

# Quantitative Techniques' and Production Planning and Control: An Empirical Analysis of Practice by Selected Nigerian Small- Scale Industries (2002-2006)

Anene Edwin Chukwudozie

Department of Management and Accounting, Faculty of Management Sciences, Ladoko Akintola University of  
Technology, Ogbomoso. Oyo State. Nigeria.  
Nonye.Anene@yahoo.com

## Abstract

Empirically, analysis was made from results of 160 randomly chosen companies from eight purposively selected Nigerian small-scale industries to assess the available quantitative techniques (QTs) applicable to Production Planning and Control (PPC). It also examined whether, Qualitative Techniques are applied by the studied companies and the actual number of these companies that apply Qualitative Techniques, as well as factors inhibiting the use of Qualitative Techniques. A wide range of 11 Qualitative Techniques (QTs) tools were found to be applicable to Production Planning and Control with 35(23.2%) of the companies actually applying QTs. 3 factors were also found as inhibiting factors.

**Keywords:** Quantitative Technique, Production Planning and Control, Small-scale Industry.

## 1. Introduction

Worldwide, small scale industries have become the bedrock and sustaining factor of many countries' economic and eventual growth. They constitute the industrial feed-stock and engine of production to the entire manufacturing technology available to larger industries. The progress of Japan, Malaysia, India, Korea and Taiwan readily come to mind. But the transformation of these economies toward mass production of goods and services would not have been possible without adequate management of production planning and control (Shubin, 1972).

Following the post Structural Adjustment Programme of 1986 in Nigeria, small scale industries were spread all over the three former Western, Eastern and Northern regions (Anene, 1986). Each type of industry was located in places where the relevant raw materials and infrastructures abound or are easily accessible for procurement. The industries were vastly local: garment, furniture, foot wares (rubber/plastic and leather), bags (paper, polythene and leather), local domestic soaps, edible oil extraction (palm, groundnut, sunflower, etc), block (brick and concrete), metal works (fabrication of equipment and tools) among others (Anene, 1993).

Many types of production systems are available for use by manufacturing industries. Each type depends however on what is to be produced. Small scale industries in Nigeria, for instance, operate the batch production type. Irrespective of the production type though, organisations must carry out their functions properly if they hope to achieve set objectives of minimum cost, maximum profit and growth, and customers' satisfaction. This calls for effective production management.

Several functions are embodied in the concept of production management. These include production planning and control, inspection and quality control, maintenance and repairs, research and development, personnel health and safety, purchasing and stores, worker training and stock records. But for what the system produces and demands to be satisfied in relation to market situation, there is need for coordination and regulation. Production planning and control seems to be the integrating function out of the above functions. It is thus appropriate that the present study examines it in relation to application of quantitative technique.

## Objectives and Significance of the Study

Generally, the study empirically analysed the practice by selected Nigerian Small-scale industries of Quantitative Techniques and Production Planning and Control. Specifically, it assessed the available QTs applicable through Production Planning and Control and also examined whether, QTs are applied by the studied companies and the actual number of this companies that apply QTs. Factors inhibiting the use of QTs were also determined. Significantly, the study has contributed to bridging the gap between QTs' application to PPC in other developed and developing economies of the world and Nigerian small-scale industries.

## Problem Statement

In any manufacturing organisation (be it big, medium, small scale) there is daily the problem of "how best" to produce in the required quantity and quality in other to meet consumers' demands with the least combination of inputs. This problem has found tremendous solution and accruing benefits in overseas countries like United States of America, Britain, Japan, Korea and China where industries (including small scaled) apply a wide range

of quantitative techniques in their production planning and control activities. Sadly this is not the case yet in Nigeria. Thus, a gap had been existing between the practice in these other countries and Nigeria.

## 2. Literature Review

### *Small Scale Industry*

All over the world, economies are sustained by the various contributions made by sectors and sub-sectors. Industries making up one of these sectors are responsible for the production of various goods and services for local consumption and export generally. The industries include big, medium and small scaled. Small scale industries are further broken down into micro and cottage industries.

