions result.

RELEVANT COSTS

In the context of making financial decisions about online education, the avoidance of arbitrarily allocating costs is one component of determining *relevant costs*. Relevant costs fall into three categories. First, they must be costs that *differ* between alternatives. In the above example, allocated indirect fixed costs of administrative support staff were irrelevant to the decision because these costs remained whether or not Courses A or B were offered.

Second, relevant costs are *future* costs. Past costs (those that have already been incurred) are referred to as *sunk costs*. They are irrelevant to future decisions because they cannot change the course of future events once they have been incurred. For example, a community college decides to implement an institution-wide document management system. Costs over the three-year implementation period are estimated at $1,000,000. Savings over the life of the system are estimated at $1,200,000. As a result of the estimated $200,000 overall savings, the project is approved. Two years into the project, however, incurred development costs amount to $2,000,000. Additional costs are virtually certain to amount to another $800,000. In other words, the project will cost $2,800,000, not the once-estimated $1,000,000. Estimated savings remain at $1,200,000. At this point, the Board of Governors decides to cancel the project based on the following analysis:

Estimated total savings	$1,200,000
Estimated total costs	2,800,000
Net cost of project	$(1,600,000)

This decision, however, is incorrect. At the end of Year 2, the project should still go ahead to minimize loss, based on this analysis:

Estimated future savings	$1,200,000
Estimated future costs	800,000
Net incremental benefit	$400,000

In other words, the $2,000,000 project costs to date are sunk costs and irrelevant to the decision at the end of Year 2. If they are considered and the project is cancelled at the end of Year 2, the college will lose $2,000,000. If the project is completed, the college will only lose $1,600,000. Granted, the project should not have been started in the first place, but this conclusion is based on hindsight. To minimize loss at the current point of decision, the college should ignore the sunk costs and continue with the project to completion.

Third, relevant costs are only those that involve *cash outlays.* An important example of this concept relates to amortization of capital assets. *Amortization* is a process that allocates the cost of acquiring something with future benefit over more than one year (for example, a computer) over its estimated useful life. Suppose the nursing faculty in a university develops a series of online courses for its Bachelor of Nursing program. Based on projected revenue exceeding costs over the five-year estimated life of the project, the nursing faculty is given a capital grant of $100,000 by the university to purchase the computers to launch this initiative. The computers are expected to have a useful life of five years and be worthless at the end of this period.

Amortization cost of $20,000 ($100,000/5 yrs.) is netted against the revenue generated by this online program. A programmer is hired by the faculty to develop the learning platform. Courses in the program are taught by faculty, who are paid additional money to teach them. These are all direct costs of the program.

At the end of Year 3, the following financial report is prepared by the administrative staff in the Faculty of Nursing:

	Year 1	Year 2	Year 3
Revenue			
Capital grant	$100,000	$ -0-	$ -0-
Registration revenue	5,000	100,000	120,000
Total revenue	105,000	100,000	120,000
Costs			
Faculty salaries	20,000	30,000	40,000
Programmer salary	60,000	60,000	60,000
Amortization	20,000	20,000	20,000
Total costs	100,000	110,000	120,000
Net revenue (loss)	$5,000	$(10,000)	$(10,000)

Table 4. Three Year Net Revenues for Online Program Faculty of Nursing

At the end of Year 3, the dean considers whether to cancel the program. Losses of about $10,000 per year are expected to continue since registrations in the online program are not expected to grow after reaching Year-3 levels.

