

QUANTITATIVE METHODS AND INDUSTRIAL CHALLENGES

(A Reference to Business Education)

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1 INTRODUCTION:

It should be obligatory for a business school to remain abreast with the kind of expertise an organization needs to meet its management challenges. Otherwise, the school cannot impart proper knowledge and produce competent graduates for the organizations to understand their problems and suggest pragmatic solutions. In Pakistan, only a few business schools appear to be mindful of this academic obligation. Therefore in general, schools are blamed for turning out substandard material.

Lack of adequate quantitative skills may also cause a variety of problems in an organization. It is the function of Mathematics to develop in students the ability to measure quantities, analyze and relate them where possible. The other source of quantitative methods used for adding strength to management is Statistics which is an art, a science, and a technique of collecting data, condensing it to provide information for decision process, and making inferences from the particular to general. Both disciplines contribute to industry to tackle its challenging problems in a rational, logical and analytical manner but one uses data to explore information from it, and the other stimulates our imagination to find ingenious solutions of certain problems. It depends where you apply what, but each discipline offers power in its unique way. It is important to understand the domain and scope of their areas of application.

In industry, the knowledge of quantitative methods is imperative to pursue various purposes. Management makes

decisions regarding product designing, process control, marketing strategies, industrial expansion and other matters. All these phases call for support from facts and figures. Limiting its scope to industry only this paper intends to discuss the role of quantitative methods for its development. Various industrial problems will be taken up in this context.

2 Interest In Quantitative Methods:

Information in its both manifestations, qualitative and quantitative, is recognized as a great asset for various purposes – planning, development, management, research. Economic considerations are also not ignored.

Data are acquired even through simple counting, measuring or weighing. Although the use of elementary quantitative methods in processing data has been in vogue for centuries, and relatively more during industrial revolution, it was throughout the twentieth century that the realization about their efficacy and importance began growing rapidly. Some sophisticated methods were developed in times of second world war and immediately after this war industry started attracting mathematicians and statisticians for their participation. One American business executive then said *“when the history of modern times is finally written, we shall read it as beginning with the age of steam and then progressing through the age of electricity to that of statistics”* - apparently it sounded then an exaggerated view but certainly now it is not. Later, the redevelopment of Japanese industry for which great contribution came from Edwards Deming, Joseph Juran, Ishikawa, Schwartz and other statisticians, had an emphasis on quality and continuous improvement through the application of statistical methods. Their ideas have been receiving appreciation and recognition. The reality is that a large part of business and industrial work is being organized around statistical systems.

The concept of total quality management has enhanced the popularity of these methods. Industries now exploit quantitative methods to gauge and improve their performance as well as increase their productivity. Statistical tools such as Pareto diagrams, histograms, control charts, fisherbone diagrams etc. are an integral part of monitoring the causes of poor quality and

improving the processes. Most of the industries in the USA and other developed countries are conscious about the necessity of developing or ensuring at least minimal quantitative know-how in their employees. Where available they hire people with specialized knowledge in quantitative methods. An American national survey conducted not more than a few years ago disclosed that more than 90% of the top companies had staff well conversant with a number of quantitative concepts and their applications.

3 Industrial Challenges And Quantitative Methods:

Industrial challenges may be many. A challenge may be as simple as measuring performance of an ongoing production and service processes, evaluating conformance of products to standards, or studying consumers' perceptions but it calls for valid data to make informed decisions. Many problems can be addressed only if relevant data are available. It is vital that data are collected in consonance with statistical principles. Fallacious data produce faulty information which can cause misunderstanding, misinterpretation, confusion etc. Competitive industries are therefore alert in matter of gathering accurate and reliable data on parameters of their concern for industrial development. For them data are sacred as they contain important information for guidance in decisions and actions. An industrial decision backed, provoked or motivated by such information has scientific basis and is therefore reliable.

Information regarding an industrial activity may be obtained through simple numerical calculations, elementary and advanced statistical analysis, and application of a mathematical technique. Probability cannot be avoided when it comes to risk involving decisions. We briefly discuss below *only* the most important industrial areas of application.

3.1 Marketing strategy design:

The planning stage for an industry is crucial, fundamental and central because here it is to::

Identify target markets

Develop positioning strategies for products and brands

Test new products

Assess market potential.

Information is needed to spot the buyers, give a general meaning of its product, determine customers' response to a product, and measure the level of its demand. Any fallacy, error or misconception can produce injurious results.

3.2 New product planning:

'Know your customers' is the first consideration for an industry if it has to prosper. One must know how to 'know' them and for it the industry should be familiar with the methods how to get to them. Therefore industries cannot behave indifferently to the following activities. Designing and developing new products, Whether or not to replace current products, Assessing the appeal for modified products, Identifying the most preferred products.

