Chapter 2 – Part II

Classifying Costs for the purposes of Decision Making

(Cost Behavior Analysis)

In order to be able to *manage costs* and to *make decisions*, managers need to understand the ***cost behavior pattern*** of each cost item (or cost object) and to identify its primary ***cost driver(s)***. To achieve this objective, we perform cost behavior analysis. To do so, we need to understand the following concepts:

- Cost Behavior Analysis
- Cost Driver
- Relevant Range of Activity
- Cost Behavior Patterns
  - variable cost
  - Fixed Cost
  - Mixed Cost
  - Step-Fixed Cost
  - Piecewise Linear Variable Costs
- Cost Estimation

Cost Behavior Analysis

Cost behavior analysis is the process of finding how the TOTAL amount that a company spends on a specific cost item (or cost object) responds to changes in its cost driver.

Knowing how a cost reacts to a change in the cost driver helps manager classifies costs as either variable or fixed cost. This classification helps managers to minimize (control) costs, make accurate decisions and carry out proper planning and control functions.

Cost Driver

A **cost driver** is an activity or a factor that ***causes*** costs to be incurred, in the first place.

Subsequent **changes** in the level of a cost driver *may* or *may not* trigger changes in the **total cost** incurred.

The way that the total cost responds to changes in its cost driver is referred to as "***cost behavior pattern***".

How to Measure Cost Driver

We measure the cost driver by the quantity of output volume of the main business activity. Following are some examples of activity cost drivers' measures:

- Number of units produced in a manufacturing company.
- Number of units sold in a retail company.
- Number of miles driven in a trucking company.
- Number of students enrolled in a school.
- Number of patient visits in a health clinic.

Example of Cost Driver:
Assume that you decided to rent a car for the weekend. What are primary factors that determine the total amount that you pay for car rental? Following are some examples:

- # of miles driven,
- # of days you keep the car,
- Car Size (Full size, medium, small),
- Type of the car (Luxury, regular, economy), etc.

Change in the cost driver should result in a changes in the total costs incurred.

In order for you to minimize the rental costs, it is necessary that you identify and manage the correct cost drivers.

Cost Behavior Pattern

There three possible types of cost behavior patterns:

(i) Total costs may remain **constant** regardless of changes in the activity level of the cost drivers. We refer to this cost behavior as **fixed cost**.
(ii) Total costs may vary directly and **proportionally** to changes in the activity level of the cost driver. We refer to this cost behavior as **variable cost**.
(iii) Total costs may vary but not **proportionally** to changes in the activity level of the cost driver. We refer to this cost behavior as **mixed cost**.

If the cost behavior pattern is *mixed*, then we need to measure and separate the fixed component from variable component. This, in turn, helps us to classify costs in ONLY two categories: variable costs and fixed costs.

We determine the cost behavior pattern (variable cost, fixed cost, or mixed cost) by examining the relationship between the total cost incurred on a cost object responds and its cost driver. We refer to this process as "Cost Estimation".

Cost Estimation

- Cost estimation is the process of identifying and measuring costs as variable or fixed based on past relationships is called cost estimation.
- Cost estimation is useful for cost prediction in the decision-making process.

Assumptions of Cost Behavior Analysis:

Three simplifying assumptions that are made in connection with the determination of cost behavior patterns:

