Appendix 4

Exercises[1]

Exercise 1. A district hospital in Bangladesh

Note: This exercise applies the principles of cost analysis and income analysis at the level of an individual hospital, providing the reader with an opportunity to calculate unit costs and practise other skills from Chapters 1 and 2.

A typical district hospital in Bangladesh has 50 beds and 74 staff (14 physicians, 26 nurses, 15 technicians and skilled staff, and 19 unskilled support staff). This type of hospital has three patient care cost centres — inpatient wards, theatre (for surgical operations), and outpatient department (for both clinics and casualty services). Four intermediate cost centres were used — ambulance, X-ray, pharmacy, and laboratory. Because of the simplicity of the hospital, only one overhead cost centre — administration — was defined; this subsumes other support functions such as security, cleaning, and maintenance.

Table A9 shows the annual direct costs of this hospital by cost centre. The average annual 1996 salary for each staff position plus benefits (rather than the individual salaries at a specific hospital) were used to estimate personnel costs. The exchange rate was 40 taka (Tk) to one US dollar. The average annual costs (including benefits amounting to 60% of base salaries) per staff are: Tk 89 000 (US$ 2225) per physician, Tk 46 000 (US$ 1150) per nurse, Tk 44 000

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(US$ 1100) per technician or administrative staff member, Tk 23000 (US$ 575) per unskilled support staff member, and Tk 48000 (US$ 1200) per staff member overall. Personnel costs were attributed to each cost centre based on how the staff members spent their time. Non-personnel costs and capital costs incurred in a patient care or intermediate cost centre were assigned to that cost centre, while all other costs (general maintenance and the annualized capital cost of the buildings and furnishings) were assigned to administration. Ambulance operations and "other" expenses, including utilities (for which fuel and equipment are imported), account for high shares of expenses because of the extent to which they rely on imports.

Exercise 1a

Calculate the total cost of each cost centre (treating all the intermediate and patient care cost centres as final cost centres) by completing the blank cells in Table A9.

Table A9. Allocating overhead costs to cost centres

Cost centre	Direct expense[a] US$	Allocation statistic	Allocation %	Allocated expense US$	Total expense US$
Overhead:					
Administration and other	34902	direct cost	0.0	0	0
Intermediate:					
Ambulance, etc.	12804				
X-ray	6199				
Pharmacy	11737				
Laboratory	9134				
Patient care:					
Inpatient wards	30582				
Theatre	14811				
Outpatient department	11054				
Total	131223				

[a] Converted at the 1997 official exchange rate of 40 Bangladeshi taka to one US dollar.

Exercise 1b

Calculate the unit cost of each final cost centre, a target fee for a typical unit of service by that cost centre, and the potential revenue generated by that cost centre by completing the blank cells in Table A10.

Hint: The target fee percentage is the proportion of the average unit cost which is charged to paying patients, and the target fee is the unit cost multiplied by the target fee percentage. The percentage of patients charged is the

share of patients not exempted from payment. The collection efficiency is the share of fees imposed that are actually collected from patients and officially remitted to the hospital. The total revenue from each cost centre is the cost (the product of the volume of service multiplied by its unit cost) multiplied by the three factors discussed on pages 43–44. The hospital administration sets the fee in each cost centre equal to the target fee percentage of the unit cost. However, not all patients are actually charged the set fee. Some are exempted due to poverty or other considerations.

Exercise 1c

The hospital needs to recover one-quarter of its total costs from user fees. Determine whether the assumptions above will enable it to meet this target. If it will not, suggest an alternative set of values that will.

Hint: Add the revenues from each final cost centre in Table A10 and compare the sum to the total costs of the hospital. Raising any of the percentages will raise the total; lowering any will lower the total. The impact will be greater if the percentages are changed on the larger sources of revenue.

Table A10. Calculating unit costs and potential cost recovery

Final cost centre	Total expense (US$)	Volume	Units	Unit cost (US$)	Target fee %	Target fee (US$)	Patients charged %	Collection efficiency %	Potential revenue (US$)
Intermediate:									
Ambulance	17 444	20 000	kilometers		60		90	80	
X-ray	8 445	4 000	films		60		80	90	
Pharmacy	15 990	30 000	scripts		75		60	90	
Laboratory	12 444	50 000	tests		50		80	90	
Patient care:									
Inpatient wards	41 663	15 000	days		30		70	70	
Theatre	20 178	2 000	operations		20		80	80	
Outpatient department	15 059	20 000	visits		60		70	80	
Total	131 223								

Exercise 2. Should we contract out laundry services?

Note: This case compares internal hospital laundry services (with either owned or leased equipment) with outsourced laundry services.

As a hospital administrator, you are constantly challenged to deliver quality services efficiently. This objective includes deciding when to make capital expenditure (i.e. expenditure that is expected to provide benefits for longer than one year). Such a decision now has to be made regarding the laundry department.