Despite the appearance that the program will continue to lose money into the future, the online program should be continued. The reasons for this may not be readily apparent, but the financial analysis needs to be revamped to exclude the amortization costs, as these do not involve cash outlays. Also, the purchase of the computers needs to be recorded in its entirety in Year 1, as this is when the related cash outflow occurs. After this point, the cash outlay is a sunk cost. Restated on these bases, the financial results would be as follows:

	Year 1	Year 2	Year 3
Revenue			
Capital grant	$100,000	$ -0-	$ -0-
Registration revenue	5,000	100,000	120,000
Total revenue	105,000	100,000	120,000
Costs			
Faculty salaries	20,000	30,000	40,000
Programmer salary	60,000	60,000	60,000
Computers	100,000	-0-	-0-
Total costs	180,000	90,000	100,000
Net revenue (loss)	$(75,000)	$10,000	$20,000

Table 5. Revised Three Year Net Revenues for Online Program Faculty of Nursing

The restated results indicate that the program should be continued. Not considering cash flows and recording amortization in Years 1–3 obscures the fact that a net cash inflow is being generated by the project in Years 2–3. The program will contribute net revenue of $20,000 in Years 4 and 5 if the same results as Year 3 are achieved. If the program is dropped at the end of Year 3, no net revenue will be generated in Years 4–5.

Overall, however, the university will not recoup its initial investment over the five-year period. The final results are projected to show an overall $5,000 net cash outflow, as follows (table 6).

If these results had been known at the start of the project, it might not have proceeded. After the initial decision to proceed has been made,

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Revenue						
Capital grant	$100,000	$ -0-	$ -0-	$ -0-	$ -0-	$100,000
Registration revenue	5,000	100,000	120,000	120,000	120,000	465,000
Total revenue	105,000	100,000	120,000	120,000	120,000	565,000
Costs						
Faculty salaries	20,000	30,000	40,000	40,000	40,000	170,000
Programmer salary	60,000	60,000	60,000	60,000	60,000	300,000
Computers	100,000	-0-	-0-	-0-	-0-	100,000
Total costs	180,000	90,000	100,000	100,000	100,000	570,000
Net revenue (loss)	$(75,000)	$10,000	$20,000	$20,000	$20,000	$**(5,000)**

Table 6. Five Year Net Revenues for Online Program Faculty of Nursing

however, the program should continue because a positive cash flow is generated in Years 2–5. A significant re-investment will be needed to replace the computers at the end of Year 5, so the decision whether to continue the program should be made at that point.

EXAMPLES OF VARIOUS DECISIONS USING RELEVANT COSTS

Relevant costing concepts can be used to inform a variety of financial decisions in a university context – for example, whether to accept one-time orders for services at a price that is less than usual. Let's assume you are the dean of your university's Faculty of Extension. An important part of your faculty's mandate is to contract with outside institutions and businesses to develop, market, and deliver online courses for their employees. Your unit is required to generate net revenue for the university. The Faculty's online learning system staff and related technological infrastructure can feasibly produce and support about 50 courses per year, about 20 more than at present. Average production costs are $20,000 per course, based on 30 courses per year and calculated as follows:

	Per-course Cost	
Production staff time	$4,000	(all variable on a per course basis)
Instructors	4,000	(all variable on a per course basis)
Online delivery system	10,000	($300,000/30 = $10,000 total per course; $9,000 fixed + $1,000 variable)
Marketing	2,000	($60,000/30 = $2,000 total per course; $1,500 fixed + $500 variable)
Total cost per course	$20,000	

An outside firm has asked your unit to develop, market, and deliver a suite of six courses. The firm has offered to pay $19,000 per course for these services. Let's assume that by accepting this contract, the Faculty of Extension will incur no additional fixed costs. The question is whether this offer should be accepted.

Using average costs per course, accepting the offer would produce a loss of $6,000 on the contract, calculated as follows:

Total revenue (6 × $19,000)	$114,000
Total costs (6 × $20,000)	120,000
Net loss	$**(6,000)**

It appears that a price of $19,000 per course is insufficient. Remember, however, that only costs that differ among alternatives and involve future cash flows are relevant. Using these two criteria, the allocated fixed costs associated with the online delivery system ($9,000) and marketing ($1,500) are irrelevant. They will not change if the outside contract is accepted. Eliminating these costs from the analysis and using the contribution margin format, the restated results would show the following incremental revenues and costs if the contract is accepted:

	Per Course	**Total**
Revenue	$19,000	$114,000
Variable Costs		
Production staff time	$4,000	24,000
Instructors	4,000	24,000
Online delivery system	1,000	6,000
Marketing	500	3,000
Total variable costs	9,500	57,000
Contribution margin	$9,500	$57,000

Since an additional $57,000 would be contributed to the faculty, the offer to produce the six courses should be accepted. In the original analysis, including allocated fixed costs that will not change produces the wrong decision. Relevant costing eliminates this conflating factor, because the fixed costs that do not change are identified and omitted.

