**INTRODUCTION**

**Uses of Quantitative Methods in Business**

Like just about every other degree student you’re probably approaching this course with a mixture of concern, worry and misunderstanding.

*Concern* about your ability in mathematics, especially as this probably wasn’t your favorite subject in school either.

*Worry* about whether you’ll be able to pass the exam and assessments in this subject.

*Misunderstanding* about why you have to do a quantitative methods course for your degree (you thought you had done away with math at High School).

One of the major reasons for taking this course is to provide students with the understanding of the practical application – and benefits – of quantitative techniques in the real business world (you will notice that regardless of the degree you are taking, you will end up working in the business world, private or public sector). We assume that students in your field have no interest in a quantitative methods course for its own sake but rather are simply interested in the practical applications of such topics and techniques to business and to management decision making.

The reason why all students nowadays need a working knowledge of these quantitative techniques is clear. In order to work effectively in a modern business organization – whether the organization is a private commercial company, a government agency, a state industry or whatever – managers must be able routinely to use quantitative techniques in a confident and reliable manner. Today’s students are striving to become tomorrow’s managers.

Accountants will make decisions based on the information relating to the financial state of the organization. Economists will make decisions based on the information relating to the economic framework in which the organization operates. Marketing staff will make decisions based on customer response to products and design. Human Resource managers will make decisions based on the information relating to the levels of employment in the organization, and so on. Such information is increasingly quantitative and it is apparent that managers (both practicing and intending) need a working knowledge of the procedures and techniques appropriate for analyzing and evaluating such information. Such analysis and certainly the business evaluation cannot be delegated to the specialist statistician or mathematician, who, adept though they might be at sophisticated numerical analysis, will frequently have little overall understanding of the business relevance of such analysis.

**Basic Definitions**

This section introduces some of the basic terminology that we shall be using.

**Variables**

The term *variable* refers to the characteristic we are investigating or analyzing- thus a variable describes some characteristic of an individual, such as a person’s height, sex, or salary. So, for example, the variable in question might relate to company profits, number of employees, salaries, length of service, customer attitudes and so on. In general, a variable may fall into one of three types.

Discrete

A discrete variable is one which can only take certain fixed numerical values. The number of cars sold in Kenya by Toyota in 2011 can only be a whole number.

Continuous

A continuous variable is one which – in principle at least – can take any numerical value. The length of a piece of sheet steel used in the vehicle manufacturing process can be measured to any degree of accuracy – centimeters, millimeters, hundredths of a millimeter and so on.

Attribute

An attribute variable is one which is not normally expressed in numerical terms. The level of education or the gender of an individual is not a variable that we can express sensibly in numerical form. For purposes of analysis, however, we may assign an arbitrary numerical value to such a variable. Many of you will have seen and completed personal questionnaires where you are asked to indicate your gender. You may recollect that there is often a numerical value printed alongside the possible responses – for example;

What is your gender? (*Tick the appropriate box*)

1. Male 2. Female

The codes 1 and 2 allow the computer system being used to quantify the number of responses in each category but actually have no meaning.

**Exercise**

Consider the following and determine what type of variable each best represents:

(**a**) The number of private houses built last year

(**b**) The average price of a house

(**c**) The number of people employed in the construction industry

(**d**) The number of tones of concrete used in house construction

(**e**) The different types of houses constructed.

Variables may also either be **categorical or quantitative.** A categorical variable places each individual into a category, such as male or female (attributes). A quantitative variable has numerical values that measure some characteristic of each individual, such as height in centimeters or salary in Kenya Shillings (discrete or continuous). You can perform arithmetic manipulations (add, subtract, divide, multiply, average) on quantitative variables, but you can’t do it on categorical variables.