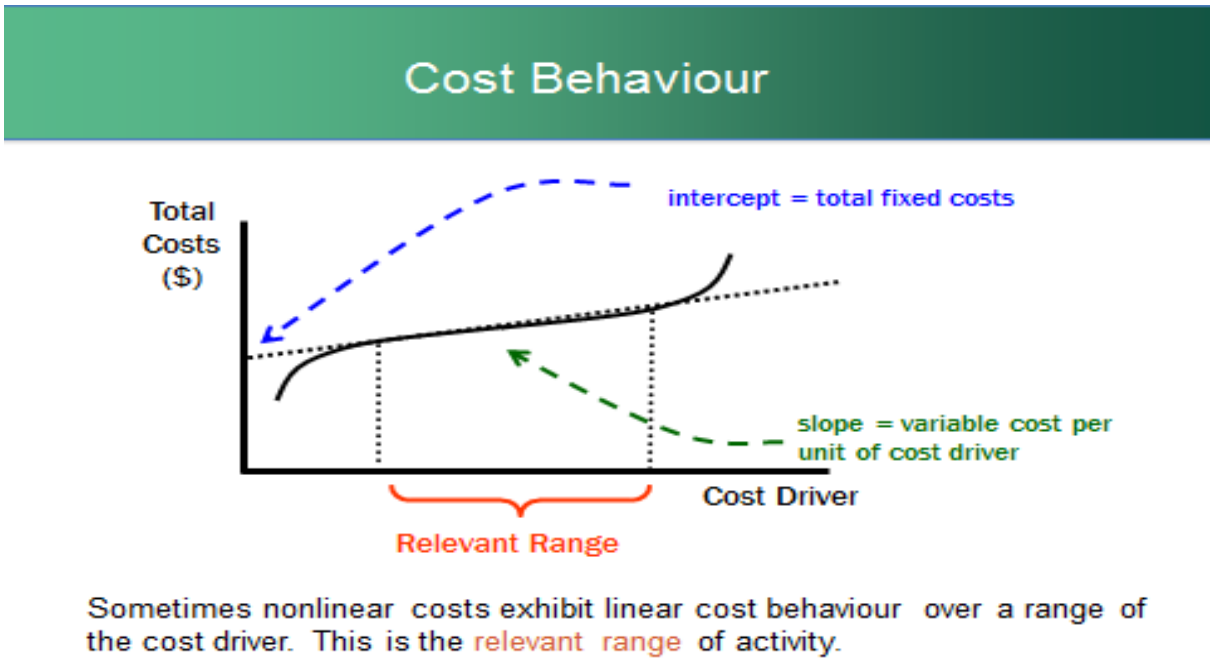
1. The Relationship between the **total cost** of a cost item and its volume of activity (or cost driver) is ***linear***. The true underlying total cost, however, is curve linear.
2. As activity level changes, the total cost exhibits two possible types of cost behavior patterns: ***variable*** cost and ***fixed*** cost. In reality, however, costs may exhibit many other behavior patterns such as mixed cost, step-fixed costs and piecewise variable Costs.
3. The identified cost behavior pattern (variable vs. fixed) is valid only within a ***relevant range of activity.***

Relevant Range of Activity:

- Relevant range is the range of activity within which the company usually operates.

- Within the relevant range, fixed costs will remain the same in total, and variable costs will increase proportionately in total as activity levels increase. Above or below the relevant range, the cost behavior may not be linear and predictions of future costs will be less accurate.

- For instance, the rent expenses that a company pays for its production facility will remain the same till the maximum production capacity of the facility. When the production increases beyond that point, the company will need to rent a new facility which will cause the fixed cost to increase with production.



Types of Cost Behavior Patterns

There are five basic possible patterns of behavior patterns: (i) variable cost, (ii) fixed cost, (iii) mixed costs, (iv) step-fixed costs and (v) piecewise variable costs.

Variable costs

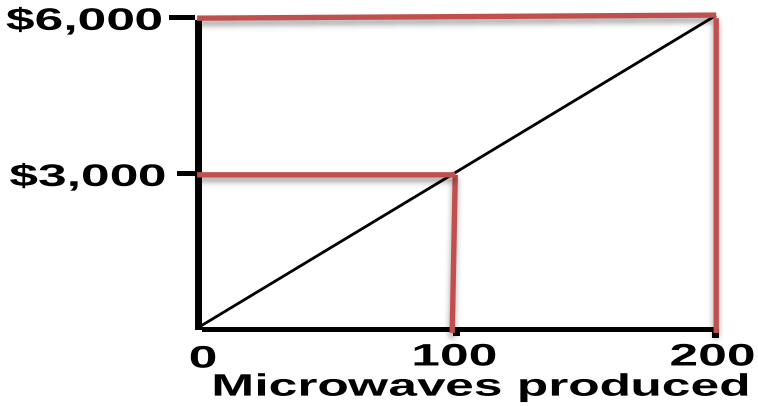
- Variable cost is a cost whose **total amount** varies in **direct proportion** to changes in the related level of activity (i.e., cost driver as measured by the volume of output).
- This implies that per unit variable cost is constant and that total variable cost equals to zero when activity level is zero.
- Examples of variable costs in a manufacturing setting include direct material and direct labor. The greater the number of units produced, the higher the total raw material costs incurred.