Your major piece of equipment in this department has become more and more unreliable. It now breaks down so often that you never know when it will be working. Linen is often not as clean as it should be and the state of employees' uniforms is embarrassing. Working conditions in the laundry are deplorable, and current space is too small to house the equipment — new or old. Laundry employees are disgruntled because of these conditions; they take great pride in their work. You know that some hospitals in the region have contracted out their laundry services. Some hospitals have been pleased with the results while others doubt the long-term benefits.

The current equipment is completely depreciated and outmoded. The capital cost of refurbishing the laundry would be as follows:

	US$
Renovation of laundry building	30 000
New equipment	65 000
Total capital cost	95 000

The expected life of the equipment and the renovation is assumed to be 20 years. The inflation rate is 7%, the real interest rate is 3%, and the nominal interest rate is about 10%. In addition, a rural hospital in the next town is willing to buy your outmoded equipment for US$ 2000 to use as a back-up to its own washing machine.

Currently, the variable cost (for soap, water, utilities and direct labour) is US$ 0.03 per kg, and your hospital processes 300 000 kg of laundry per year. Your annual fixed operating costs are:

	US$
Maintenance	1400
Administrative salaries	8000
Total fixed costs	9400

A company with three years' experience has indicated that it would be prepared to collect the laundry, wash it at its own facility and return it to the hospital for US$ 0.06 per kg (rising annually with inflation) if it were to get the contract to do so. In-house administrative oversight of a contract would cost the hospital US$ 2000. Alternatively, the company is willing to refurbish the space and lease the equipment to the hospital at US$ 10 000 per year — renewable annually for up to 20 years with the annual lease payment rising at the rate of inflation. The hospital would be responsible for all variable costs and maintenance.

Exercise 2

a. Given this information, identify the three options contained in the description above.

b. For each option, estimate the capital costs, operating (both fixed and variable) costs, and total costs.

c. Choose the best option in terms of the lowest annualized costs.

d. *Discuss other features of the best option (e.g. flexibility, future cost expectations, reliability).*
e. *Identify at least one more option, not mentioned above, which could also be considered.*

Exercise 3. A missed opportunity

Note: This case deals with preparation of a cost analysis at the level of a hospital, identifying all the departments affected, and interpreting the results for hospital policy.

As the administrator of a crowded but respected provincial public hospital, you have calculated that, by the end of this fiscal year, your hospital should be operating at a surplus. If you make no changes, your hospital's costs will be US$ 15 000 less than its budget from the national government and you will need to return this balance to the government. As an experienced administrator, you know that if you return the funds you will miss an opportunity to improve services.

Dr Vivek, chief surgeon at your hospital, has just heard the good news. He approaches you before you can draft the memo to other department heads informing them of this opportunity and requesting their immediate input. With a tone of urgency, Dr Vivek asks that the hospital should purchase new endoscopy equipment that detects and replaces the surgical treatment of colon cancer. The equipment is estimated to cost US$ 10 000. Dr Vivek tells you that this cost is "minimal" and he sees no reason why his request should not be approved for funding.

After discussing this matter with Dr Vivek for two hours and after talking to a friend who is a financial analyst at a nearby hospital, you realize that there are other costs involved in purchasing this new piece of equipment. Dr Vivek could give only "soft numbers" when you asked him how many patients with colon cancer were treated on an inpatient and outpatient basis in the hospital in each of the last three years and, of those, how many could have benefited from the proposed equipment. According to Dr Vivek, around 500 patients a year could benefit from the new equipment — about half are patients now receiving other diagnostic procedures only and half are patients receiving both diagnostic procedures and surgical treatment. Without the new equipment, each of the surgical cases would spend a week in the hospital. If they do not need to be admitted, their place would be taken by other elective surgical patients who usually wait several weeks for admission.

With your friend's help and Dr Vivek's information, you estimate the full capital costs as follows:

	US$
New endoscopy equipment (10-year life)	10 000
Expanded outpatient treatment room (20-year life)	5000
Total capital costs	15 000

Your friend advises you that the necessary approvals to apply the US$ 15 000 anticipated surplus to these capital costs could be obtained if you make an adequate case.

The inflation rate is 7% and the real interest rate is 3% per year. Variable costs are: physician (0.25 of annual salary of US$ 10 000), technician (0.5 of annual salary of US$ 3000), nurse (0.5 of annual salary of US$ 5000), and supplies (US$ 4500 per year). Your analysis is based on the principle of fully allocated costs. That is, it is assumed that staff and facilities are being utilized as intensively as they can be, given existing salaries, working conditions and supervision. While it may theoretically be possible for existing hospital staff to perform more services, in practice managerial changes and incentives that are beyond the scope of the proposed new service would be needed to achieve such gains. Fixed annual operating costs are maintenance (US$ 500) and salaries (US$ 1000).

Dr Vivek foresees a charge of US$ 25 for patients receiving diagnosis only, and US$ 50 per patient receiving diagnosis and treatment. Because of free care and incomplete collection of fees, net revenue will be half of these amounts.