Now let's use the same information as above, except that an additional fixed online delivery platform cost of $40,000 must be incurred to accommodate development and delivery of the additional six courses. Should these still be produced for $19,000 revenue per course?

The answer is that yes, they should, if other factors remain the same. Incremental net revenue will be $57,000 – 40,000 = $17,000 higher. As we can see in this example, fixed costs can be relevant if incurred as a result of the decision at hand. Again, the essential cost characteristics represent *cash flows* that can be *expected in the future* and are *different* under the various alternatives.

Having said this, non-quantitative factors always need to be weighed and subjectively assessed. In the above example, for instance, lower prices may be demanded by current on-campus customers if the potential contract with the outside firm is accepted and the terms become known. Though these subjective considerations are not within the scope of this chapter's analysis, the point is that relevant costing concepts can improve financial decision making in any environment, for profit or otherwise.

Often, cost-volume-profit decisions need to consider competing alternatives. For instance, let's assume that you are the manager of the learning technology division of your university. You enter into contracts with various Faculties to produce multimedia courses. Your division also has the opportunity to produce courses for either the Faculty of Medicine or the Faculty of Arts, and can sell all the courses that can be produced to these faculties. Detailed information about course production costs is as follows:

	Faculty of Arts	**Faculty of Medicine**
Revenue per course	$30,000	$80,000
Variable production costs per course	$20,000	$50,000
Contribution margin per course	$10,000	**$30,000**

In this case, the Faculty of Medicine opportunity should be pursued, since each additional course will produce an additional $30,000 of contribution margin compared to only $10,000 for each Faculty of Arts course. What happens, though, if the learning technology unit is operating at capacity? This is a *capacity* constraint. Under capacity constraints, managers should look at the highest contribution margin *per unit of the scarce resource*, not just total contribution margin.

Assume that a total of 40 person-hours are available per day in your unit. Faculty of Arts courses take 1,000 person-hours to produce and Faculty of Medicine courses take 4,000 person-hours to produce. The appropriate analysis is as follows:

	Faculty of Arts	**Faculty of Medicine**	
Contribution margin per unit (see above)	$10,000	$30,000	(a)
Person-hours to produce	1,000	4,000	(b)
Contribution margin per person-hour	**$10**	$7.50	(a/b)

In this case, with other factors being equal, the Faculty of Arts courses should be produced because this activity produces the highest contribution margin per unit of scarce resource ($10 per hour). Looking at this decision another way, the learning technology unit can produce only one Faculty of Medicine multimedia course in the same time that it can produce four Faculty of Arts courses. Because each Faculty of Arts course contributes $10,000, a total of $40,000 of contribution margin can be generated in the same time it takes to produce one Faculty of Medicine course that produces only $30,000 of contribution margin. This difference may not be apparent unless the contribution margin is recast in terms of the scarce resource – in this case, of staff time.

Relevant cost concepts can also be applied to capital asset replacement decisions. *Capital assets* are tangible items like machines or buildings that have value to an organization for some time into the future, generally for longer than one year. The key to this type of analysis is to recognize that past costs, like the purchase price of capital assets in the past, are irrelevant to replacement decisions. These costs are sunk. Only future cash flows that differ among alternatives are relevant – for example, the cost of a new machine to be purchased, the amount that the old machine can be sold for, and differences in future maintenance costs or production efficiency savings.

