Appendix 8A

***Multi-product Break-Even Analysis***

Questions

**8A-1** The term sales mix means the relative proportion in which a company’s products are sold. The usual assumption in cost-volume-profit analysis is that the sales mix will not change.

**8A-2**  A higher break-even point and a lower net income could result if the sales mix shifted from high contribution margin products to low contribution margin products. Such a shift would cause the average contribution margin ratio in the company to decline, resulting in less total contribution margin for a given amount of sales. Thus, net income would decline. With a lower contribution margin ratio, the break-even point would be higher since it would require more sales to cover the same amount of fixed costs.

Brief Exercises

**Brief Exercise 8A-1** (30 minutes) (LO2 CC 11A, 12A)

1. The overall contribution margin ratio can be computed as follows:

Overall CM ratio 

 = 30%

2. The overall break-even point in sales dollars can be computed as follows:

Overall break-even 

 = $120,000

3. To construct the required income statement, we must first determine the relative sales mix for the two products:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Claimjumper | Makeover | Total |
|  | Original dollar sales | $65,000 | $85,000 | $150,000 |
|  | Percent of total | 43.333% | 56.667% | 100% |
|  | Sales at break-even\* | $52,000 | $68,000 | $120,000 |
|  |  |  |  |  |
|  |  | Claimjumper | Makeover | Total |
|  | Sales | $52,000 | $68,000 | $120,000 |
|  | Less variable expenses\*\* | 36,000 | 48,000 | 84,000 |
|  | Contribution margin | $16,000 | $20,000 | 36,000 |
|  | Less fixed expenses |  |  | 36,000 |
|  | Net income |  |  | $    - |

\*Break even sales: Brake even sales × % of total ($120,000 × 43.333%; $120,000 × 56.667%)

\*\*Claimjumper variable expenses: ($45,000/$65,000) × $52,000 = $36,000

Makeover variable expenses: ($60,000/$85,000) × $68,000 = $48,000

**Brief Exercise 8A-2** (15 minutes) (LO2 CC12A)

|  |  |  |
| --- | --- | --- |
|  | X | Y |
| Sales price per unit  Less: Variable cost per unit | $36.00  21.00 | $24.00  12.00 |
| Contribution margin per unit | $15.00 | $12.00 |
| Ratio of sales | 60% | 40% |

Weighted-average sales

= ($36 × 60%) + ($24 × 40%) = $31.20

Weighted-average contribution margin

= ($15 × 60%) + ($12 × 40%) = $13.80

Weighted-average contribution margin ratio

= $13.80 ÷ $31.20 ≈ 44.23%

Overall break-even sales

= $276,000 ÷ 0.4423

≈ $624,011

The exact amount is $624,000 (the $11 difference is due to a rounding error).

**Brief Exercise 8A-3** (10 minutes) (LO1 CC2; LO2 CC12A)

1.

Budgeted sales mix is computed as follows:

Gamma: 12,000 units

Delta: 18,000 units

Total: 30,000 units

Gamma = 12,000 ÷ 30,000 = 40%

Delta = 18,000 ÷ 30,000 = 60%

2.

Contribution margin per unit is as follows:

Gamma = $42 - $22 = $20

Delta = $28 - $18 = $10

Weighted-average contribution margin

= ($20 × 40%) + ($10 × 60%)

= $8 + $6 = $14

**Brief Exercise 8A-4** (10 minutes) (LO2 CC25A)

The sales mix may be restated as 10%, 30%, 40% and 20% for the four products, using the given data (1:3:4:2).

Weighted-average contribution margin

= ($42 × 1/10) + ($36 × 3/10) + ($50 × 4/10) + ($20 × 2/10)

= $39

Break-even sales

= $273,000 ÷ $39 = 7,000 units

The break-even unoits for each of the four products using given sales mix will result in 700, 2,100, 2,800 and 1,400 units respectively. This is computed as 10% of 7,000 units and so on.

