

Linear Algebra and Calculation of the Margin Rate of Product Safety

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Abstract: Based on the existing scholars' theoretical researches on the traditional cost-volume-profit analysis and theory of activity-based costing, this paper introduces the activity-based cost-volume-profit analysis into the actual cases, redivides the cost of M Company on the basis of theory of activity-based costing, and analyzes the break-even point and sensitivity coefficient of the redivided cost. Moreover, the results of the traditional cost-volume-profit analysis are compared with the results of the activity-based cost-volume-profit analysis, in aid of helping M Company find the most critical points that really affect the profit of the enterprise and find the profitability of each product. Furthermore, combined with the actual situation of M Company, this paper puts forward the corresponding cost control countermeasures, and draws the conclusion that the work-based cost-volume profit analysis is more suitable for the current production of the enterprise, which also provides certain reference value for other similar furniture manufacturing enterprises.

Keywords: Cost-volume-profit analysis, Theory of activity-based costing, Furniture enterprises, Cost control.

1. Introduction

Currently, as the competition intensifies and the production of enterprises requires transformation, furniture manufacturing enterprises not only usher in unprecedented opportunities, but also face more severe challenges. Cost, as the lifeblood of enterprises, is an important factor for enterprises to increase their competitiveness and obtain high profits. Adopting the cost analysis method in line with the actual situation of the enterprise, the enterprise can find the shortcomings of the current cost and the aspects that need to be improved. For wooden furniture manufacturing enterprises, they have always adopted the business strategy of small profits and quick turnover, but the cost of high material, production and transportation causes high total cost for the enterprises. Therefore, it is urgent to reduce the cost for them.

2. Literature Review

The theoretical research of cost-volume-profit analysis has been developed in foreign countries for hundreds of years. During this period, foreign scholars have completed the basic concept, graphic expression, profit and loss model research, as well as the restriction conditions and break-even point research of cost-volume-profit analysis. Dionysius Landner put forward the idea of cost-volume-profit analysis. Later, Johann Friedrich Schar discovered and proposed the calculation method of break-even point, and further explained the formula through cases. After the formula and calculation method of the break-even were put forward, scholars began to study the relationship between cost and profit on this basis. As the cost-volume-profit analysis model was gradually known by scholars abroad, quantities of scholars have conducted further research on the volume-profit analysis model from the perspective of the limiting factors of cost-volume-profit analysis, the break-even model and the impact on the cost control of enterprises. D.R.Finley and Woody concluded that the cost-volume-profit analysis model can only be employed under certain restrictions called the

assumption conditions of cost-volume profit analysis, which can reduce the difficulty of use by reducing the scope of application of cost-volume-profit analysis. Luis Gonza focused on the key concepts of cost-volume-profit analysis, and proposed a linear function model related to cost-volume-profit, building a model diagram relevant to cost, profit and business volume, obtaining the possible combination of profit and break-even, and exploring the practicability of this model. Ayub Mehar believed that the cost-volume-profit analysis has a special position in the field of cost management that can be accepted by everyone as a convenient and understandable calculation tool. In the same year, Jams A.Yunker proposed that cost-volume-profit analysis can solve the problem how product revenue and cost will affect sales volume, and provide clear and understandable results to managers through simple calculation. After that, Johann Friedrich Schar proposed the concept of "break-even point" and explained how to calculate the break-even point.

3. Research Process

3.1. Design Formulas

This paper is mainly about break-even point analysis and sensitivity analysis. Break-even analysis is an analytical method used to study the condition of neither loss nor profit of an enterprise. Break-even point refers to the sales volume when the enterprise reaches this state, under which the revenue of the enterprise is just equal to the positive cost. When sales are above this level, the firm makes a profit. On the contrary, if the sales volume is lower than this level, the enterprise will generate negative profits. With break-even analysis, the break-even point can be expressed in terms of sales volume and operating income of break-even point. The calculation formula of break-even sales volume is [1]: break-even point = fixed cost (unit price – unit variable cost) = marginal contribution of fixed cost.