Exercise 3

a. *Determine the annualized costs of Dr Vivek's proposal, counting all fixed and variable costs, and compare them to his original US$ 10 000 estimate.*
b. *Discuss how this project might affect costs in other patient care units.*
c. *Estimate the net income from the new procedure. Compare net income and costs and indicate the impact on the hospital's finances.*
d. *Discuss whether benefits to the health of the hospital's patients justify these costs.*
e. *If the capital costs of the new service are financed through the surplus, would the annualized costs be zero?*

Exercise 4. The wish list

Note: This case deals with thinking quantitatively about the costs of a new service, and qualitatively about its contribution to the facility's goals.

The Ministry of Health has asked each hospital to submit details of one capital improvement project that its administration wishes to be funded. Improvement projects can range from beautifying one or all wards to adding a new medical service or opening a new operating theatre. No dollar limit has been given, but the instructions state that you are to submit a financial feasibility statement showing all projected costs and revenues within a three-year time frame, and that you should not exceed an allowable net increase in operating cost of 1% of the hospital's operating budget, including annualized capital costs. It is noted that the funds from the ministry are "one-time only", implying that costs beyond the 1% guideline will need to be self-financed.

Exercise 4

Think of a capital improvement project for your hospital. Describe the types of data you would obtain to determine whether the impact is worth the cost of achieving it.

Exercise 5. Data sources and analysis

As the financial analyst in the Ministry of Health, you have been asked to check on Baba Hospital's estimated drug costs per admission for the recently completed fiscal year. Officials at the Ministry of Health feel that the hospital administrator's own estimates are inaccurate, both in terms of the overall average drug cost per admission and in the breakdown by each of the three wards (medicine, surgical, maternity). For the purpose of this exercise, assume that outpatients do not receive drugs and can be ignored.

One problem with the administrator's estimates is that they are based only on records of drugs purchased through official requisitions to the state pharmaceutical purchasing board. In reality, hospital staff often buy drugs locally (or on the private market) when emergencies arise, or when the state board runs out of certain drugs. The administrator did not know the amount of "unofficial" drugs purchased and counted only the US$ 900 000 in officially purchased drugs. The head pharmacist maintains a separate log that includes invoices on all drug purchases (i.e. official and unofficial) but the hospital administrator forgot this.

Your first task is to estimate the expenditures on "unofficial" drug purchases during the year. Your data source is a 60 cm-deep file drawer in the hospital pharmacy, which is full of paper invoices for all drugs obtained over the year. It would be extremely time-consuming to enter all these invoices into a database, so you decide to sample.

a. What two pieces of information do you need to obtain from the sample?
b. Suggest a sampling approach to estimate these two pieces of information.

Suppose you use a ruler to divide the invoices into 20 equal batches of 3 cm each, which you then mark with a paperclip. Then, in order to estimate the total number of invoices for the year, suppose you arbitrarily choose two of the batches and count the number of invoices in each batch (which turn out to be 98 and 102). You also randomly choose a percentage between 0 and 100 — e.g. 37%. By putting a mark on your ruler at 1.11 cm (37% of the 3 cm width of each batch), you quickly sample the invoice that is 37% of the way down each batch. Suppose the sampling results tell you that the average amount per invoice is:

	US$
Official drugs	440
Unofficial drugs	105
Total	545

c. *Using the total number of invoices per year, what is the amount of "unofficial drug purchases"? Is the estimate of US$ 900 000 for official drugs plausible? What is your estimate of the total being spent on both official and unofficial drugs, and what percentage is being spent on each?*
d. *Assuming that there were 12 000 hospital admissions in the most recent fiscal year, what is the average drug cost per admission?*
e. *Assuming that the proportional breakdown of drug cost per clinical department for each of the three wards (medicine, surgical, maternity) is 33%, 50% and 17% respectively, what is the total cost for each of these clinical services? What is the average drug cost per admission for each clinical service?*

Assume that you do not know the proportional breakdown of total drug costs across the three inpatient departments. Another problem presented to you as the Ministry of Health's financial analyst is that the hospital administrator did not have computerized data showing which wards were responsible for each drug purchase. She therefore estimated drug costs for each ward by allocating the total drug cost in proportion to each ward's share of the total inpatient floor space. As a result, she predicts the following drug costs per admission:

Administrator's estimate of official drug costs per admission, by ward

Ward	Floor space of each ward (m^2)	Distribution of floor space (%)	Estimated total drug cost (US$)	Admissions	Drug cost per admission (US$)
Medicine	250	25	225 000	3 000	75.00
Surgery	360	36	324 000	4 000	81.00
Maternity	390	39	351 000	5 000	70.20
Overall	1000	100	900 000	12 000	75.00

f. *Do you think floor space is a reliable measure of drug use? If not, what do you think is an appropriate measure?*