Exercises

**Exercise 8A-1** (45 minutes) (LO2 CC15A)

1.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Flight Dynamic | |  | Sure Shot | |  | Total Company | |
|  | Amount | % |  | Amount | % |  | Amount | % |
| Sales | P300,000 | 100 |  | P500,000 | 100 |  | P800,000 | 100.0 |
| Less variable expenses | 90,000 | 30 |  | 270,000 | 54 |  | 360,000 | 45.0\* |
| Contribution margin | P210,000 | 70 |  | P230,000 | 46 |  | 440,000 | 55.0 |
| Less fixed expenses |  |  |  |  |  |  | 327,500 |  |
| Net income |  |  |  |  |  |  | P112,500 |  |

\*P360,000 ÷ P800,000 = 45%.

1. The break-even point for the company as a whole would be:

Fixed expenses = P327,500 = P595,455

Overall CM ratio 0.55

3. Incremental contribution margin:

|  |  |
| --- | --- |
| P150,000 × 55% CM ratio | P82,500 |

Assuming no change in fixed expenses, all of the incremental contribution margin of P82,500 should carry forward to the bottom line as increased net income.

This answer assumes no change in selling prices, variable costs per unit, fixed expense, or sales mix.

Problems

**Problem 8A-1** (60 minutes) (LO1 CC1; LO2 CC15A)

1.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | ***White*** | | ***Fragrant*** | | ***Loonzain*** | | ***Total*** | |
| Percentage of total sales | 40% | | 24% | | 36% | | 100% | |
| Sales | B600,000 | 100% | B360,000 | 100% | B540,000 | 100% | B1,500,000 | 100% |
| Less variable expenses | 432,000 | 72% | 72,000 | 20% | 216,000 | 40% | 720,000 | 48% |
| Contribution margin | B168,000 | 28% | B288,000 | 80% | B324,000 | 60% | B 780,000 | 52%\* |
| Less fixed expenses |  |  |  |  |  |  | 898,560 |  |
| Net income (loss) |  |  |  |  |  |  | B 118,560 |  |

\*B780,000 ÷B1,500,000 = 52%.

2. Break-even sales would be:



3. Memo to the president:

Although the company met its sales budget of B1,500,000 for the month, the mix of products changed substantially from that budgeted. This is the reason the budgeted net income was not met, and the reason the break-even sales were greater than budgeted. The company’s sales mix was planned at 20% White, 52% Fragrant, and 28% Loonzain. The actual sales mix was 40% White, 24% Fragrant, and 36% Loonzain.

As shown by these data, sales shifted away from Fragrant Rice, which provides our greatest contribution per dollar of sales, and shifted toward White Rice, which provides our least contribution per dollar of sales. Although the company met its budgeted level of sales, these sales provided considerably less contribution margin than we had planned, with a resulting decrease in net income. Notice from the attached statements that the company’s overall CM ratio was only 52%, as compared to a planned CM ratio of 64%. This also explains why the break-even point was higher than planned. With less average contribution margin per dollar of sales, a greater level of sales had to be achieved to provide sufficient contribution margin to cover fixed costs.

**Problem 8A-2** (60 minutes) (LO2 CC7, 12A)

1.

|  |  |  |
| --- | --- | --- |
|  | (fixed costs for 5,000 units) |  |
| Price |  | $629.99 |
| Variable costs: |  |  |
| Materials | $700,000 |  |
| Labour | $175,000 |  |
| Overhead | $600,000 | $295.00 |
| Shipping |  | $ 10.99 |
| Contribution margin |  | $324.00 |
|  |  |  |
| Fixed costs: |  |  |
| Manufacturing | $755,000 |  |
| Advertising | $200,000 | $955,000 |



≈ 2,948 units

**Problem 8A-2** (continued)

2.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Gold Model | | Silver Model | |
|  | (fixed costs for 5,000 units) |  | (fixe costs for 5,000 units) |  |
| Price |  | $629.99 |  | $549.99 |
| Variable costs: |  |  |  |  |
| Materials | $700,000 |  | $500,000 |  |
| Labour | $175,000 |  | $175,000 |  |
| Overhead | $600,000 | $295.00 | $500,000 | $235.00 |
| Shipping |  | $ 10.99 |  | $ 10.99 |
| Contribution margin |  | $324.00 |  | $304.00 |
|  |  |  |  |  |
| Fixed costs: |  |  |  |  |
| Manufacturing | $755,000 |  | $500,000 |  |
| Advertising | $200,000 | $955,000 | $150,000 | $650,000 |

