COST BEHAVIOUR, COST-VOLUME-PROFIT (CVP) ANALYSIS, AND BREAK-EVEN PLANNING

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Executive Summary

This report uses cost accounting and cost-volume-profit (CVP) analysis to a hypothetical, multi-product commercial enterprise, UrbanBite Foods Ltd., which sells three packaged snack products: Classic Bites, Protein Crunch and Fruit Mix. Objective is to demonstrate the classification of costs, estimation of their behaviour, how to calculate break-even sales, how the margin of safety can be calculated and how the sales needed to reach a target profit can be calculated. These figures are merely estimates and are not facts or the financial statements of an actual company.

The report then distinguishes between fixed, variable and mixed costs and provides an illustration of the high-low method of estimating the variable and fixed components of a mixed delivery cost. The weighted-average contribution margin ratio is 40% assuming the sales mix. The break-even sales are about £150,000 per month and planned sales of £200,000 give a margin of safety of £50,000 (or 25%). The business's sales are required to be £225,000 for the operating profit to be £30,000 per month, assuming that all sales mix and cost mixture are unchanged.

If the selling price were lowered by 5% instead of being offset by increased volume and/or a reduction in cost, the effect of this scenario would be significant on profit. On the other hand, a slight decrease in the variable costs increases contribution and decreases the break-even point. The report suggests tracking contribution by product, checking cost estimates regularly, conducting spreadsheet sensitivity analysis, and steering clear of only looking at the number of sales when taking pricing decisions. CVP is a good tool for short term planning but it is based on assumptions that the price, cost and sales mix remain fixed; managers should therefore use CVP in conjunction with demand forecasts and qualitative judgement.

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1 Introduction

1.1 Background and purpose

Cost accounting supplies management with data for planning, controlling operations and determining pricing, product mix and capacity decisions. Management cost information can be organized around the various decisions that face an enterprise; financial accounting is primarily used to report information to external users. Some costs vary with activity, others do not, and this is crucial to the concept of cost behavior (Drury, 2018).

Cost volume profit analysis is the relationship between selling prices, sales volume, variable costs, fixed costs and operating profit. It serves to answer practical questions like: What level of sales is needed to prevent a business from losing money, what can the level of sales drop by before the business becomes unprofitable, and what level of sales will be needed for a specified profit level? CVP is especially valuable for short run planning, as long as the assumption(s) are stated (Garrison, Noreen and Brewer, 2021).

1.2 Business case and objectives

The business in question is a hypothetical business called UrbanBite Foods Ltd which sells three packaged snack products online and in retail stores. Management has been suffering from ups and downs in sales and would like to find out if the level of sales it is experiencing is sufficient to maintain a safety margin. The objective of the report is to simulate the company's cost by month and offer pricing and profit-planning advice that is based on evidence.

To classify and estimate costs, to use the high-low method with a mixed cost, to calculate product contribution, weighted-average contribution, break-even sales, margin of safety and target-profit sales, to test changes in prices and costs, and to recommend controls for use by management in a spreadsheet-based planning model.

2 Theoretical Framework and Cost Principles

2.1 Cost classification and behaviour

A fixed cost is a cost that is the same in total for a specific range of production (within a specific range) and a specific time period, but that decreases per unit of production when output is increased. Examples include a monthly software subscription, or a warehouse lease. A variable cost varies with respect to the volume of activity, but the cost per unit is assumed to stay constant (packaging, ingredients). A mixed cost has a fixed cost component and a variable cost component; for example, a delivery contract that includes a base monthly charge, plus a cost for each delivery (Drury, 2018).

The importance of correct classification is that a cost can vary in different capacities and different time periods. The lease can be monthly, but can be added to if more space in the warehouse is needed. Labour may be step fixed if a new supervisor is required, it may be variable if the shifts are flexible. Managers would then need to record the activity driver and period and range of the activity for each cost, rather than assuming classifications for all costs.

2.2 CVP concepts and assumptions

Contribution is the difference between how much sales are made and how much variable costs are. It first accounts for fixed costs, and if there are any contributions left over, then it becomes an operating profit. The contribution per unit is selling price – variable cost per unit. Break-even is the activity level where Total Revenue equals Total Cost; so that there is no profit. Break-even units = Fixed costs / Contribution per unit (for 1 product) In a multi-product firm, the calculation is based on an average contribution margin and a constant sales mix.

The following assumptions are normally made for CVP: The selling price and unit variable cost will be constant; the change in the volume of production and sales will not change

fixed costs within the relevant range; the volume of production and sales will be the same; and the mix will not change. What's actually happening, however, is that discounts, inflation, waste, capacity constraints, and shifting customer preferences can undermine these assumptions! The model should not be used as a prediction but as a decision aid (Atrill and McLaney, 2022).

3 Cost Calculations and Scenario Analysis

3.1 Data on product mix and costs assumed

The following figures are only indicative monthly planning assumptions. Units of sales mix is 50% Classic bites, 30% Protein crunch, and 20 % Fruit mix. Each product is sold in a standard pack and the expected sale quantity of the month is 10,000 packs each product.