Example

A company manufactures microwave ovens. Each oven requires a timing device that costs $30. The following table presents per unit and total cost of the timing device at various levels of activity

Cost per Timing Device	*Number of Ovens Produced*	***Total Variable Cost—Timing Devices***
$30	1	$ 30
30	100	3,000
30	200	6,000

Total Variable Cost



Note the following:

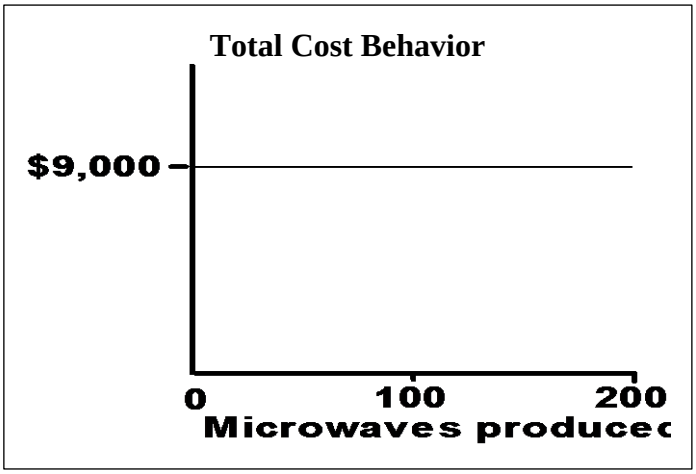
- **The *graph*** of a variable cost is a straight line beginning at the origin with positive slope.
- The slope of the variable cost line is the variable cost per unit.

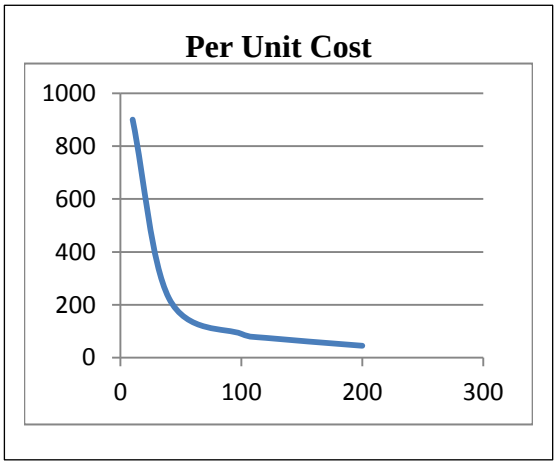
Fixed cost

- Fixed cost is a cost whose **Total amount** remains unchanged for a given time period, regardless of the changes in the related level of total activity or volume.
- As production volume increases, **total fixed costs stay the same** within the relevant range. However, the ***per unit costs decreases*** as the total output increases. This is because we are dividing a constant numerator [total fixed costs] by a progressively larger denominator [total production or sales]. Thus, the resulting costs per unit become smaller and smaller but not at a constant rate.
- For example, rent cost of factory building is a fixed cost because total rent will not change regardless of the level of production. However, the per unit of rent cost declines as the production volume increases.

Example:
Assume again that a company manufactures microwave ovens. The company pays $9,000 per month to rent its factory building. The total and per unit cost of rent at various levels of activity would be:

Rent Cost per Month	*# of Ovens Produced*	*Rent Cost per Oven*
$9,000	1	$9,000
9,000	10	900
9,000	100	90
9,000	200	45





Note the following:

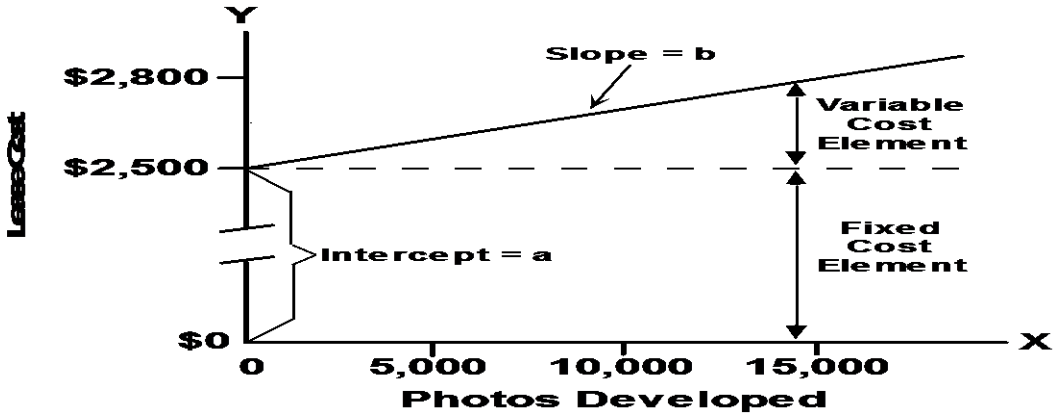
1. Costs are defined as variable or fixed with respect to a particular relevant range. **Relevant range** is the span of activity for a given cost object within which total fixed costs remain constant and variable costs per unit of activity remain constant.
2. The definition of variable and fixed are with reference to the **TOTAL** Cost.
3. The behavior of per unit cost is the opposite of the total cost. That is, per unit of variable cost is constant and per unit of fixed cost decreases as the number of units produced increases (and vice versa).