You doubt that the maternity ward could really have incurred higher drug costs than the surgical ward. You think you can improve on the hospital's estimates. Your data source is a box full of requisition forms submitted to the hospital pharmacy by the wards, filed in approximate chronological order. Each requisition shows the name of the drug, the quantity, and the ward that placed the request. Again, the box is large, so you decide to sample the requisitions randomly and pull out 20 records. You summarize the information in the following table (for simplicity, we assume there are only three drugs):

Number of bottles distributed by ward

	Drug A	Drug B	Drug C
Quantity for:			
Medicine	100	50	40
Surgery	80	30	20
Maternity	70	50	10

The requisitions do not show price, so you assume that each drug costs the amount usually charged by the state purchasing board. The prices per bottle are therefore $ 5 for drug A, $ 10 for drug B and $ 20 for drug C.

g. *Combine the prices and quantities to compute the total value of drugs purchased by each ward for the 20 sampled records.*
h. *Compute each ward's share of drug costs for this sample. Apply these shares to the total drug cost you computed earlier in order to estimate the total drug cost by ward.*
i. *Divide each ward's drug costs by its admission volume to obtain the drug cost per admission by ward. How do these numbers compare with the hospital's own estimates? Does it seem reasonable to allocate drug costs on the basis of each ward's share of floor space as the hospital administrator did?*

Exercise 6. Hospital reform case study

The state of Caribana is on the brink of health reform. Its Ministry of Health is currently designing a system of national health insurance expected to cover almost all of the country's residents. Persons insured under this system are to be covered for "essential hospital services". A new national health insurance organization will collect premiums from individuals and employers (and from government on behalf of the poor) and will pay hospitals. Essential hospital services, while not yet defined in detail, are expected to include a limited set of common and cost-effective treatments, such as deliveries (both ordinary and complicated), treatment of respiratory infections, appendectomy and other emergency surgery, and so on. General government revenues will continue to fund primary care services in public facilities and will also be used to cover highly specialized and expensive tertiary care in the country's major referral hospitals. Private physicians' services will continue to be paid for by voluntary private insurance or by patients themselves.

Currently, almost all of the country's hospitals are run by the Ministry of Health or by a regional health authority. Almost all (95%) of their funding comes from those sources, and only 5% comes from so-called "cost recovery" (private insurance and patient fees). While the ministry and health authorities would like to increase revenue from cost recovery, they have so far succeeded only with outpatient services and drugs. With regard to inpatient services, they

fear that if fees approach the real economic costs and exemptions become difficult to obtain, the services may become prohibitively expensive. If that happened, ordinary citizens would not be able to afford hospital care (or would experience financial hardship if they paid for it). Under a system of health insurance, hospitals could raise their inpatient fees and reduce their dependence on government subsidy while preserving access to needed hospital care.

Your assignment is to advise the government, as it moves from concepts to specific plans, by answering the following questions:

a. *On what basis would you define essential hospital services (i.e. the benefit package of the proposed insurance plan), and what kind of system of hospital costing would be needed to support this?*
b. *How should the health insurance authority pay hospitals for services that are covered?*
c. *Based on your answers to the preceding questions, what are the implications for the level and rate of change of hospital costs?*

Answers

Answers to Exercise 1

1a. As overhead costs represent only about one-quarter of the hospital's total cost and comprise a range of overhead services, administrators felt that overhead costs could be assigned in proportion to the direct costs of the final (intermediate and patient care) cost centres. Thus, the direct cost of each final cost centre should be used as the allocation statistic. The allocation percentages should be calculated as the share of each cost centre in total direct expenses (less overhead direct expenses). The total costs of each final cost centre are the sum of its direct and allocated costs. The total costs should equal (except for possible rounding error) the sum of the overhead costs plus the direct costs of each cost centre.

Table A11 contains the answer to Exercise 1a.

Table A11. Allocating overhead costs to cost centres (US$)

Cost centre	Direct expense (US$)	Allocation statistic: direct cost	Allocation %	Allocated expense (US$)	Total expense (US$)
Overhead:					
Administrative and other	34902	—	0.00	0	0
Intermediate:					
Ambulance, etc.	12804	12804	13.29	4640	17444
X-ray	6199	6199	6.44	2246	8445
Pharmacy	11737	11737	12.19	4253	15990
Laboratory	9134	9134	9.48	3310	12444
Patient care:					
Inpatient wards	30582	30582	31.75	11081	41663
Theatre	14811	14811	15.38	5367	20178
Outpatient department	11054	11054	11.48	4005	15059
Total	**131223**	**96321**	**100.00**	**34902**	**131223**

1b, 1c. Table A12 shows the answers to Exercises 1b and 1c.