Weighted-average sales price

= ($629.99 × 70%) + ($549.99 × 30%)

= $605.99 per unit

Weighted-average contribution margin

= ($324 × 70%) + ($304 × 30%)

= $318 per unit

**Problem 8A-2** (continued)

Weighted-average contribution margin ratio

= $318 ÷ $605.99

= 52.48%

Overall break-even sales

= Total fixed expenses ÷ Weighted-average contribution margin ratio

= ($955,000 + $650,000) ÷ 0.5248

≈ $3,058,308 (rounded up)

3. In computing the overall break-even sales, we use the total fixed costs. The total fixed costs will not change regardless of how they are allocated to the two products. Therefore, the overall break-even sales dollars will remain the same. If the sales mix changes to 50:50 the contribution margin ratio will change to 53.22%, and the break-even sales will change to $3,015,784 (rounded up).

**Problem 8A-3** (75 minutes) (LO2 CC8, 11A, 12A)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. | a) |  | Hawaiian Fantasy | | | Tahitian Joy | | |  | Total | |
|  |  |  | Amount | % |  | | Amount | % |  | Amount | % |
|  |  | Sales | $900,000 | 100.0 |  | | $1,500,000 | 100.0 |  | $2,400,000 | 100.0 |
|  |  | Less variable expenses | 540,000 | 60.0 |  | | 300,000 | 20.0 |  | 840,000 | 35.0 |
|  |  | Contribution margin | $360,000 | 40.0 |  | | $1,200,000 | 80.0 |  | 1,560,000 | 65.0 |
|  |  | Less fixed expenses |  |  |  | |  |  |  | 1,427,400 |  |
|  |  | Net income |  |  |  | |  |  |  | $  132,600 |  |

b)



Margin of safety:

|  |  |
| --- | --- |
| Margin of safety | = actual sales – break-even sales |
| $2,400,000 – $2,196,000 | = $204,000 |
| Margin of safety in percentage | = margin of safety in dollars ÷ actual sales |
| $204,000 ÷ $2,400,000 | = 8.5% |

**Problem 8A**-**3** (continued)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2. | a) |  | Hawaiian Fantasy | |  | | Tahitian  Joy | |  | | Samoan  Delight | |  | Total | |
|  |  |  | Amount | % |  | Amount | | % |  | Amount | | % |  | Amount | % |
|  |  | Sales | $900,000 | 100.0 |  | $1,500,000 | | 100.0 |  | $1,350,000 | | 100.0 |  | $3,750,000 | 100.0 |
|  |  | Less variable expenses | 540,000 | 60.0 |  | 300,000 | | 20.0 |  | 1,080,000 | | 80.0 |  | 1,920,000 | 51.2 |
|  |  | Contribution margin | $360,000 | 40.0 |  | $1,200,000 | | 80.0 |  | $ 270,000 | | 20.0 |  | 1,830,000 | 48.8 |
|  |  | Less fixed expenses |  |  |  |  | |  |  |  | |  |  | 1,427,400 |  |
|  |  | Net income |  |  |  |  | |  |  |  | |  |  | $   402,600 |  |

**Problem 8A-3** (continued)

2. b)



Margin of safety:



3. The reason for the increase in the break-even point can be traced to the decrease in the company’s overall contribution margin ratio when the third product is added. Note from the income statements above that this ratio drops from 65% to 48.8% with the addition of the third product. This product (the Samoan Delight) has a CM ratio of only 20%, which causes the average contribution margin per dollar of sales to shift downward.

This problem shows the somewhat tenuous nature of break-even analysis when the company has more than one product. The manager must be very careful of his or her assumptions regarding sales mix, including the addition (or deletion) of new products.

It should be pointed out to the president that even though the break-even point is higher with the addition of the third product, the company’s margin of safety is also greater. Notice that the margin of safety increases from $204,000 to $825,000 or from 8.5% to 22%. Thus, the addition of the new product shifts the company much further from its break-even point, even though the break-even point is higher.