Operating income at break-even point = sales volume at break-even point × unit price of sales, this formula can be employed to analyze the impact of the number of products

sold on operating profit on the condition that other factors remain unchanged, so as to control the sales volume accordingly. Sensitivity analysis refers to the degree of influence of the changing factor on the change of the target value when only one factor is assumed to change and the rest factors remain intact. Its main purpose is to analyze the degree of change of the target index caused by the change of different factors. This paper adopts the sensitivity analysis of profit, which means the impact on profit when a certain factor of the cost changes.

3.2. Relevant Assumptions

Cost-volume-profit analysis contains four assumptions as follows. First, the assumption of relevant scope means the premise of cost division into fixed cost and variable cost is established within a certain range. Second, the linear model hypothesis includes the linear relationship among fixed cost, variable cost and sales volume, and revenue and sales volume. Third, the hypothesis of production sales balance means that the output in the cost-volume-profit analysis is equal to the sales volume. The products produced by the enterprise can always be completely sold out. Four, the assumption of constant variety structure means that the proportion of sales revenue of each product will not change in enterprises which run multiple varieties of products.

3.3. Cost-volume-profit Analysis Decision Index

3.3.1. Contribution Margin

Contribution margin refers to the amount of the selling price of a commodity minus variable costs, which can be used to cover fixed cost and generate profits. What's more, calculating marginal contribution can be used to evaluate the profitability of a product. If the calculation result is positive, it means that the revenue of the commodity can cover its variable cost and create value for the enterprise, deserving continuous production. When the enterprise has fixed cost, the contribution margin amount of the commodity is equal to the fixed cost of the enterprise, indicating that the enterprise is in the state of capital preservation. When the contribution margin is greater than the fixed cost, it is the operating profit. If the marginal contribution is less than the fixed cost of the enterprise, it indicates that the enterprise has problems in operation and has the risk of failure [2].

3.3.2. Margin of Safety

Margin of safety refers to the distance between the target sales volume and the break-even sales volume in the presence of the target sales volume. If the margin of safety is greater than zero, the greater the number is, the greater the distance between the target sales volume and the break-even point is, meaning that the product has better profitability, and the enterprise is in an environment of safe production and operation. If the margin of safety is less than zero, it means that the product is of no profit, and continued production will bring risks to the enterprise, so the production of the product should be reduced or stopped [3].

Similarly, on the basis of the margin of safety, margin-of-safety ratio can be obtained, which refers to the margin of safety as a percentage of expected sales volume, helping the enterprise managers judge whether the enterprise is currently in a safe and stable operating environment which is conducive

to making more reasonable production and operation decisions through intuitive comparison. Margin-of-safety ratio = margin of safety ÷ actual or expected sales × 100% = Margin of safety ÷ actual or expected sales × 100%

4. Break-even Analysis

Operation basis cost-volume-profit analysis break-even analysis includes break-even point sales and break-even point operation volume analysis. Based on the zero profit point of the enterprise, this kind of analysis is targeted at the cost, operation volume, sales volume and profit.

After the behavior analysis under activity-based costing, the cost-volume-profit analysis can be adopted for M Company. Assume that the production and sales volume of the product i ($i=1-4$) is x_i , the unit short-term variable cost is v , the unit sales price is p , the amount of operations consuming j ($j=1-5$) is y_{ij} [4], and the total fixed cost of the four products $a = \text{CNY } 1,304,900$, expressing the contribution margin is calculated differently from the traditional cost-volume-profit analysis under the activity-based approach. The contribution margin is the unit price of sales minus the unit short-term variable cost, not the unit variable cost. Meanwhile, the two analysis methods are also different in the numerator when calculating the break-even point. The numerator of traditional break-even analysis only has fixed cost, but the numerator of activity-based break-even analysis includes long-term variable cost and fixed cost, and the calculation formula of break-even point is as follows [5]:

$$Q1 = (1.38y_{11} + 0.03y_{12} + 19.19y_{13} + 0.08y_{14} + 0.03y_{15}) + 8.72/p_1 - 0.46$$

$$Q2 = (1.38y_{11} + 0.03y_{12} + 19.19y_{13} + 0.08y_{14} + 0.03y_{15}) + 6.97/p_2 - 0.24$$

$$Q3 = (1.38y_{11} + 0.03y_{12} + 19.19y_{13} + 0.08y_{14} + 0.03y_{15}) + 11.04/p_3 - 0.68$$

$$Q4 = (1.38y_{11} + 0.03y_{12} + 19.19y_{13} + 0.08y_{14} + 0.03y_{15}) + 83.76/p_4 - 0.58$$

Under this formula, the break-even sales volume and sales volume of each product under the analysis of activity-based cost and profit can be calculated. The calculation process and results are shown in the table:

Western enterprises regard the products with a margin-of-safety ratio of more than 40% as very safe, the products with a margin-of-safety ratio of 20% to 30% as relatively safe, and the ones with a margin-of-safety ratio of 10% to 20% as alert products. According to this standard, under the activity-based cost-volume-profit analysis, the wardrobe and the sofa made of solid wood of M Company are very safe products, wooden bed is relatively safe products, and the table made of solid wood is the product that should be vigilant. The product safety degree calculated under the activity-based cost-volume-profit analysis is different from the one under the traditional cost volume-profit analysis. The table made of solid wood with small output under the traditional cost-volume-profit analysis has the highest safety degree, but this is not the case under the activity-based cost-volume-profit method. This phenomenon is mainly caused by the division of indirect costs [6].

Table 1. Basic data of commodities

Name of the Commodities	Wooden Bed	Solid Wood Dining Table	The Wardrobe	Solid Wood Sofa
Sales Unit Price (ten thousand yuan/piece)	0.5	0.32	105	0.71
Unit Short-term Variable Cost (ten thousand yuan/piece)	0.37	0.22	0.68	0.51
Marginal Contribution (ten thousand yuan/piece)	0.13	0.1	0.37	0.2
Long-term Variable Cost (ten thousand yuan)	49.23	28.01	117.68	304.57
Fixed Cost (ten thousand yuan)	8.72	6.97	11.04	83.76
Total Long-term Variable and Fixed Costs(ten thousand yuan)	57.95	34.98	128.72	388.33
Profit Before Interest and Tax (ten thousand yuan)	6.79	4.82	104.38	568.07
Profit Margin Before Interest and Tax	2.28%	3.78%	15.76%	16.73%
Break-even Sales (piece)	445.77	349.8	347.89	1941.65
Break-even Sales Volume(ten thousand yuan)	222.89	111.94	365.28	1378.57

Table 2. Calculation of margin of safety rate

Name of the Commodities	Wooden Bed	Solid Wood Dining Table	The Wardrobe	Solid Wood Sofa
Sales Volume (ten thousand yuan)	298.98	127.59	662.27	3395.3 1
Break-even Sales Volume (ten thousand yuan)	222.89	111.94	365.28	1378.57
Amount of Margin of Safety (ten thousand Yuan)	76.09	15.65	296.99	2016.74
Rate of Margin of Safety	25%	12.27%	44.84%	59.40%

5. Conclusion

Under the traditional cost-volume-profit method, the overhead cost is divided according to the product output. The products with small output will be allocated with little overhead cost, while the products with large output will bear most of the overhead cost, which will cause the cost of products with large output to be falsely inflated and the cost of products with small output to be deflated. With the activity-based cost-volume-profit analysis, the cost of the product is allocated according to the actual amount of work consumed, which effectively avoids the distortion of cost allocation. Products with a small output may consume a large amount of work, while correspondingly, products with a large output do not necessarily consume a large amount of work. In a consequence, the product safety degree of M Company has deviations because of different analysis methods.

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