Obviously all customers cannot be approached as a target population may be large. In Statistics, sampling, a commonly used statistical device, has become a necessity for industry to contact its customers to see what they want, what their attitudes and feelings are. Without this prior knowledge no industry can design or modify its product and yet think they will like it. Through marketing research surveys it can gauge the level of customers' satisfaction and its product's potential market share. This research based on sampling provides information regarding who its buyer is, how frequently he purchases, for what purpose, its effects on other established brands, any changes to make in marketing strategy for a better edge etc. Care is to be taken in sampling not just one section of customers holding similar views. Research must be planned and conducted in accordance with statistical principles whether it concerns product designing, product launching, demand analysis or pricing decisions.

It is important to know that the concepts of sampling and sampling methods are often misunderstood. . For the validity and accuracy of research results we should not forget that sampling is a primary tool. Though not linked with industry, yet not too irrelevant for the purpose of conveying the message I reproduce the following narration from Business Statistics by Levine, Krehbiel and Berenson – “ *In 1948, major pollsters predicted the outcome of the US presidential election between Harry S Truman, the incumbent president, and Thomas E Dewey of New York. The Chicago*

Tribune was so confident of the polls' predictions that it printed its early edition based on predictions rather than waiting for the ballots to be counted. An embarrassed newspaper and the pollsters it had relied on had a lot of explaining to do. How had the pollsters been so wrong? Intent on discovering the source of the error, the pollsters found that their use of a non-probability sampling method was the culprit. As a result polling organizations adopted probability sampling methods for future elections”.

It is for this reason that appropriate steps should be taken to collect data giving due consideration to the sampling requirements. As a matter of fact unless data is validly and accurately measured in view of the objectives any information based on it is of no use. But experience shows that problems start appearing in the initial stages of data collection, which may culminate in the form of reporting or non-sampling errors. Sampling is one technical feature, it is the measurement making, questionnaire filling, or observation recording that has to be carefully done.

3.3 Process quality control:

A process is a sequence of operations that an industry has to follow from beginning to completion. Processes are analyzed to understand the causes of variation in the product. Even tools as simple as average and dispersion in Statistics produce focussed light on an industry's performance. The display of data in tables communicates useful information in exposing the underlying realities and promoting their visibility and clarity. The charts, graphs or interesting configurations for data presentation also lend enormous help to management in conceiving new ideas. Most of the basic statistical tools, both descriptive and inferential, are useful for the assessment of the quality of products, services and processes. Management by process has a foundation based on thorough understanding of variability. Tools such as Pareto and Fisherbone diagrams for instance, have now become popular charts among the ISO 9000 certified industries because they provide visual information on the causes of problems experienced in their industrial business.

Statistical control charts call for a good understanding of the knowledge of probability as it is directly applicable to quality control aspects of products, services and processes. Educational institutions should not ignore this knowledge in their curricula. As

for control charts they provide product inspection mechanism for never-ending process improvement by identifying the out-of-control conditions and controlling the factors that cause variation in the product. Companies manufacturing products and extending services now directly link quality, reliability and productivity with their survival. It is the constant improvement that matters in the global economy. *The themes of the Total Quality Control also refer to Statistics for their understanding and implementation.*

3.4 Consumer satisfaction and loyalty:

Consumer satisfaction and loyalty studies have become an essential part of industrial research activities. For it as well an industry has to bank on marketing research to monitor whether consumers are well satisfied with its product. Among airlines, restaurants and other service industries feedback is taken from customers after a service is rendered – ‘Overall how satisfied were you with our ...? Would you recommend it to your friends? are frequently questions. If an industry is not sure about customers’ reaction regarding its product it may investigate this uncertainty through this knowledge of Statistics. Such studies demand a good understanding of statistical inference. The industrial researcher should be able to statistically analyze the trend in their response to other similar products in the market.

3.5 Demand analysis and forecasting:

Before production there frequently arises a question in the mind of an industrialist – ‘How large is the demand potential within a specified target market?’. The marketing managers are often interested to know what is to happen in future. Scientifically, this question calls for the study of past trend, change in customers’ taste, population growth, competition by other similar products in the market.

Demand analysis is a method intended to estimate the level of customers’ demand. It also explores the reasons for that demand through a market survey. Sales forecasting is done by relating demand with financial strategies using a target population.

Over the past years economic and business conditions generally vary as a consequence of various factors undergoing changes. Careful managers keep on collecting data about the factors of their interest. When time series data is available, statistical tools make it

possible to study trends and seasonal effects and do prediction following regression analysis or other forecasting models. Hundreds of soft-wares have been developed by industries to suit their needs which consist in providing forecasts for demand, firm sales, etc. By these software packages, future staff needs are also determined by projecting a firm's sales, volume of production and personnel required to maintain specified output.

3.6 Inventory management:

Some mathematical methods are available to manage specific problems of industries. These methods are applied to business problems relating to decision-making, model building, designing production strategies, constructing networking schedules, determining economic inventory sizes.