Mixed costs

- **Mixed costs**, often called **semi-variable costs**, contain both a variable cost component and a fixed cost component. When changes in production/sales occur, mixed costs change in total, but not proportionately to the change in activity.
- In order to use a mixed cost in decision-making, we must break down the mixed costs into fixed and variable components using a cost ***estimation method***.

Example 1 of Mixed Costs

Lori Yang leases a photocopy machine for $2,500 per year plus 2¢ per copy.

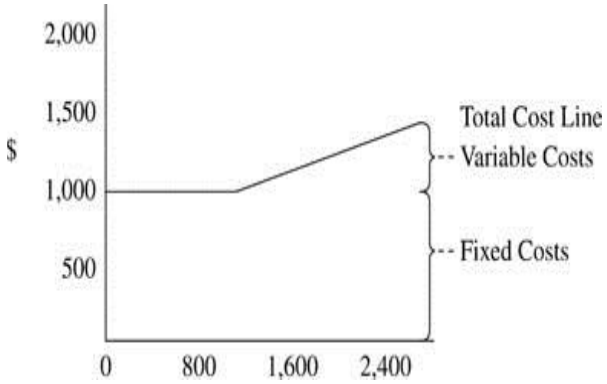


Equation of a straight line: Y = a + b(x) **Y = $2,500 + $0.02(x)**

Example 2 of Mixed Cost

Mixed costs

Some costs, called **mixed costs**, have characteristics of both fixed and variable costs. For example, a company pays a fee of $1,000 for the first 800 local phone calls in a month and $0.10 per local call made above 800. During March, a company made 2,000 local calls. Its phone bill will be $1,120 ($1,000 + (1,200 × $0.10)).

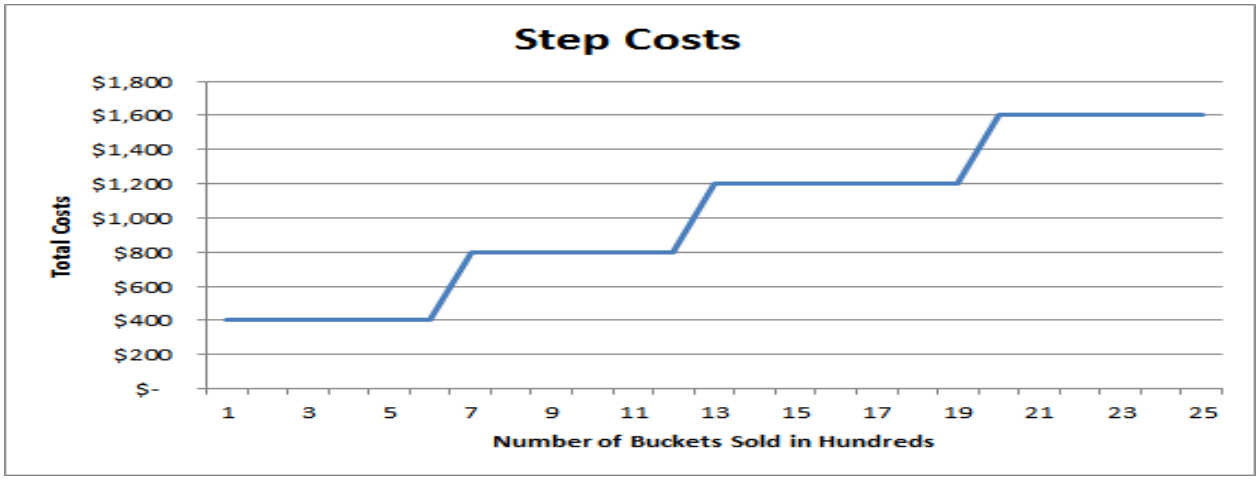


To analyze cost behavior when costs are mixed, the cost must be split into its fixed and variable components. Several methods, including scatter diagrams, the high-low method, and least-square regression, are used to identify the variable and fixed portions of a mixed cost, which are based on the past experience of the company. This topic will be covered in Chapter 10