Product	**Sales mix**	**Selling price (£/pack)**	**Variable cost (£/pack)**	**Contribution (£/pack)**
Classic Bites	50%	£10.00	£6.00	£4.00
Protein Crunch	30%	£15.00	£9.00	£6.00
Fruit Mix	20%	£8.00	£4.00	£4.00

If the mix is assumed to be 10,000 packs, then there are 5,000 Classic Bites, 3,000 Protein Crunch and 2,000 Fruit Mix. Revenue is £50,000 + £45,000 + £16,000 = £111,000, and variable costs are £30,000 + £27,000 + £8,000 = £65,000. Contribution is therefore £46,000. The fixed cost budget is assumed to be £60,000 for a simple monthly operating model, which covers premises, fixed cost of management (salaried), depreciation, insurance and fixed administration costs. The company at this volume would run at a loss of £14,000. This is a reason for management to evaluate the sales level instead of just the revenue.

3.2 Using high-low method to estimate mixed cost

In the high-low method, the activity levels are contrasted in the highest and lowest periods of use to estimate the fixed and variable parts of a mixed cost. Suppose that in a low-activity month 8,000 shipments cost £18,000 and that in a high-activity month 14,000 shipments cost £27,000.

Measure	High month	Low month	Difference
Shipments	14,000	8,000	6,000
Total delivery cost	£27,000	£18,000	£9,000

Variable delivery cost per shipment = change in cost ÷ change in activity = £9,000 ÷ 6,000 = £1.50. Fixed cost = total cost - (variable rate x activity). Using the high month: £27,000 − (£1.50 × 14,000) = £6,000. The cost equation for the estimated total delivery cost is thus: Total delivery cost = £6,000 + (£1.50 × shipments).

The method is simple but only two observations are used, so if the weather is unusual or if fuel prices or a one-off surcharge happens, this may affect the estimate. Management should make comparisons with additional months of data, and in case sufficiently reliable data are available, regression analysis should be considered. The estimate is the most defensible one in the case that both observations are in the same relevant range and that there is no change in cost conditions.

3.3 Contribution and break-even analysis

To make a multi-product calculation, the weighted-average contribution per pack is (50% x £4) + (30% x £6) + (20% x £4) = £4.60 per pack. The weighted-average selling price is (50% × £10) + (30% × £15) + (20% × £8) = £11.10. The weighted-average variable cost is £11.10 − £4.60 = £6.50. The contribution margin ratio is £4.60 ÷ £11.10 = 41.44%.

The number of break-even units = £60,000 ÷ £4.60 is 13,044.48 which rounds up to about 13,044 packs. The break-even sales dollars are calculated as: Break-even sales dollars = fixed costs / Contribution margin ratio = £60,000 / 0.4144 = approximately £144,800. The 13,044-pack estimate is based on the assumption that the same sales mix (50:30:20) will be maintained as it was for this multi-product business. The larger the shift the greater the required volume.

CVP measure	Formula	Result
Weighted-average contribution	Σ (mix × unit contribution)	£4.60 per pack
Contribution margin ratio	£4.60 ÷ £11.10	41.44%
Break-even volume	£60,000 ÷ £4.60	13,044 packs (approx.)
Break-even sales	£60,000 ÷ 41.44%	£144,800 (approx.)

3.4 Margin of safety and target profit

Let's say that your management is predicting that sales revenue will be £200,000 per month. Margin of safety is budgeted sales minus break-even sales: £200,000 − £144,800 = £55,200. The margin of safety ratio is £55,200 ÷ £200,000 = 27.6%. This means that if costs and mix stay as forecasted, sales will need to drop by approximately 27.6% below the forecast level for the business to break-even.

To determine the target-profit sales, the desired profit is added to the fixed costs and divided by the contribution margin ratio. To earn £30,000 operating profit, required sales = (£60,000 + £30,000) ÷ 0.4144 = approximately £217,181. This equates to approximately 19,566 packs at the weighted average selling price of £11.10. These figures are planning estimates and should be rounded up to practical pack volumes.

3.5 Sensitivity analysis

Sensitivity analysis is used to assess the impact of varying important assumptions. The following table is based on forecast sales of £200,000, variable costs 58.56% of sales and fixed

costs of £60,000. The base case contribution is £82,880 with an estimated operating profit of £22,880.

Scenario	Assumption	Estimated operating profit	Management interpretation
Base case	Sales £200,000; variable costs 58.56%	£22,880	Reference position
Price reduction	Average price falls 5%; volume unchanged	£12,880	Profit falls because contribution per sale declines
Variable-cost reduction	Variable-cost ratio falls from 58.56% to 56.56%	£26,880	£4,000 additional profit at the same sales level
Sales decline	Sales fall 10% to £180,000; cost ratio unchanged	£14,592	Profit remains positive but safety margin narrows
Target profit	Sales increase to about £217,181	£30,000	Sales target required at current mix and cost assumptions

If the volume of sales stays constant and the price reduction is 5%, the total variable costs are assumed not to change, and the revenue drop is £200,000 x 5% = £10,000, meaning that the profit drops by around £10,000. In reality, a price cut could lead to an increase in demand, but that volume must be modelled before it can be approved. Profit is increased by £4,000 at £200,000 of revenue due to a decrease of two percentage points in the variable-cost ratio. This can be done by product standardization and/or the reduction of waste and/or better packaging efficiency, where product quality is guaranteed.