Table A12. Calculating unit costs and potential cost recovery

Final cost centre	Total expense (US$)	Volume	Units	Unit cost (US$)	Target fee (%)	Target fee (US$)	Patients charged (%)	Collection efficiency (%)	Potential revenue (US$)
Intermediate:									
Ambulance	17 444	20 000	kilometers	0.87	60	0.52	90	80	7 536
X-ray	8 445	4 000	films	2.11	60	1.27	80	90	3 648
Pharmacy	15 990	30 000	scripts	0.53	75	0.40	60	90	6 476
Laboratory	12 444	50 000	tests	0.25	50	0.12	80	90	4 480
Patient care:									
Inpatient wards	41 663	15 000	days	2.78	30	0.83	70	70	6 124
Theatre	20 178	2 000	operations	10.09	20	2.02	80	80	2 583
Outpatient dept.	15 059	20 000	visits	0.75	60	0.45	70	80	5 060
Total	**131 223**								**35 907**

Based on these calculations, the hospital will recover 27% (35 907/131 223) of its costs through fees, slightly exceeding its target. While it may be possible to increase the amounts by increasing the target fee percentage, such increases may cause reductions in the percentage of patients from whom fees are actually collected (as higher fees may cause more exemptions). Alternatively, raising fee levels may simply lead to a reduction in the total number of patients, thereby reducing the effect of the fee increase on total revenues.

Answers to Exercise 2

2a. Failure to make the needed investment would mean discontinuing the service. Care should be exercised in identifying the choices. In this case, the three options for the hospital administrator are to maintain the laundry department as an in-house service with purchased new equipment, to contract an outside company to perform this service, or to lease the equipment from an outside company.

2b. First, we note that all three options involve a one-time income inflow of US$ 2000 from the sale of the old laundry equipment. We then examine the costs of each of these options in the order above. We present below the first-year costs, recognizing that they will rise by the rate of inflation.

- The capital cost of renovating and equipping the hospital's laundry facility is estimated to be US$ 95 000. We annualize this amount using the procedures in Box 1. Using 3% as the real interest rate, the annualization factor is 14.877. With an inflation rate of 7%, the replacement capital cost of the project at the end of the first year would be US$ 101 650 (US$ 95 000 × 1.07). The annualized capital cost is US$ 6833 (US$ 101 650 ÷ 14.877). Using the information above, total variable and fixed costs are:

	US$
Variable costs (0.03/kg × 300 000 kg)	9000
Fixed costs/year	
Annualized capital cost	6833
Maintenance and space costs	1400
Administrative salaries	8000
Total fixed and variable costs	25 233

  The net first-year cost of the in-house option is US$ 23 233 (US$ 25 233 less the one-time income of US$ 2000 from selling the equipment). The second-year cost is US$ 26 999 (US$ 25 233 × 1.07). We assume that operating costs rise with inflation, and our method of annualizing the capital costs gives values that also rise with inflation.
- The next step in the analysis is to determine the cost of the second option, i.e. to contract a company to do the laundry services for the

hospital. Using the price quotation from a company of US$ 0.06 per kg, the cost of the second option is:

	US$
Contract fee (US$ 0.06 × 300 000 kg of laundry)	18 000
In-house administrative oversight of contract	2000
Total cost of contract	20 000

The net first-year cost of the contract option is US$ 18 000 (US$ 20 000 less the one-time income of US$ 2000 from selling the equipment). The second-year cost is US$ 21 400 (US$ 20 000 × 1.07), as the price in the renewable contract will rise with inflation.

- The leased equipment would entail:

	US$
Variable costs	9000
Fixed costs/year	
Lease payment	10 000
Maintenance and space costs	1400
Administrative salaries	8000
Total fixed and variable costs	28 400

The net first-year cost of the lease option is US$ 26 400 (US$ 28 400 less the one-time income of US$ 2000 from selling the equipment). The second-year cost is US$ 30 388 (US$ 28 400 × 1.07) as the lease fee and other costs will rise with inflation.

2c. The first-year costs of the three options can now be compared: US$ 23 233 (in-house option), US$ 18 000 (contract option) and US$ 26 400 (lease option). The second-year costs have the same relationship, without the one-time income inflow. The hospital administrator would then choose the least-cost option of contracting out the work (US$ 18 000). The lease option is most expensive in this example. The cost of each of these options, as we have calculated it, would rise at the annual rate of inflation (7% per year).

2d. The option of contracting out the work provides flexibility for the hospital if the laundry or the space it occupies needs change. A laundry service that is contracted out might achieve efficiencies through more productive staff, better management, economies of scale through larger equipment, better use of plant and equipment through multiple shifts, or lower labour costs. One liability of this approach is the risk that transport may be interrupted, whether by vehicle breakdown, bad weather, civil disturbance or war. If this risk of interruption is significant, the in-house option may be necessary (as it proved to be when this analysis was done in a hospital in wartime Beirut, Lebanon). Alternatively, additional inventory and storage could provide another way to ensure adequate laundry even if transportation is disrupted. Financing the in-house option might pose a significant challenge for the hospital. Although the hospi-

tal may have some capital reserves, public hospitals usually need special approval for this type of capital expenditure.

2e. Other options are to share laundry services with another hospital, or group of hospitals. The laundry could be based either at your hospital or at another. Or one could buy used equipment, or see whether limited renovation could keep the laundry functional for a few more years.