**Primary and secondary data**

It is frequently important in business to ascertain the source of the data which is being analyzed and upon which decisions might be based. We need to distinguish between what is known as *primary* data and *secondary* data. Primary data relates to that which has been collected at first hand and which has been collected for the purposes of analysis which is then undertaken. Secondary data, on the other hand, relates to data which has been collected for some purpose other than the analysis currently being undertaken. Consider the Finance Department of a local authority with the responsibility for collecting a local tax from residents in its area. It may well construct a database of those residents who have not paid the tax this year. Clearly for the department this will be primary data: collected by the department for its own use. This database, however, may then be used by a University Researcher, who is investigating income, poverty levels and tax compliance in the area and evaluating strategic options to try to alleviate these. Although the database may well be useful for their purposes, it is now a secondary source of data. In principle we would need to be more cautious about analyzing and using such information on a secondary basis, since we would not have been involved in the initial data collection and may be uncertain about the precise logistics used to obtain this data. Its quality therefore on a secondary basis must be suspect.

Equations and Mathematical Models

We shall be expressing relationships between variables frequently in the form of an equation and using such equations to develop business mathematical models. An equation is simply any expression where we have an equals sign (=). Once again, to the uninitiated they seem more complex than they actually are. Consider a store selling some item for Ksh. 9.99. For any given level of sales the firm can calculate its sales income. If the store sells 100 items then its income is readily calculated as Ksh. 999. But if we are interested in a more general expression – allowing us to calculate income for any level of sales – we will benefit from an equation. The income, or revenue, the firm gets from selling this item can be expressed as a simple equation:

Or R

Where R denotes the revenue from sales, P the selling price and Q the quantity, or number, of items sold

Clearly this is a generic equation (it will fit any such situation). For this firm the corresponding equation would be:

R

since the selling price is fixed at Ksh. 9.99. All this equation does is to define numerically the relationship between the two variables R and Q. In simple terms it allows us to calculate R for any value of Q. So, if Q = 1000, R will be 9990 (9.99 x1000); if Q = 5000, R = 49,950 and so on. Such equations can be used with others to develop simple mathematical models. Equally, if R is known we can find the corresponding value for Q.

Let us expand the problem. The firm actually buys these items from a supplier at Ksh. 6.99 and has calculated that, on an annual basis, its overheads are Ksh. 45 000 (made up of rent and various fixed costs). In the same way as with revenue we can derive an equation showing the firm’s costs: where C is costs. These costs are made up of two elements: a fixed cost and a variable cost. We see clearly that fixed costs are independent of Q (that is, if Q changes, the fixed cost element will not). The variable cost is affected by Q, however. We can go one step further. The firm wishes to quantify the profit it will have earned for any level of sales. In simple terms profit (F) will be the difference between revenue (R) and costs (C). So we have:

F

but we know that C = 45 000 + 6.99Q and R = 9.99Q, so substituting these for C and R we have:

F

Note we have enclosed 45 000 - 6.99Q in brackets to make it clear that all of this must be subtracted from 9.99Q. If we multiply everything in the brackets by the minus sign in front of the bracket we get:

F

We now have two terms involving Q on the right-hand side of the equation and so to simplify we can bring them together. We have +9.99Q and -6.99Q. This gives an equation for profit of:

F or R

Effectively, this equation allows us to determine the profit we would achieve for any given level of Q.

Such an equation becomes useful when we wish to carry out some business analysis such as determining the break-even level of sales. It is evident that the profit equation consists of a negative element (-45 000) and a positive (+3Q). It will also be evident that when Q takes low values the calculation for F will turn out to be negative (since the -45 000 part will more than outweigh the +3Q part). This means that the firm will make a negative profit (i.e. it will make a loss). Conversely, if Q is sufficiently high, profit will become positive. The break-even point by definition is where we are about to move from a loss situation into one where we earn a positive profit. What we require is a value for Q where this will happen. Also, by definition, at the break-even point F = 0. So we have:

F

Solving for Q, we get Q= 15,000 units. So the firm will make zero profits (that is, break even) if it is able to sell 15,000 units. Any sales below this will be a loss. And any sales above result in a profit.

The equations we have examined in this section are all technically known as linear equations. They can be recognized as such since they involve only variables of the first power – they do not involve variables which are squared, cubed, rooted, etc. Such equations are referred to as linear because they can be represented as a straight line on a graph. Other types of equation are non-linear, since they will not show as a straight line.

**Other terminology**

Other terminology will be discussed per topic.