There is no universally accepted definition of small scale industry rather every country is inclined to derive its own definitions based on the role the industry is expected to play in that very economy, including the programmes of assistance designed to achieve the desired goal. There is a lack of uniformity in the acceptable criteria or measure in the size of small scale industries due to the fact that the concept of being big or small is relative. Thus it varies over time, from country to country and within a particular country (Ekpenyong and Nyang, 1992). The above notwithstanding, the consensus is that the firm size is quantitatively measured in terms of number of employees and capital (asset) base, land not inclusive.

Some definitions arise from differences in industrial organisation at different levels of economic development and differences in economic development within areas of the same country (Sule, 1986). Over time, definitions change due to changes in price levels, advances in technology among other considerations that can include policy focus of the institutions within the same country and outside countries. Consequently, a small scale enterprise according to Olasore (1985) is any manufacturing enterprise whose business turnover does not exceed five hundred thousand naira (₦500, 000.00). Diyan (1987) has similar view for the case of Nigeria.

In terms of employment and investment ceiling, Kepa (1988) gave a summary of some international criteria for defining small scale industries. The Criteria are investment ceiling and employment capacity.

Use of investment cost is popular in the developing countries, while developed countries pay more attention to employment size. White and Feldman (1989) stated that comparatively most developed countries seem to have agreed on a maximum limit of 500 employees for a small firm. In Nigeria however, there has been a review by National Council on Industries at its 13th Meeting (NCI-13) in Makurdi, Benue State in July 2001 (Akande, 2005) favouring investment outlay as the measuring tape. Similarly, the Central Bank of Nigeria (CBN) and the Federal Ministry of Industry officially emphasize nominal financial outlay for small scale enterprises.

### *Characteristics of Small Scale Industries*

As noted earlier, various definitions and/or explanations have been adduced for small scale industries by various groups and individuals among countries of the world. This notwithstanding, small scale industries share certain characteristics that are universally recognized (Venkataraman, 1988). Basically, they are 'small' due to limited access to financial resources. Their management structure is very simple, combining ownership and management in just one person known as the chief executive officer (CEO). He sees to the various functions and numerous activities (including those of production planning and control) of the organisation. To worsen it all, most of such CEOs would attempt to keep in their memories or 'heads' all that need be done, rather than keep written records. Another characteristic is flexibility in decision making. This is often the case as directors would want to change their decisions on issues only according to their whims and caprices. Largely too, there is informal employer-employee relation. World over too, small scale industries are widely spread or dispersed due to their intensive use of local raw materials. Small scale industries in Nigeria for instance are heterogeneous owing to size of investment, the number of people employed and volume of product (Akande, 2005). In the case of Nigeria and for the purpose of this study, small scale industries refer to those whose individual firms are employing between 10 and 30 persons and whose capital base is not in excess of One million Naira (₦1,000,000 or \$ 6,450) excluding building and some sophisticated machineries/equipment in few cases.

### *General Concept of Production*

Conceptually and indeed practically, the conversion of materials into goods (or products) and services or the assembly of components into marketable products could rightly be called production (Anene, 1986; Carson et al, 1972). Almost all the activities of any manufacturing industry revolve around production hence its description as the hub of the wheel of the manufacturing industry. It determines what is available for sale, in what quantity and quality and to a considerable extent, at what price (Buffa, 1972; Ahuja, 2004). Production logically follows a system. Production system is one whose function is to convert a set of inputs into a set of desired outputs.

### *Basic Elements of Production Planning and Control*

Production planning and control could be regarded as the integration, coordination, overseeing and regulating of the use of manpower, machines and materials for efficient output of goods to meet customers'

demand and requirements at minimum costs. It therefore guides production, regulates and controls the “how”, “when”, and “where” work is to be done (Shubin, 1972). Thus the various techniques used in production planning and control activities by various industries are of utmost importance if cost is to be minimized. The same is true for small scale enterprises. In an attempt to provide a guideline, Maurice and Thomas (1999) remarked that quantitative techniques constitute a veritable tool in solving the decision problem confronting all manufacturing firms, namely, how best to determine the least cost combination of inputs needed to produce the desired product.

In all organisations where goods and services are produced, management of production cannot be discussed without considering production planning and control. Regardless of the size of an organisation in this contemporary period, one can rarely talk of manufacturing operations without considering being given to production planning and control. The process of production planning and control involves the performance of certain vital functions on either sides of planning and control.