Let's assume you have a photocopier that cost $20,000 when purchased yesterday. Today, you find out that you can buy another photocopier for $25,000, and it will save you $.03 per page in production costs compared to yesterday's purchase. Each machine has an estimated useful life of 1,000,000 pages. The expected life of both machines is five years. The maintenance contract with the vendor will remain at $50 per 10,000 pages produced, regardless of whether the newer machine is purchased. The one-day-old machine can be sold for $2,000. Should the one-day old machine be replaced?

Yesterday's cash outlay of $20,000 is irrelevant, as it is a sunk cost. Maintenance costs are irrelevant, as they do not differ between the two alternatives. Focusing on future cash flows that differ among the alternatives, the relevant cost analysis would be as follows:

	Cash Inflow (Outflow)
Purchase price of new machine	$(25,000)
Sale of one-day old machine	2,000
Production savings over estimated life of new machine (1,000,000 × $.03)	30,000
Net cost savings if new machine is purchased	**$7,000**

As a result, the new machine should be purchased. Net costs savings of $7,000 will be realized.

TIME VALUE OF MONEY

Recall that future, differing cash flows are the only relevant costs for a variety of decisions. Because these cash inflows and outflows may occur over several future years, however, the *time value of money* needs to be considered. This factor considers that a dollar received today is worth more than a dollar received in the future, because interest can be earned on the money in the meantime.

Let's assume you can invest $100 at 8% per year. By the end of the first year, your $100 would grow to $100 × 1.08 = $108. By the end of the second year, your investment of $108 would grow to $108 × 1.08 = $116.64 (earning interest on the accumulated interest is known as *compounding*). By the end of the third year, the investment would total $116.64 × 1.08 = $126. In general mathematical terms, the future value of your investment can be calculated as

$F = P(1 + r)^n$, where P = present value
F = future value of P
r = rate of return
n = number of periods

Substituting the information in the above example, the future value (F) of $100 received today (P), assuming that interest of 8% is paid and compounded at the end of each year, is

$$100(1.08)^3 = 100 \times 1.08 \times 1.08 \times 1.08 = \$\underline{\underline{\mathbf{126}}}$$

P is the *present value* of some amount to be received in the future. It is simply the inverse of future value. In this case, the present value of $126 received three years from now is $100, assuming the funds can be invested in the interim at 8%. Similarly, the general mathematical equation to calculate present value is merely the inverse of the future value equation:

$$P = F/(1 + r)^n$$

As an example, if you could receive $100 two years from now, what amount of money would you be indifferent to receiving today, assuming that you could invest the money in the meantime at 10%? Substituting into the equation, you would get $P = \$100/(1.10)^2 = \$82.60$. In other words, if you received $82.60 today, you could invest this at 10% per year and have $100 at the end of two years ($\$82.60 \times 1.10 \times 1.10 = \$100$). You should therefore be indifferent between receiving $82.60 now, or $100 two years from now.

Mathematical tables have been developed to make present value calculations easier. (Refer to Appendix A.) The present value of $1, compounded annually at 10% for a period of two years, is .826 (see bolded cell in Appendix A). Applying this factor to the amount to be received in the future ($100) would produce a present value of $\$100 \times .826 = \$82.60$, as above.

A somewhat similar process is available to determine the present value of a *series* of equal payments received at the end of each year, for a number of years into the future. For instance, if you received $100 per year at the end of each year for three years, and could invest this at 8% per year, how much money would you have at the end of three years? To calculate this, determine what the future value of each $100 amount received would be at the end of Year 3 and total these. At the end of

Year 3, the total of each year's revenue would grow to $324.64, calculated as follows:

Yr. 1: $100 × 1.08 × 1.08	= $116.64
Yr. 2: $100 × 1.08	= 108.00
Yr. 3:	= 100.00
Total future value	**$324.64**

There is also a general mathematical formula to determine this:

$F = P[(1 + r)^n - 1]/r$, where
P = amount of *each* revenue payment
F = future value of *all* revenue payments
r = rate of return
n = number of periods