**Problem 8A-4** (90 minutes) (CC12A)

a.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MITCHELL CO. LTD.** | | | | | | | | | | | |
| **MULTI-PRODUCT BREAK-EVEN SALES ANALYSIS**  **(All dollar amounts are in thousands)** | | | | | | | | | | | |
|  | **Economy** | |  | **Standard** | |  | **Fancy** | |  | **Total** | |
|  | Amount | Percent |  | Amount | Percent |  | Amount | Percent |  | Amount | Percent |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Budgeted Sales and Income** |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Sales (units) | 875 |  |  | 450 |  |  | 350 |  |  | 1,675 |  |
| Sales | $157,500 | 100.0 |  | $ 99,000 | 100.0 |  | $112,000 | 100.0 |  | $368,500 | 100.0 |
| Less: variable expenses | $ 81,900 | 52.0 |  | $ 49,500 | 50.0 |  | $ 44,800 | 40.0 |  | $176,200 | 47.8 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Contribution margin | $ 75,600 | 48.0 |  | $ 49,500 | 50.0 |  | $ 67,200 | 60.0 |  | $192,300 | 52.2 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Less: fixed expenses |  |  |  |  |  |  |  |  |  | $170,300 |  |
| Net income |  |  |  |  |  |  |  |  |  | $ 22,000 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Break-even Sales** |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Overall break-even sales | Fixed expenses, $170,300,000 | | | | | ≈ | $ 326,245,211 (rounded up) |  |  |  |  |
|  | Weighted-average contribution margin ratio, 52.2% | | | | |  |  |  |  |

Sales price per unit ($’000s) $180 $220 $320

Variable cost per unit ($’000s) $93.60 $110 $128

b.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MITCHELL CO. LTD.** | | | | | | | | | | | |
| **MULTI-PRODUCT BREAK-EVEN SALES ANALYSIS**  **(All dollar amounts are in thousands)** | | | | | | | | | | | |
|  | **Model I** | |  | **Model II** | |  | **Model III** | |  | **Total** | |
|  | Amount | Percent |  | Amount | Percent |  | Amount | Percent |  | Amount | Percent |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Actual Sales and Income** |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Sales (units) | 775 |  |  | 550 |  |  | 350 |  |  | 1,675 |  |
| Sales | $139,500 | 100.0 |  | $121,000 | 100.0 |  | $112,000 | 100.0 |  | $372,500 | 100.0 |
| Less: variable expenses | $ 72,540 | 52.0 |  | $ 60,500 | 50.0 |  | $ 44,800 | 40.0 |  | $177,840 | 47.7 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Contribution margin | $ 66,960 | 48.0 |  | $ 60,500 | 60.0 |  | $ 67,200 | 60.0 |  | $194,660 | 52.3 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Less: fixed expenses |  |  |  |  |  |  |  |  |  | $ 170,300 |  |
| Net income |  |  |  |  |  |  |  |  |  | $ 24,360 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Break-even Sales** |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Overall break-even sales | Fixed expenses, $170,300,000 | | | | | ≈ | $325,621,415 |  |  |  |  |
|  | Weighted-average contribution margin ratio, 52.3% | | | | |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Notes**: |  |  |  |  |  |  |  |  |  |  |  |
| Selling price per unit (from #1) | $ 180 |  |  | $ 220 |  |  | $ 320 |  |  |  |  |
|  | | | |  |  |  |  |  |  |  |  |

Note: The appendix uses sales dollars as the basis for computing sales mix; therefore actual units have been converted into sales dollars in order to compute sales mix percentage.