Answers to Exercise 3

3a. We first derive the annualized capital costs. Assuming a life of 10 years, the annualization factor for the new endoscopy equipment is 8.530. The annualized capital cost for the endoscopy equipment in the first year is US$ 1254 (calculated as US$ 10 000 × 1.07 = US$ 10 700; US$ 10 700 ÷ 8.530). Assuming a life of 20 years, the annualization factor for the treatment room is 14.877, and its annualized capital cost in the first year is US$ 360 (US$ 5000 × 1.07 = US$ 5350; US$ 5350 ÷ 14.877). Together, the annualized capital costs in the first year are US$ 1614.

The variable and fixed costs are as follows:

	US$
Variable costs:	
Physician (0.25 of annual salary of US$ 10 000)	2500
Technician (0.5 of annual salary of US$ 3000)	1500
Nurse (0.5 of annual salary of US$ 5000)	2500
Supplies	4500
Total variable costs	11 000
Fixed costs:	
Annualized capital costs	1614
Maintenance	500
Administrative salaries	1000
Total fixed costs	3114
Total fixed and variable costs	14 114

3b. The new endoscopy procedure will forestall the admission of 250 surgical patients who would each have spent about a week in the hospital. Thus, the procedure will relinquish the beds that would have been occupied by these patients. As the hospital is crowded, it is likely that doctors would use the capacity in the surgical ward, operating room and recovery rooms to admit 250 "replacement" patients who, on balance, would not otherwise have been accommodated at the hospital. (The number of replacement patients assumes that they would have had the same length of stay as the former surgery patients now receiving endoscopy.) The impact on the surgical department would be twofold: saving the cost of the patients whose surgery was averted, but adding the cost of the replacement patients. If the hospital did not have a long waiting list of eligible patients, overall surgical admissions might decline.

3c. The anticipated gross revenues for the new programme would be US$ 6250 (250 diagnostic patients at US$ 25) plus US$ 12500 (250 surgical patients at US$ 50), or US$ 18750. The net revenues are half of this amount, or US$ 9375. Thus, the net revenues would cover about two-thirds of the costs of this programme. Several options need to be considered to cover this shortfall. First, the charge for diagnosis could be raised to US$ 38 and that for treatment (which forestalls a week of hospitalization) could be raised to US$ 75. Second, collections could be increased and free care reduced. Third, it might be possible to improve collections overall for the hospital. Finally, additional subsidy could be sought from the Ministry of Health.

3d. The project produces three types of health benefit. First, there is benefit to both types of endoscopy patient. Those receiving diagnosis only may obtain a more reliable diagnosis. Some patients may be spared unnecessary surgery and others will receive treatment earlier. Second, the patients receiving treatment would benefit from a faster recovery and, perhaps, a lower complication risk. Third, replacement patients admitted to the hospital because beds are made available will enjoy an improvement in health. On balance, the new service would allow the hospital to treat 250 additional surgical patients at an annual cost of US$ 14114, or US$ 56 per patient or US$ 8 per day. This is commensurate with or lower than the costs of many secondary hospitals in developing countries (Barnum & Kutzin, 1993). This service justifies its costs at least as much as that of other hospital services. Dr Vivek's proposal represents a reasonable, though not extraordinary, programme.

3e. The annualized capital cost of US$ 1614 would not be reduced to zero from an economic viewpoint. It represents the one-year value of money invested in the capital asset of the equipment and the room renovation. The depreciation, computed by accountants, is less. Using straight-line depreciation it would be US$ 1250 [US$ 10000/(10 years) plus US$ 5000/(20 years)]. The difference between these amounts is the opportunity cost of the money invested in the project.

Answers to Exercise 4

Making decisions on which capital projects will be undertaken is not an easy task for the Ministry of Health. The ministry's challenge is to allocate limited resources to a small number of projects. Your challenge is to present the best project information possible to enable the ministry to make a decision. Your part is extremely important because inadequate or inaccurate project information can lead to bad decision-making by the Ministry of Health.

Ideally, five major categories of information should be presented as part of your analysis:

Coherence with hospital and ministry goals. This is the whole rationale behind the ministry's decision-making: scarce resources are to be allocated among a virtually unlimited number of investment opportunities. The ministry's limitation on allowable operating cost is an encouragement for you to

submit only those projects that are in the hospital's best interests, and to submit those that are not in conflict with the broader goals and objectives of the ministry as a whole.

Identifying the alternatives available. Too many times, capital expenditures are presented on a "take it or leave it" basis; yet there are usually alternatives. For example, you may want to select different companies in the purchasing process to acquire the highest quality and lowest cost. Also, you may want to define different boundaries in the scope of the project over a certain time period.

Cost data. It is clear from this manual that cost information is an important variable in the capital project decision-making process. The life cycle costs of your proposed project should be presented. Limiting cost information to capital costs or operating costs can be counterproductive.