Step-Fixed Cost

Step costs are fixed costs that that remain constant for a short range of activity, then the total cost jumps up (rises) to a new fixed cost level once the level of activity exceeds the relevant range. The total fixed costs continue to 'steps up' (rises) by the same amount at each new range of activity. Step costs look like stair steps when graphed.

Example
Consider the cost of cashier salaries in a company that produces and sells buckets. Each cashier is paid $400 per week. When sales are less than 600 buckets during a month, the store needs only one cashier, resulting in total cashier salaries of $400 for the month. When production and sales range from 600 buckets up to 1,200 buckets, two salaried workers are necessary costing $400 a week, for a total fixed salary cost of $800. The total fixed costs rises (steps up) by the cost of one additional cashier at each new range of activity.

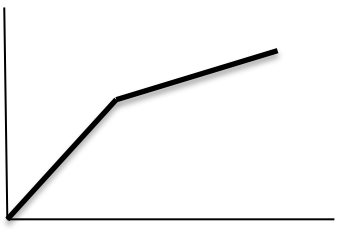


Piecewise Linear Variable Costs

The variable cost per unit changes across different relevant ranges. A common example is volume price discounts.

Example:

Pay as you go phone service. The rate is $0.35 per minute for the first 100 minutes and $0.25 per minute thereafter.



Total Cost Equation

The following formula expresses costs the *total cost equation*:

Total costs (TC) = Total fixed costs (TFC) + Total variable costs (TVC)

Total costs (TC) = Total fixed costs (TFC) + [Variable cost per unit × Number of units (***X***)]

$$TC = TFC + VC(X)$$

$$\text{Average Unit Cost} = \frac{\text{Total fixed costs} + \text{Total variable costs}}{\text{Number of units}}$$

Note that the average cost per unit declines with the increase in production due to decrease in the unit fixed cost, and vice versa.

How to Objectively Determine Cost Behavior Types

What happens to the *total* cost when sales or production levels increases.

- If an increase in sales/production causes the *total* cost to increase proportionately, the cost is considered variable.
- If an increase in sales/production has no effect on the amount of the total cost, the cost is considered fixed.
- If an increase in sales/production causes the *total* cost to increase but not proportionately, the cost is considered mixed.

Practice Problems

Problem1:
Use the following information about shipping cost to identify its type.

	Total Cost
Shipping 400 units	$1,200
Shipping 350 units	$1,020

Solution:

	Total Cost	Cost Per Unit
Shipping 400 units	$1,200	$3.00
Shipping 350 units	$1,020	$2.91

- Because the total costs at the two levels are not the same, we conclude that the cost is not fixed.
- Because the unit costs differ at the two activity levels, the cost is not variable.
- Thus, since the cost is not fixed or variable, it is a mixed cost.

Problem 2:
Two costs at Amcor Co. appear below for two months of operations.

	Month	Total Cost	Units Produced	Per Unit cost
Copying costs	March	$9,800	9,800	
	April	$8,064	8,400	
Communications costs	March	$6,080	800	
	April	$5,168	680	
Maintenance costs	March	$10,080	800	
	April	$10,080	680	

Required:

Determine the type of cost behavior for each cost.

1. **Copying costs**
2. **Communications costs**
3. **Maintenance costs**

Problem 3:
ABC Company produced last month 650 units of its single product with total costs of $2,825. Of this amount $1,625 is variable. The relevant range is (300 units – 800 units).

Required:

1. How much is total fixed costs if 500 units are produced?

2. How much is the total cost when 540 units are produced?

3. How much is the incremental cost if the company produces 10 more buckets?

4. How much is the total cost when 900 units are produced?

Problem 4:

In July, the Allen Co. incurred total shipping costs of $40,000 and shipped 3,200 units. In August it shipped 6,200 units and paid total shipping costs $58,000

Required:

1. Determine the type of cost behavior for shipping cost.

   Mixed

2. How much is the total cost when 5000 units are shipped?

   We need to Estimate the cost function to answer this question.
   We will cover this in the next section.