**Problem 8A-5** (50 minutes) (LO2 CC 12A)

1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Party Animal** | **Study Mate** | **Total** |
|  |  |  |  |  |
| Sales proportion |  | 60% | 40% | 100% |
| Sales units |  | 12,000 | 8,000 | 20,000 |
| Selling price per unit |  | $400 | $260 |  |
| Contribution margin/unit |  | $124 | $ 70 |  |
|  |  |  |  |  |

Weighted-average sales price/unit = ($400 × 60% + $260 × 40%)

= $344.00

Weighted-average contribution margin per unit = ($124 × 60% + $70 × 40%)

= $102.40

Weighted-average contribution margin ratio = $102.40 ÷ $344 = 29.77%

Break-even sales in dollars = ($950,000 + $604,430) ÷ 0.2977

≈ $5,224,824 (rounded up)

Break-even sales in units = ($950,000 + $604,430) ÷ $102.40

≈ 15,180 (rounded up)

Break-even sales for individual products can be computed as follows:

Party Animal = 15,180 × 60% = 9,108 units

Study Mate = 15,180 × 40% = 6,072 units

**Problem 8A-5** (continued)

2.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Party Animal** | **Study Mate** |  |
|  |  |  |  |  |
| Selling price |  | $400.00 | $260.00 |  |
| Variable costs: |  |  |  |  |
| Direct materials |  | $100.00 | $ 78.00 |  |
| Direct labour |  | $ 80.00 | $ 60.00 |  |
| Overhead |  | $ 64.00 | $ 40.00 |  |
| Selling |  | $ 32.00 | $ 22.00 |  |
|  |  |  |  |  |
| Contribution margin/unit |  | $124.00 | $ 60.00 |  |
| Fixed costs: |  |  |  |  |
| Manufacturing |  |  |  | $ 950,000 |
| Selling & Administrative |  |  |  | $ 804,430 |
|  |  |  |  | $1,754,430 |
| Sales mix (based on sales in units) |  | 50% | 50% |  |

**Problem 8A-5** (continued)

Weighted-average sales price/unit = ($400 × 50% + $260 × 50%)

= $330.00

Weighted-average contribution margin per unit = ($124 × 50% + $60 × 40%)

= $92.00

Weighted-average contribution margin ratio = $92.00 ÷ $330 = 27.88%

Break-even sales in dollars = ($950,000 + $804,430) ÷ 0.2788

≈ $6,292,791 (rounded up)

Break-even sales in units = ($950,000 + $804,430) ÷ $92.00

≈ 19,070 (rounded up)

Break-even sales for individual products can be computed as follows:

Party Animal = 19,070 × 50% = 9,535 units

Study Mate = 19,070 × 50% = 9,535 units

From a profitability standpoint this change does not make much sense because additional money is being spent to increase sales of the product with a lower contribution margin ratio. The break-even sales increases by over 25%.

**Problem 8A-5** (continued)

3.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Party Animal** | **Study Mate** |  |
|  |  |  |  |  |
| Selling price |  | $400.00 | $260.00 |  |
| Variable costs: |  |  |  |  |
| Direct materials |  | $ 80.00 | $ 62.40 |  |
| Direct labour |  | $ 64.00 | $ 48.00 |  |
| Overhead |  | $ 64.00 | $ 40.00 |  |
| Selling |  | $ 32.00 | $ 12.00 |  |
|  |  |  |  |  |
| Contribution margin/unit |  | $160.00 | $ 97.60 |  |
| Fixed costs: |  |  |  |  |
| Manufacturing |  |  |  | $1,400,000 |
| Selling & Administrative |  |  |  | $ 604,430 |
|  |  |  |  | $2,004,430 |
| Sales mix (based on sales in units) |  | 60% | 40% |  |

**Problem 8A-5** (continued)

Weighted-average sales price/unit = ($400 × 60% + $260 × 40%)

= $344.00

Weighted-average contribution margin per unit = ($160 × 60% + $97.60 × 40%)

= $135.04

Weighted-average contribution margin ratio = $135.04 ÷ $344 = 39.25%

Break-even sales in dollars = ($1,400,000 + $604,430) ÷ 0.3925

≈ $5,106,828

Break-even sales in units = ($1,400,000 + $604,430) ÷ $135.04

≈ 14,844 (rounded up)

Break-even sales for individual products can be computed as follows:

Party Animal = 14,844 × 60% = 8,907 units

Study Mate = 14,844 × 40% = 5,937 units

From a profitability standpoint this change appears to make sense because the investment results in a much lower break-even sales level. The increase in the fixed costs is more than offset by the higher contribution margin achieved with the new machine. Both the weighted-average contribution margin per unit and contribution margin ratio increases substantially.