Substituting the information from the example above,

$$F = \frac{100[(1.08)^3 - 1]}{.08} = \$\mathbf{324.64}$$

However, this formula does not tell us how much we would require if we wanted to receive just *one lump sum today*, invest this amount for three years at 8% per year, and have $324.64 at the end of the third year. Similar to the present value of a one-time payment to be received at a future date, the present value of a *future revenue stream* received at the end of each year can be determined by a mathematical formula. This formula is:

$P = F[(1 + r)^n - 1]/r$, where
P = present value of *all* future revenue streams
F = future value of *each* revenue amount
r = rate of return
n = number of periods

In the example at hand, this formula can determine the lump-sum amount one would be indifferent to receiving today rather than receiving

$100 at the end of each of three years, assuming the money could be invested at 8% in the meantime:

$$P = \frac{100[(1 + .08)^3 - 1]}{.08} = \$\underline{\underline{\mathbf{257.70}}}$$

Proof: $\$257.70 \times 1.08 \times 1.08 \times 1.08 = \$\underline{\underline{\mathbf{324.64}}}$

Note that the $324.64 amount is the same as the future value calculated above, assuming a revenue stream of $100 received at the end of each of three years. As shown in Appendix B, a mathematical table can also be used to determine this amount. Referring to the bolded cell in Appendix B, the present value of a future revenue stream received at the end of each of three years and invested at 8% compounded each year is **2.577**. $100 × 2.577 = $257.70, the same present value amount calculated above.

TIME VALUE OF MONEY AND RELEVANT COSTS

The essential relevant cost concepts – *future cash flows* that *differ* among alternatives – combined with the concept of the time value of money are the essential components of discounted cash flow (DCF) analysis. This technique enables decision makers to translate future cash flows that are projected to occur at different times back to the same point in time by using present value techniques, and thus to more accurately assess investment alternatives.

Capital budgeting is the process of planning purchases of assets that will be used for more than one year. Using the same relevant costing concepts discussed previously, future cash inflows and outflows that differ among alternatives are evaluated. Based on when these relevant cash flows are projected to occur, they are translated back to present values, using the techniques discussed above.

Let's assume you are the dean of the Faculty of Business. You are trying to determine whether to replace equipment in a multimedia classroom. The new equipment will cost $240,000. This new equipment, however, should require less maintenance time and expenditures, saving approximately $6,000 per year over the four-year estimated life of the new equipment. The old equipment was purchased five years ago for $100,000. You estimate that this equipment can be sold for $8,000, but that it will likely take one year to find a buyer. Assume that you will have to borrow money from the university's central revenue fund, at 10% annual interest, to finance this possible capital purchase.

To evaluate this decision, first calculate the relevant costs. Ignore the time value of money concepts for now. Note that the $100,000 original purchase price of the old equipment is irrelevant to this decision; it is a sunk cost. The relevant cash inflows (outflows) are as follows:

Purchase price of new equipment	$(24,000)
Maintenance savings over life of new equipment (4 × $6,000)	24,000
Sale of old equipment	8,000
Net cost savings	$8,000

Based on this analysis, the new equipment should be purchased. To account for the differing time frame in which cash inflows and outflows will occur, however, they need to be discounted back to the present, using discounted cash flow analysis as follows:

Cost of purchasing new equipment today ($24,000 × 1)	$(24,000)
Maintenance savings over life of new equipment ($6,000 × 3.170 – see app. B)	19,020
Sale of old equipment ($8,000 × .909 – see app. A)	7,272
Discounted net cost savings	$2,292

Note that the net cost savings, using discounted cash flow analysis, is still positive. This indicates that the new equipment should be purchased, all other things being equal. The positive cash flow, however, is now much lower than when cash flows are not discounted back to the present. Cash inflows related to the maintenance savings and the sale of the old equipment are worth less in present value terms because they are not realized until some time in the future.

Now assume that the university requires all its centrally-funded projects to earn a return of 20% per year. Recalculate the cash flows.