In his view, Kumar (2011) observed that Production planning without production control is like a bank without a bank manager: Planning initiates actions while control is an adjusting process, providing corrective measures for planned development, production control regulates and stimulates the use of materials in the manufacturing process from the beginning to the end.

In a nutshell, production planning and control is the making of decisions regarding the use of the human and non-human resources available to a manufacturing firm to produce output of goods to meet customers' demands profitably at a minimum cost. The ultimate objective is the realisation of the supply and movement of materials and labour, machines utilization and relative activities, in order to bring about the desired manufacturing results in terms of quality, quantity, time and place.

The eventual solution to the quest for efficiency and economy of production lies with the choice of the type of technique to employ to both carry out and to enhance these activities. Basically, there are two broad applicable techniques: Qualitative and Quantitative techniques. The present study focuses on the application of quantitative techniques to the activities of production planning and control of small scale industries in Nigeria.

Production planning and control could therefore be regarded as the most important of all management production functions. For purposes of clarity and in-depth analysis, some authors have suggested the splitting of the concept into two: production planning and production control.

The eventual solution to the quest for efficiency and economy of production lies with the choice of the type of technique to employ to both carry out and to enhance these activities. Basically, there are two broad applicable techniques: Qualitative and Quantitative techniques. This study therefore looks at the application of quantitative techniques to the activities of production planning and control of small-scale industries in Nigeria.

### *Quantitative Technique*

As described by the British Standard, Quantitative Technique (QT) is the attack of modern science on complex problems arising from the direction and management of large systems of men, machines, materials and money in industries, business, government and defence.

Products are often unique, as such, for each product there exists a best or optimal method of manufacturing. In the same vein, allocation problems are concerned with the utilization of limited resources. Management decisions therefore are essentially those of resource allocation decisions which are achieved through application of various quantitative techniques (Lucey, 1997).

Quantitative techniques provide a basis for decision making. In this regard, Owen and Jones (1984) opined that if business – no matter its nature – is to be controlled effectively and efficiently, there is need for established businessmen and those pursuing a career in business (including their counterparts in the manufacturing world) to appreciate quantitative techniques as basic, important and necessary tools for decision making. They stressed further that now is the era when it is necessary for managers to be numerate, no matter their background.

Besides being important, quantitative technique is also relevant. It is the application of scientific approach to solving management problems in order to assist managers to make better decisions. It therefore encompasses a good number of mathematically based tools that have either been developed within the field of management science or adopted from other disciplines such as natural science, mathematics, statistics, engineering and social science. The applications of quantitative techniques have since been frequently credited with increasing the efficient and productivity of business firms (Forgionne, 1983). This is pertinent considering that the primary aim of quantitative technique is to identify the best way of conducting the affairs of the organisation; that is, the optimum in solving problems. To achieve this, quantitative technique tries to optimize the operations of the organisation as a whole rather than narrow aspect of the business such as a single department or section (Lucey, 1997; Taha, 2002).

The application of quantitative technique is quite distinctive. The process begins with developing a scientific model of the system which incorporates measurement of factors such as change and risk with which to

predict and compare the outcome of alternative decisions, strategies or control. The purpose of quantitative technique also is to help management determine its policy and action scientifically. Essentially, the features include: application of a model-based scientific approach (systems approach) to organisations, recognition of risks and uncertainty, and assistance to management decision making and control. The application of quantitative techniques in planning and control activities of production management is therefore vast given that it falls within the scope of enabling managers to understand and predict the behaviour of the production system.

Literature furnishes us with report of researchers who strongly recommend quantitative technique over qualitative technique in the business of ensuring efficiency of production. Owen and Jones (1984) is one such. Their preference is based on the fact that they believed that quantitative techniques have narrower but sharper focus than qualitative techniques. Quantitative technique serves the purpose of helping managers recognise risk and uncertainties while determining their policies and actions scientifically. Furthermore, quantitative techniques offer assistance to managers in decision making for increased efficiency and productivity of manufacturing industries with no exception to small scale industries (Forgionne, 1983). In production planning and control, the application of quantitative technique is important and should be sought for and applied by managers in charge of production. This will ensure that they have better understanding and prediction of their various production systems' behaviour (Okoko, 1999). It is also helps in reaping economic benefits such as improved output volume and profitability (Orga 2006). To cap it all, Bronson (1997) identified the most important feature of quantitative technique: It allocates scarce resources efficiently. It is therefore indispensable to production planning and control.