Problem 5:

Premium Pickups is an up-scale, higher-priced, specialty pickup truck maker based in Irvine California. The management accountant for Premium Pickups compiled information for various levels of pickup truck output:

	Pickup Truck Output		
	3,000 trucks	**6,000 trucks**	**9,000 trucks**
Variable Manufacturing costs	$ 29,640,000	$_____	$_____
Fixed Manufacturing costs	_____	39,200,000	_____
Variable S&A costs	4,500,000	_____	_____
Fixed S&A costs	13,660,000	13,660,000	_____
Total costs	$_____	$_____	$_____
Selling price per truck	**46,000**	**40,100**	**35,900**
Average Unit cost	**29,000**	_____	_____
Profit per truck	_____	_____	_____

Required:

Fill in the blanks with the correct figures.

Solution

	Pickup Truck Output		
	3,000 trucks	6,000 trucks	9,000 trucks
Variable production costs	$ 29,640,000	$ 59,280,000	$ 88,920,000
Fixed production costs	39,200,000	39,200,000	39,200,000
Variable selling costs	4,500,000	9,000,000	13,500,000
Fixed selling costs	13,660,000	13,660,000	13,660,000
Total costs	87,000,000	121,140,000	155,280,000
Selling price per truck	46,000	40,100	35,900
Unit cost	29,000	20,190	17,253
Profit per truck	17,000	19,910	18,647

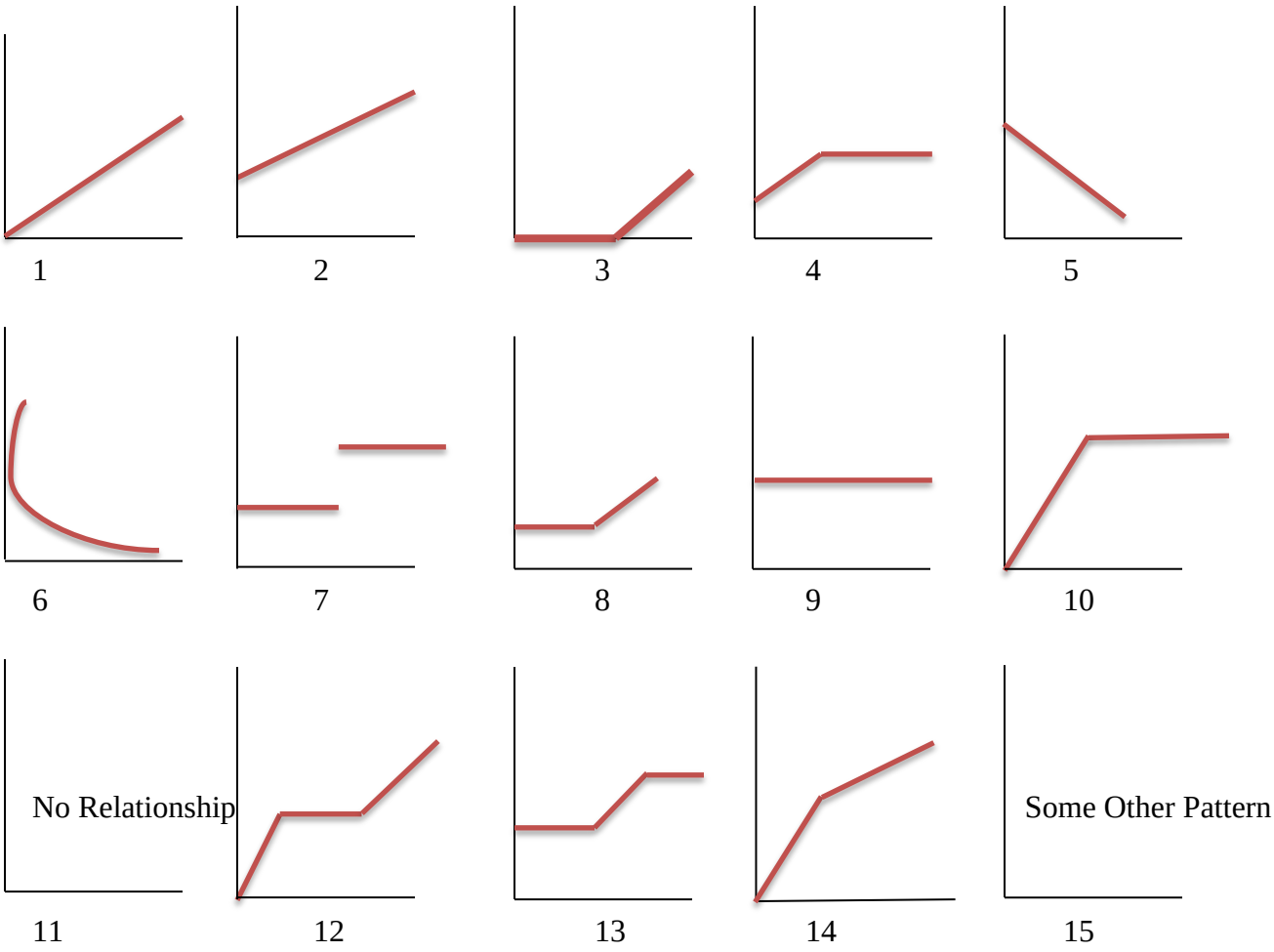
Problem 6: Cost Behavior Patterns (Graphs):