Cost of purchasing new equipment today ($24,000 × 1)	$(24,000)
Maintenance savings over life of new equipment ($6,000 × 2.589 – see app. B)	15,534
Sale of old equipment ($8,000 × .833 – see app. A)	6,664
Discounted net cost	$(1,802)

The discount applied to future cash inflows is much higher if a higher rate of return is required. This calculation reduces the present value of the future cash flows to amounts that are less than the purchase price of the new equipment today. In this case, the equipment should not be replaced, since the discounted net cost is $1,802.

ACTIVITY-BASED COSTING

Recall the earlier example about whether to produce six multimedia courses. In this analysis, the fixed online delivery system and marketing costs were irrelevant to the decision at hand because they did not differ between the alternatives. There are instances, however, where all costs need to be identified and allocated on some rational basis: to determine what price should be charged for a product or service. For instance, *time-driven, activity-based costing* (TDABC) is a means to accomplish this; it estimates the cost of all resources needed to produce a product or service.

Let's examine the case of a multimedia unit at a community college. The unit must break even on an annual basis; revenues must cover all costs incurred. The unit staff consists of a manager, a programmer, and an administrative assistant. The unit rents computers and space in a privately owned building near the campus. It is also responsible for purchasing liability insurance against unforeseen legal actions, and for paying all utilities. The estimated annual cash outlays are as follows:

Programmer salary	$60,000
Manager salary	80,000
Administrative assistant salary	40,000
Office supplies	3,000
Rent	12,000
Utilities	8,000
Liability insurance	2,000

Various academic units at the college and, at times, private firms, contract with your multimedia unit to produce online course material. You need to determine the amount you should charge for each project to ensure that your unit's costs do not exceed revenues. To accomplish this, the following steps should to be taken.

1. Identify the direct costs of producing multimedia courses, but only to the point where this exercise is worth the time and effort involved. In the example above, the programmer's time would likely be a direct cost, as this could be identified with the production of a specific online course (e.g., if time sheets are maintained).
2. Combine the remaining (indirect) costs into various "cost pools." Each cost pool should consist of indirect costs that are incurred by the same general sort of activity. For example, the manager's and administrative assistant's salaries could be grouped together with office supplies, as these relate to general day-to-day activities of the unit. Call this the Administrative cost pool. Utilities and rent could be lumped into another cost pool, as these relate to the costs of maintaining the physical premises, without regard to the level of course production activity. Call this the Building cost pool. Liability insurance (the Insurance cost pool) could be a third cost pool, assuming that legal action is equally possible for any project.
3. Identify a basis for cost allocation that has some relationship to the incurrence of costs for each indirect cost pool. For example, the manager's and administrative assistant's salaries, as well as office supplies, could be allocated on the basis of the manager's estimated hours incurred on a project. Building costs could be allocated based on the estimated number of working days that a project is active. Liability insurance could be allocated based on the number of expected projects in a year.
4. Calculate an appropriate hourly rate for each type of cost. To do this, it is important to choose a realistic allocation base, not an ideal one. For instance, although ideally staff might work 1,920 hours per year [(52 weeks-4 weeks holidays) × 8 hrs/day], their actual hours worked will be less than this, due to sickness, breaks, socializing, and training time. A more realistic estimate might be 80% of 1,920 hours, or 1,536 hours per year. On this basis, the allocation of the programmer's $60,000 salary would amount to ($60,000/1,536 hours) = $39 per hour. Using the same estimate of hours per year, the first indirect cost pool (Administration) application rate could also be calculated, as follows:

	Cost	Allocation Base	Allocation Amount	Application Rate
Manager salary	$80,000			
Admin. Assistant salary	40,000			
Office supplies	3,000			
Total	$123,000	Mgr.hours/yr	1,536 hrs.	$80/hr.