#### *Quantitative Techniques Available for Production Planning and Control*

Past and present records show that more quantitative techniques abound and are increasingly needed for use in production planning and control activities of especially the manufacturing industries. Wild (1998) noted vital aspects of quantitative technique which are readily employed in production planning and control to include: Graphical and Charting Techniques, Control Charts, Linear Programming, Forecasting Techniques (like Regression and Time Series Analysis, Markov Chain, Sensitivity Analysis, etc), Critical Path Scheduling (CPS) Analysis, Programme Evaluation and Review Technique (PERT), Inventory Models, Dispersion Measures (like Variance and Standard Deviation), Capacity Utilisation Model, Vendor Rating and lastly Acceptance Sampling. Specifically, further classifications can be made by reviewing some of the above techniques according to their applications in production planning and control when considered as separate activities. However, it is noteworthy that a few of these techniques can actually be applied to both production planning and production control activities.

From the foregoing it could be seen that a wide range of quantitative technique (some of which are quite simple in nature) are available for use. Whereas they are actually being used by industries in countries outside Nigeria (Wild, 1998; Taha, 2002; Lam, 1993), their application in particularly small scale industries in Nigeria is of concern - the essence of this study.

### **3. Methodology**

The three former regions of Nigeria constitute the area of the study. These are the Eastern, Western and Northern regions of the country. Each of these regions is vast and has numerous towns/cities spread across the length and breadth of the regions. Covering the entire areas in a study like this would be cumbersome, therefore four towns – Aba (East), Kano (North), Oshogbo and Lagos (West) were purposively selected due to the fact that these towns are the commercial and/or industrial nerve centres of the regions. Additionally, these towns have a long record of making products such as dresses, beddings, window and door blinds (curtains), blocks, shoes (covered), sandals and slippers, hand bags, boxes, washing and toilet soaps, cooking oil, chairs, tables and beds, door and window shutters, burglary protectors, safes, machine tools, and agricultural farm implements (for mowing and ploughing). This is due to the peculiarity of the towns having in abundance (naturally or otherwise) most of the necessary raw materials and the largely unskilled and semi-skilled manpower (Anene, 1993).

The questionnaire method was adopted so as to obtain first-hand data. Twenty companies from each of the eight purposively selected industries: Garment, Block-making, Foot-wears, Bag-making (leather), Domestic soap-making, Edible oil extraction, Furniture, and Metal works (fabrication of equipment and tools) were randomly selected. Each of either the managing director or the production manager or any other designated staff directly concerned with production planning and control activities of the companies responded to the Questionnaire on whether quantitative techniques are applied in their production planning and control activities. They also supplied information on the actual quantitative technique/tool (if any) applied and the factors militating against the application of same. The instrument was validated by a simple test and re-test method involving first a pilot survey and then the main survey.

### Population and Sample of the Study

The population consists of eight small scale industries: Garment, Block-making, Foot-wears, Bag-making (leather), Domestic soap making, Edible oil extraction, Furniture, and Metal works (fabrication of equipment and tools). A total of One hundred and sixty (160) companies made up the sample of the study: twenty (20) companies each from the eight originally selected small scale industries were randomly chosen through simple balloting of the non-probability random sampling technique. Questionnaires were sent to each of the 160 small scale companies and the questionnaires were administered to persons directly involved in the production unit.

### Method of Analysis

The returned questionnaires were collated and the responses were coded. For instance, the number of companies that applied quantitative techniques were coded “A”, while those that do not apply came under “NA”. Similarly “R” was used to designate Questionnaire retrieved whereas “NR” refers to those not retrieved. The sub-totals, grand total and the corresponding percentages were equally calculated. The data were analysed descriptively method. The selected small scale industries: Garment, Block-making, Foot-wears, Bag-making (leather), Domestic soap-making, Edible oil extraction, Furniture and Metal works (fabrication of equipment and tools) are designated as A, B, C, D, E, F, G and H respectively.