- Figure 1 on the next page presents a number of charts, each indicating some relationship between cost and a cost driver. No attempt has been made to draw these charts to any particular scale; the absolute numbers on each axis may be closely or widely spaced.
- Indicate by number which one of the charts best fits each of the situations or items described. Each situation or item is independent of all others; all factors not stated are assumed to be irrelevant.
- **Some charts may be used more than once**; some may not be used as they may not apply to any of the situations.
- Note that chart 11, "No Relationship" and chart 15, "Some other pattern."

Required:
If the horizontal axis represents the ***production output over the year*** and the vertical axis represents ***total cost or revenue***, indicate the one best chart for the following:

A. Direct material costs.
B. Plant Manager's salary.
C. Mixed costs – for example, fixed electrical power demand charge plus variable usage rate.
D. Amortization of plant, computed on a straight-line basis.
E. Pay as you go phone voice service. The rate is a minimum fixed fee of $50 for the first 500 minutes and $0.25 per minute for the next 1000 minutes. All usage above 1500 minutes are free.
F. Incentive bonus plan that pays managers $0.10 for every unit produced above some level of production.
G. Interest charges on money borrowed at a fixed rate of interest to finance the acquisition of a plant, before any payments on principal.
H. Monthly property taxes for manufacturing plant
I. Pay as you go phone voice service. The rate is $0.35 per minute for the first 100 minutes and $0.25 per minute thereafter
J. Monthly salaries of production supervisors. One supervisor is required for every batch of 1,000 units produced
K. Cost of wood planks used in the production of furniture
L. Sales commissions to sales persons that are paid at a rate of 10% of sales up to a maximum of $10,000 per month
M. Compensation for sales supervisors who are paid an annual salary of $50,000 and an additional commission at 1% of sales
N. Pay as you go phone voice service. The rate is a minimum fixed fee of $20 for the first 100 minutes and $0.25 per minute thereafter

Figure 1



Situation	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Graph #														

Solution:

A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**
1	**9**	**2**	**9**	**13**	**3**	**11**	**9**	**14**	**7**	**1**	**10**	**2**	**8**

T/F Questions

1. As volume of activity changes within a relevant range, variable cost per unit remains constant and fixed cost per unit changes in the opposite direction to changes in the activity level.

2. Assume that output level increases. If the cost per unit remained unchanged, then we can conclude that the total cost is variable.

3. Assume that output level increases. If the cost per unit decreased, then we can conclude that the total cost is fixed.

4. As activity level (or output volume or cost driver) changes, total variable cost increase or decrease proportionately with the activity change, but unit variable cost remains the same.

5. When labeling a cost as variable or fixed, you must assume that the company is operating within its normal range of activity.

MC Questions:

1. The following three data points represent the total costs of a particular cost object at three production levels:

Units	Total Costs
100	$400
110	420
120	440

Based on the above three data points, the cost behavior appears to be:

a. variable costs
b. fixed costs
c. mixed costs
d. step costs
e. Cannot be determined from the given data.