Table 7. Calculation of Application Rate Cost, Pool 1 – Administration

Let's assume that an estimated 40 projects will be completed in the upcoming year and that there are 250 business days per year. The second type of indirect costs (Building) can be allocated as follows:

	Cost	Allocation Base	Allocation Amount	Application Rate
Rent	$12,000			
Utilities	8,000			
Total	$20,000	Project-days/yr (40 × 250 days)	10,000	$2/day

Table 8. Calculation of Application Rate Cost, Pool 2 – Building

The third type of indirect costs (Liability Insurance) can be allocated across the estimated number of projects to be completed, as follows:

	Cost	Allocation Base	Allocation Amount	Application Rate
Insurance	$2,000	Projects/yr	40	$50/project

Table 9. Calculation of Application Rate Cost, Pool 3 – Liability Insurance

To provide an estimated cost for the project, these rates can now be combined, as applicable, with estimates of the programmer's and manager's time, the number of days the project will be active, and a fixed amount to cover liability insurance ($50 per project). Assume that Project 1 is estimated to take 280 hours of the programmer's time and 60 hours of the manager's time, and should be completed over a period of 150 days. The quoted price would be:

Programmer's time (280 hours × $39)	$10,920
Administration (60 hours × $80)	4,800
Building (150 days × $2)	300
Insurance	50
Quoted price	$16,070

Let's assume that the terms are accepted and the project proceeds. In the end, it turns out that Project 1 actually took 300 hours of programmer time to complete, over a period of 200 days. The manager's time on this project amounted to 50 hours. The net revenue on this project would be calculated as follows:

Revenue, as quoted		$16,070
Less actual costs		
Programmer	300 hrs. × $39	11,700
Administration	50 hrs. × $80	4,000
Building	200 days × $2	400
Insurance		50
Total costs		16,150
Net loss, Project 1		$(80)

Table 10. Calculation of Net Loss – Project 1

At this point, if the loss of $80 is deemed significant, the manager would compare the actual allocated costs to the original estimated costs to determine if inaccurate estimates were used. If warranted, rates for estimating total costs would then be adjusted. Also, if additional types of fixed costs are incurred, new cost pools and application rates can be created and the estimated cost of the new activity included in future price quotations.

At the end of a reporting period (let's assume one year for this example), total costs for all projects and for each cost pool can be calculated and compared to the actual costs incurred for the year in each category. This process will indicate further adjustments that may be needed to estimate future costs more accurately.

Assume that 35 projects were actually completed during the year, and that the financial results for the year's activities are as follows:

	Project 1 (see above)	Projects 2 through 35 (summarized)	Total Costs Allocated	Total Actually Incurred	(Under)-Over-Allocated	
Revenue	$16,070	$182,000	N/A	N/A	N/A	
Less costs						
Programmer	11,700	50,000	$61,700	58,000	$3,700	(a)
Administration	4,000	115,000	119,000	125,000	(6,000)	(b)
Building	400	18,000	18,400	21,000	(2,600)	(c)
Insurance	50	1,700	1,750	2,000	(250)	(d)
Total costs	16,150	184,700	$200,850	$206,000	$(5,150)	
Net revenue (loss)	$(80)	$(2,700)	N/A	N/A	N/A	

Table 11. Calculation of Net Revenue – All Projects

Analyzing this information indicates the following:

a. More of the programmer's time was assigned than actually incurred, resulting in a $3,700 over-application of this cost to all projects. Two possible causes should be investigated to inform future pricing decisions:
    i. The salary actually paid may be less than the original estimate. This appears to be the case, as the programmer's salary was estimated at $60,000 at the start of the year, but actually only amounted to $58,000.
    ii. In total, the actual hours billed to individual projects may add up to more than the original estimate of 1,536 hours.
b. Less of the Administration cost pool was allocated to the year's projects than actually incurred, resulting in a $6,000 under-application of this cost pool. This may have occurred for the following reasons:
    i. Salaries actually paid to the manager and administrative assistant, or actual office supplies costs may have exceeded estimates.
    ii. Fewer manager's hours may have been charged to individual projects than estimated.
c. Less of the Building cost pool wasallocated than incurred, resulting in a $2,600 under-application. Part of the cause is the fact that fewer projects werecompleted than originally estimated (35 vs. 40). There are other possible causes:
    i. Actual costs may have exceeded original estimates. This appears to be the case. Estimated building costs at the start of the year were $20,000. Actual costs totalled $21,000.
    ii. The average number of days to complete each project may have been less than the original estimate of 250 days.
d. Less of the professional liability insurance costs wereallocated than incurred. Since the actual costs incurred were the same as originally estimated ($2,000), the cause of this under-application is solely the result of fewer projects being completed than originally estimated.