Benefit data. Benefit data can be divided into two categories: quantitative and qualitative. Quantitative information is not only synonymous with financial data but also encompasses service utilization data. Thus, it is important that your proposal includes an impact analysis that discusses the existing situation and the anticipated effects of implementing a programme.

For example, let us assume that your hospital is located in the Tansa Valley of India, a very rural area of many villages and towns. The nearest hospital that provides inpatient care in obstetrics and gynaecology is 30 miles away in Mumbai in a tertiary setting. One of the stated goals of your proposed project is to open 12 inpatient beds for obstetrical and gynaecological care, using a phased-in approach based on demonstrated demand. A realistic and quantifiable benefit of this project would be a numerical increase in patient-days for your institution and an associated increase in revenue (in some small way from paying patients). To show these benefits, you need to provide demographic data on your catchment area, including the proportion of women by certain age categories you expect to admit to your new inpatient unit. A qualitative benefit of the project is that it will allow local residents to have access to obstetrical and gynaecological care without travelling long distances.

Data regarding prior performance. Information on prior operating results of projects funded by the Ministry and/or the hospital can provide insight regarding the hospital's performance and reliability in forecasting.

Answers to Exercise 5

5a. The two pieces of information that need to be obtained from the sample are the number of invoices for unofficial drugs and the average expenditure per invoice for unofficial drugs. By multiplying these two pieces of information, one can estimate expenditures on unofficial drugs. Expenditures on official drugs had apparently already been obtained, but could be validated using the same process. These two expenditures should then be summed to obtain an estimated total amount spent on drugs during the sampling period.

5b. The first step is to choose the time period for the sample. The second step is to choose the sampling approach or method. There are several sampling approaches that can be used.

Monthly sampling: If you choose a sampling period of 12 months of a particular fiscal year, one sampling approach is to divide the invoices by month, which gives you 12 batches. From each month, randomly choose three calendar days (not necessarily regular workdays). Pull out the invoices for these three days for each month. The result is 36 batches. Some of these batches may contain no invoices if no drugs were ordered on that day. Include them anyway. Now separate the 36 batches into two piles: official and unofficial. Total each of these categories to estimate total expenditures on official drugs and total expenditures on unofficial drugs. To obtain the average amount per invoice for each category of expenditure, divide the respective total expenditure by the total number of invoices sampled for each category. To find the average number of invoices per day, divide the total count of invoices by 36. To arrive at the annual number of invoices, multiply the daily average by the number of regular workdays in the year (if the sample days were drawn only from workdays), or by the total number of calendar days in the year (365 or 366) if the days were sampled without regard to their workday status (i.e. if holidays and weekends were included).

Weekly sampling: Here the sampling units are weeks and you control for day-of-week effects. For the first week, randomly select one day by choosing a random number between 1 and 7. For each successive week, choose the next day of the week. For example, if Tuesday is selected for the first week, Wednesday would be selected for the second week, Thursday for the third, and so on. Now separate the invoices into two piles: unofficial and official. Continue the same process as for monthly sampling.

5c. This fixed-size sampling approach uses batches based on 3 centimetres rather than months or weeks. The choice of approach should be based primarily on convenience in identifying the requisite batches. In the fixed-size approach, the number of invoices per year is 2000. The value of unofficial drug purchases is estimated at US$ 210 000. This is calculated as US$ 105 per invoice multiplied by 2000 invoices. Similarly, the estimated official invoices total US$ 880 000 (calculated as US$ 440 per invoice multiplied by 2000 invoices), which means that the administrator's report of US$ 900 000 in official drug purchases is close to this approximation from the sample. Adding the official and unofficial expenditures, the total drug expenditures are US$ 1 110 000 (adding the estimated US$ 210 000 in unofficial drugs to US$ 900 000 in official drugs). The unofficial share is 18.9%.

5d. Based on a total of 12 000 hospital admissions for the most recent fiscal year, the average drug cost per admission is US$ 92.50 (US$ 1 110 000/12 000 admissions).

5e. The total cost for the three clinical services using the proportional breakdown of drug cost is as follows: US$ 366 300 (0.33 × US$ 1 110 000) for

medicine wards, US$ 555000 (0.50 × US$ 1110000) and US$ 188700 (0.17 × US$ 1110000).

5f. Floor space is not a reliable measure of drug use. This is because drug disbursements are not a function of the area of space on a particular ward but rather of the number of patients admitted to a hospital or the number of visits to a particular clinic and the utilization by each patient. Obviously, floor space is a reliable measure for housekeeping or janitorial costs. A reasonable measure of drug use could be the number of prescriptions filled by the inpatient and outpatient pharmacy services. A sample that includes the average cost per prescription by ward would improve the estimate.

5g,h. As is shown below, the total value (price multiplied by quantity) of drugs purchased by each ward is as follows: US$ 1800 (medicine), US$ 1100 (surgery), and US$ 1050 (maternity). For this sample, each ward's share of drug costs (rounded) was 46% (medicine), 28% (surgery), and 27% (maternity).