**Table 1** Summary of Respondents’ Feedback on Whether Quantitative Technique is Applied in their Production Planning and Control

Industry	Responses		Sub-Total		% Applied (A)	% Not Applied (NA)
	A	NA	R	NR		
A	6	14	20	-	30	70
B	4	16	20	-	20	80
C	3	17	20	-	15	85
D	2	13	15	5	13.3	86.7
E	3	17	20	-	15	85
F	4	14	18	2	22.2	77.8
G	5	14	19	1	26.3	73.7
H	8	11	19	1	42.1	57.9
Total	35	116	151	9	23.2	76.8

Source: Field survey, 2006.

Where: A = Applied  
 NA = Not Applied  
 R = Retrieved (Questionnaire)  
 NR = Not Retrieved (Questionnaire)

**Table 2** Paired Sample Statistics

#### Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 A	4.38	8	1.923	.680
NA	14.50	8	2.070	.732

**Table 3** Paired Samples Correlations

#### Paired Samples Correlations

	N	Correlation	Sig.
Pair 1 A & NA	8	-.628	.095

### 4. Discussion on Results

The study found out that out of the 11 applicable quantitative technique tools, only six (Graphical and Charting Techniques, Control Charts, Forecasting Techniques (Regression and Time series Analyses, Markov Chain), Measures of Dispersion (Range, Variance and Standard Deviation), Capacity Utilization Model and Acceptance Sampling) were actually used by different companies from the selected small-scale industries. Actually, 35 companies representing 23.2% applied QTs to their PPC.

Linear Programming, Critical Part, Scheduling Analysis, Programme Evaluation and Review

Technique Analysis, Vendor Rating and even one of the simplest and commonly used inventory models were not used by 116 companies representing 76.8%. This percentage far outweighs the percentage of those that applied QTs. From the result shown in Table 1, Metal Works industry recorded the highest percentage application (42.1%) which is not even up to an average of 50%. Next to this are; Garment industry (30%), Furniture industry with 26.3%, Edible Oil extraction (22.2%), Block-making (20%), Foot Wears industry and Domestic Soap Making followed with 15% each and lastly Bag-making (leather) with 13.3%.

From Table 2, it is revealed that across all 8 industries sampled, application of quantitative techniques to production planning and control dropped between 10 and 11 points on average since take off. At -0.628, the correlation between the baseline or take-off and the point at which the survey was conducted is high and consistent as shown in Table 3. Companies within the industry experimented with the application of quantitative techniques in production planning and control. Firms who did sustained the procedure whereas those who did not probably saw no need to try the method.

The study also revealed Unawareness, Lack of Qualified Manpower and Lack of Financial Resources as Factors inhibiting the application of Quantitative Techniques to PPC. Their combined and individual effects on QTs' application are however not the concern of this very study. This is in line with the findings in a similar study in Hong Kong (Lam, 1993). That study reviewed the application of quantitative techniques in Hong Kong and reported a fair usage (74% of respondents). Application was confined to relatively few and simple techniques which were however used in a wide spectrum across the country. He cited lack of understanding of quantitative techniques among top management as the respondents' greatest barrier to the use of the method.

## 5. Conclusion

The study concluded that 11 QT tools were found to be applicable to PPC with 35 (23.2%) of the companies actually applying QTs. Companies from Metal Works industry led the others in the use of QTs with 42.1%. Garment (30%), Furniture (26.3%), Edible oil extraction (22.2%), Block-making (20%), Foot wears and Domestic soap-making (15% each), and Bag-making (Leather) (13.3) industries followed in that order. The application of QTs to PPC was found to drop between 10 and 11 points on average since take offs in all the selected industries small-scale industries surveyed.

At -0.628, the correlation between the base line or take-off and the point at which the survey was conducted is high and consistent. Companies within the industries experimented with the application of QTs to PPC, sustained the procedure. Whereas those who did not, saw no need to try the techniques. Further unawareness, lack of qualified manpower and lack of financial resources were found to be factors inhibiting the use of QTs across the surveyed companies from selected small-scale industries.

The study has also brought out the evidence of little progress in the application of QTs to PPC by small-scale industries in Nigeria, thus suggesting more effort to create more awareness and the need for increased financial resources for these industries.

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