Inventory of raw material for manufacturing products must not go down to a zero level if the continuity in production is to remain undisturbed. An economy minded industry cannot ignore the question as to how much of raw material to order so that ordering and raw material holding costs provide a reasonable balance. Quantitative methods offer information in this regard . For this both deterministic and probabilistic methods may be used but it depends on the nature of a situation which may be described by certain parameters. If discount is available this aspect should also be cared for accordingly. If optimal order size is not employed the cost of an inventory model increases. An industry that uses this expertise can cut the production costs and so acquire an edge over others. Often economic order quantity and production lot size models are used, but again it depends; an inventory manager may have to develop his own economic model .

3.7 Production strategy:

For manufacturing a number of products sharing the same resources there has been an industrial question for mathematicians how many units of each product to produce within the limitation of resources so that the profit from their sale is maximum. It took more than two hundred years for its answer to appear. During the second world war when linear programming, a technique that is used to solve this problem, was developed by George Danzig and first applied by the US Air Force as an aid in decision making.

Today linear programming has wide applications in industry, finance, marketing and economic analysis. A full course on this

topic is offered to students of mathematics and also to students of business administration. Business scholars have given a new name 'Management Science' to a body of such mathematical methods.

3.8 Production scheduling:

Linear programming is applied by an industry to employ a low cost production schedule for one or more products spread over a period of days, weeks or months in view of demand requirements, production capacity, availability of labour and machine hours, storage space etc. Often the same system formula is used from period to period with slight changes in data. Inventory costs may also be included in the analysis.

3.9 Labour planning:

Whereas the limitation of hours in production departments poses an important constraint in determining a production strategy, slacks appearing in the solution worry the production managers. When labour skills are available in more than one department they make inter-transfers of labour to reduce costs of products. Here as well the use of linear programming is made in industries in developing an optimal labour plan.

3.10 Market surveys:

An industry when developing a survey design may impose certain restrictions on the specified groups to be represented. Costs of surveying these segments of target populations may also be asked for not to exceed beyond indicated limits. Linear programming is also used to develop a design to embody these characteristics.

3.11 PERT / CPM networks:

Construction industry often relies on mathematical techniques to develop schedules for the completion of projects in shortest possible times when information is known about each activity that makes up the project. This information is on the activity's immediate predecessors and the time it takes for completion. PERT methods have been developed for activities for which times are uncertain and the information is available in terms of optimistic, most probable, pessimistic times.

3.12 General industrial research and other applications:

An industry may undertake local research to improve its internal practices and processes. For instance, a clothing factory

may be interested in determining whether its new machine produces cloth bearing a specified mean breaking strength. An operations manager may want to compare different levels of air-jet-pressure on the breaking strength of some yarn spun under specified temperatures for textile usage. His curiosity may lie in studying the effects of air-jet-pressure, or the temperatures, or the interactive effect of both factors. In order to objectively assess the results he is expected to apply the relevant statistical methodology if maximum precision is to be achieved in his investigation. Increasing levels of treatments respond differently generating different curves, which may use different methods to study them. Factors forming treatments require in-depth investigation regarding main effects and interactions. The use of regression, statistical design of experiments (ranging from as simple as completely randomized designs to as sophisticated as crossover designs), factor analysis, classification analysis etc is made to explore information of the sort indicated. Even data from the focus group within the industry may call for statistical analysis.

The use of mathematical methods is also now beginning to appear in paper industry to design a production strategy with a view to minimizing paper waste, in media selection to select the media to achieve a maximum audience exposure, for pollution control etc. Mathematical and statistical methods may be complex to apply when the use of calculators is made. Soft-wares have been developed for various programs thus simplifying this problem as well. Information technology has tremendously contributed in enhancing the scope of usefulness of quantitative methods in industry. During last few years the western countries have experienced an exponential growth with regard to the applications of quantitative methods in industry.

4 CONCLUDING REMARKS:

In Pakistan the awareness about the modern applications of quantitative methods in industry is generally nonexistent. The above applications indicate that more or less every industry can benefit from these methods in one way or the other. We can therefore briefly conclude and recommend that:

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- *Quantitative methods play a significant role in industry for its development. Their applications are helpful for reliable decision making and creative problem solving. This knowledge must not be ignored if an industry aims to be functional, dynamic and research conscious. In fact the education of these methods is also vital to create a knowledgeable industry so that it may have the capability to compete with the fast-running world in quality, quantity, economy.*
 - *Industries should hire consultants for assistance in solving problems of the kind mentioned above if they lack expertise in quantitative knowledge. A little fee for them can generate not only financial benefits but also contribute to industrial growth in consonance with modern approaches to challenges.*
 - *Industries should invite experts to hold periodical seminars for their staff to initiate and enhance in them awareness about the importance of quantitative methods for industrial development.*
 - *The effectiveness, necessity and power of these methods in managing industrial problems suggests that educational institutions teaching business administration and industrial sciences must incorporate this material in their curriculum. Where possible, interaction between educational institutions and industry must be encouraged for employment of the indicated knowledge in effectively dealing with its challenges.*