Total value of drugs purchased by each ward (example)

Ward	Drug A (US$)	Drug B (US$)	Drug C (US$)	Total cost by ward (US$)	Ward share of total (%)
Medicine	500 (100 bottles × $5)	500 (50 bottles × $10)	800 (40 bottles × $20)	1800	45.6
Surgery	400 (80 bottles × $5)	300 (30 bottles × $10)	400 (20 bottles × $20)	1100	27.8
Maternity	350 (70 bottles × $5)	500 (50 bottles × $10)	200 (10 bottles × $20)	1050	26.6
Total cost by drug	**1250**	**1300**	**1400**	**3950**	

Using the total cost figure of US$ 1110000 and each ward's share of drug costs, the total drug cost by ward is the following: US$ 506160 (0.456 × US$ 1110000), US$ 308580 (0.278 × US$ 1110000), and US$ 295260 (0.266 × US$ 1110000).

5i. Dividing each ward's drug costs by its admission volume, the drug cost per admission by ward is as follows: US$ 169 (US$ 506160/3000), US$ 77 (US$ 308580/4000), and US$ 59 (US$ 295260/5000). Compared to the hospital's own drug cost estimates, which were based on official records only and allocated on the basis of each ward's share of floor space, the drug cost per medical admission is 125% more (i.e. US$ 169 rather than US$ 75). The drug cost per surgical admission is about 5% less than the hospital's estimate (US$ 77 rather than US$ 81), and the drug cost per maternity admission is about 16% less than the estimate (US$ 59 rather than US$ 70).

Comparison of pharmacy revenues using floor space allocation versus actual purchases

Ward	Number of admissions	Method 1: total pharmacy costs using floor space allocation (US$)	Method 2: total pharmacy costs using actual purchases (US$)	Difference (method 1 minus method 2) (US$)
Medicine	3000	225 000 ($75 × 3000)	506 160 ($169 × 3000)	−281 160
Surgery	4000	324 000 ($81 × 4000)	308 580 ($77 × 4000)	15 420
Maternity	5000	351 000 ($70 × 5000)	295 260 ($59 × 5000)	55 740
Total		**900 000**	**1 110 000**	**−210 000**

The difference of US$ 210 000 is attributed to unofficial drugs not being accounted for by the administrator. The difference points to the inaccuracies of the hospital administrator's own estimates, both in terms of the overall average drug cost per admission and in the breakdown by each of the three wards (medical, surgical, maternity). This example also highlights the fact that the hospital administrator was erroneous in using floor space allocation as the measure of pharmacy costs.

Answers to Exercise 6

6a. Essential hospital services can be defined as those services that make a substantial contribution to the health of the people of Caribana, can be delivered at relatively low cost, and can be delivered effectively in most hospitals. Key factors in defining these services are high frequency of admission, capacity to deliver cost-effective treatments, and relatively low levels of technology (to ensure their widespread use). To operationalize these factors, it is useful to determine the leading causes of hospital admission, their cost-effectiveness (measured, in part, as the relationship between hospital costs and subsequent health improvement), and technology (measured perhaps by the proportion of the country's hospitals that can deliver the service with adequate quality).

To determine the cost of these services, some system of estimating cost by type of admission would be needed. A rough approximation would be an estimate of cost per day by type of admission (e.g. medicine, surgery, paediatrics). Then the cost of each type of admission could be estimated as the cost per day for the respective type of admission multiplied by the length of stay.

6b. A payment system must cover the hospital's reasonable and necessary costs. It should also provide incentives for economic efficiency — i.e. encourage the hospital to admit the appropriate patients and to treat them effectively and efficiently. Unfortunately, all payment systems create a mix of "positive" and "negative" incentives.

If everyone in the population selects or is assigned to a particular hospital for covered services, then each hospital could be prepaid a capitated rate (a

fixed amount for each person who is enrolled or assigned with the hospital). This process ensures the hospital a flow of resources while not encouraging excessive hospitalization. Prepayment, however, creates the risk that the hospital will not provide a sufficient quantity or quality of service, either in terms of the number of persons admitted or the level of treatment provided per case.

Reimbursement on a per case basis, as used in the United States' Medicare Programme (using Diagnosis Related Groups, or DRGs), provides an incentive for cost control during the course of a hospitalization, though not on the decision about which or how many patients to admit. It also provides perverse incentives to under-provide care to keep treatment costs below reimbursement levels, and to have frequent readmissions of patients in order to receive additional case-based payments. Payment on the basis of fee-for-service induces increased quantity of treatment but is often inflationary.

Because of the mixed incentives of all payment systems, corresponding administrative systems are needed to compensate for the negative incentives. A good example is utilization review, which can be used to compare treatment (including prescribing) patterns with defined protocols, determine if admissions are justified, and so forth.

6c. Hospital costs are likely to rise from expanding reimbursement for essential services. It is likely that some areas and some persons are underserved. If non-essential drugs were previously covered, the insurance system might actually reduce the utilization of those services.