All of these possible explanations should be investigated to determine if the estimated application rates for each type of cost are reasonable. If not, appropriate adjustments should be made to future estimates. Also, notice that initial estimates do not need to be extremely accurate. If they are grossly in error, the results will be obvious over time and adjustments can be made. Overall, the use of TDABC can provide more accurate information about the costs and underlying efficiency of value-creating processes.

CONCLUSION

Decision-makers in any organization need to base financial decisions on relevant costs. These include only the estimates of future cash flows that differ among alternatives. When cash flows from investment decisions will occur over a longer period of time, techniques should also be used to equate these amounts back to their present values. Finally, time-driven activity-based costing is a useful and relatively powerful method to inform pricing decisions. With increased interest in online learning and greater reliance on revenue-generating activities, all of the concepts discussed in this chapter are useful means to analyze the financial decisions that all institutions of higher learning face.

ABOUT THE AUTHOR

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APPENDIX A

Present Value of $1

$P = F/(1 + r)$

Periods	2%	4%	6%	8%	10%	12%	14%	16%	18%	20%	Periods
1	0.980	0.962	0.943	0.926	0.909	0.893	0.877	0.862	0.847	0.833	1
2	0.961	0.925	0.890	0.857	**0.826**	0.797	0.769	0.743	0.718	0.694	2
3	0.942	0.889	0.840	0.794	0.751	0.712	0.675	0.641	0.609	0.579	3
4	0.924	0.855	0.792	0.735	0.683	0.636	0.592	0.552	0.516	0.482	4
5	0.906	0.822	0.747	0.681	0.621	0.567	0.519	0.476	0.437	0.402	5
6	0.888	0.790	0.705	0.630	0.564	0.507	0.456	0.410	0.370	0.335	6
7	0.871	0.760	0.665	0.583	0.513	0.452	0.400	0.354	0.314	0.279	7
8	0.853	0.731	0.627	0.540	0.467	0.404	0.351	0.305	0.266	0.233	8
9	0.837	0.703	0.592	0.500	0.424	0.361	0.308	0.263	0.225	0.194	9
10	0.820	0.676	0.558	0.463	0.386	0.322	0.270	0.227	0.191	0.162	10

APPENDIX B

Present Value of a Future Revenue Stream of $1

$P = F[(1 + r)^n - 1]/r$

Periods	2%	4%	6%	8%	10%	12%	14%	16%	18%	20%	Periods
1	0.980	0.962	0.943	0.926	0.909	0.893	0.877	0.862	0.847	0.833	1
2	1.942	1.886	1.833	1.783	1.736	1.690	1.647	1.605	1.566	1.528	2
3	2.884	2.775	2.673	**2.577**	2.487	2.402	2.322	2.246	2.174	2.106	3
4	3.808	3.630	3.465	3.312	3.170	3.037	2.914	2.798	2.690	2.589	4
5	4.713	4.452	4.212	3.993	3.791	3.605	3.433	3.274	3.127	2.991	5
6	5.601	5.242	4.917	4.623	4.355	4.111	3.889	3.685	3.498	3.326	6
7	6.472	6.002	5.582	5.206	4.868	4.564	4.288	4.039	3.812	3.605	7
8	7.325	6.733	6.210	5.747	5.335	4.968	4.639	4.344	4.078	3.837	8
9	8.162	7.435	6.802	6.247	5.759	5.328	4.946	4.607	4.303	4.031	9
10	8.983	8.111	7.360	6.710	6.145	5.650	5.216	4.833	4.494	4.192	10