4 Discussion and Managerial Implications

These calculations reveal that revenue is not a good measure of financial security of a business. Contribution is the most important measure because it enables us to see what contribution each product makes towards the fixed costs and profit. Protein Crunch provides the highest unit contribution at £6, but the price and demand for it might differ from other products.

However, contribution per pack should not be the only parameter management should look at, they should also consider contribution per limiting resource, repeat purchase, market demand and the production capacity.

The margin of safety is a valuable risk indicator. The 27.6% forecast margin is not a safety margin, but rather a margin: it can be quickly shortened by reducing demand or by increases in input costs, or by a change in product mix. Cost drivers are also of importance as seen in the high-low estimate. In the event of an increase in shipment volume, delivery cost will be £1.50 per shipment over the base rate subject to the limitations of this estimate.

Prices should be determined by the expected customer reaction to the contribution. A reduction in price can lead to a higher sales volume, but can also lead to a loss in profit if the additional contribution is not enough to cover the price reduction. Likewise, cost reduction efforts need to make the distinction between waste and costs that are a safeguard for quality or customer service. A quick price hike due to ingredient or packaging quality cut-back may hurt demand and brand reputation.

When the business has multiple products with varying sales mixes and step fixed costs or capacity limitations, the CVP approach is not as reliable. Management to revise assumptions on monthly basis, review actual performance against the budget, analyze differences and use various demand scenarios. The model should be used in conjunction with market research and competitor analysis and operational judgement, not in place of.

5 Conclusion and Recommendations

This report has illustrated the uses of cost classification and the high-low method and CVP analysis in the process of profit planning in a multi-product business. The weighted-average contribution margin ratio is 41.44%; break-even sales are approximately £144,800 and the margin of safety at sales forecast of £200,000 is 27.6% and sales of about £217,181 are required to generate an operating profit of £30,000 under the illustrative assumptions. The sensitivity analysis reinforces that price and variable-cost shifts can be significant in terms of profitability.

These are the steps recommended:

- Keep a monthly cost ledger, distinguishing between fixed, variable and mixed costs and with notation of the activity driver for each estimate.
- Monitor and alternatively update the contribution (i.e. the weighted-average contribution) for each month seeing the sales mix of it and then contribute by product; this should be reviewed whenever the sales mix or the contribution from the products changes.
- Use the High: Low result as a first approximation only and compare to a longer series of data or / and regression, if applicable.
- Create a spreadsheet-based CVP dashboard that includes assumptions, formula-driven outputs and base, optimistic and downside scenarios that can all be readily uploaded and edited.
- As opposed to assuming that by having a higher sales amount, there will also be greater profit, test any discount against a volume increase that will help to keep total profit the same.
- Established a plan to sell for making a target profit and compares actual sales with a plan based on break even and margin of safety.

In general, CVP analysis provides a straightforward model for short-term decisions that can be very helpful if information is accurate, assumptions are clear, and assumptions are continually reevaluated. Together with demand forecasting and management judgement, it should be a valuable tool for Urban Bite to safeguard profitability in a volatile market.

References

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Appendices: Spreadsheet Output and Cost Breakdowns

Appendix A: Core formulas

Measure	Formula
Contribution per unit	Selling price per unit − variable cost per unit
Total contribution	Total sales − total variable costs
Operating profit	Total contribution − fixed costs
High-low variable rate	(High cost − low cost) ÷ (High activity − low activity)
High-low fixed component	Total mixed cost − (variable rate × activity)
Break-even units	Fixed costs ÷ weighted-average contribution per unit
Break-even sales	Fixed costs ÷ weighted-average contribution margin ratio
Margin of safety	Budgeted/actual sales − break-even sales
Margin of safety ratio	Margin of safety ÷ budgeted/actual sales × 100
Target-profit sales	(Fixed costs + target operating profit) ÷ contribution margin ratio

Appendix B: Monthly fixed-cost budget (illustrative)

Cost item	Monthly amount (£)	Behaviour assumed
Warehouse and office lease	18,000	Fixed within current capacity
Salaried management and administration	22,000	Fixed within current staffing level
Depreciation and equipment lease	8,000	Fixed
Insurance and software subscriptions	4,000	Fixed
Marketing and general administration	8,000	Fixed for the planning month
Total fixed costs	60,000	—

Appendix C: Spreadsheet setup

Suggested input cells: product selling prices; unit variable costs; sales mix; forecast sales volume; fixed-cost budget; shipment activity; and high/low delivery cost observations. Suggested calculated cells: contribution per unit, weighted-average contribution, contribution margin ratio, break-even units and sales, margin of safety, target-profit sales, and scenario profit. Protect formula cells from accidental editing and label all assumptions clearly. All financial values in this report are hypothetical and are provided solely to demonstrate the method.