UNIVERSITY OF ILORIN

THE TWO HUNDRED AND FIFTH INAUGURAL LECTURE

QUALITY BLENDED STATISTICS - A VERITABLE TOOL FOR UNIVERSAL BREAKTHROUGH

By

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My Lords, Spiritual and Temporal,
Members of my Family – Nuclear and Extended,
My Dear Friends and Relatives,
Distinguished Invited Guests,
Gentlemen of the Print and Electronic Media,
Great Students of the University of Ilorin,
Distinguished Ladies and Gentlemen

Preamble

I like to start by giving Honor and Glory to the Almighty God, the King of kings and the Most High for giving me the privilege and Grace to enable me stand before you today to present this inaugural lecture after spending more than four decades at the University of Ilorin.

My journey to this status started some years back at Kabba Division Joint Education Committee (KDJEC) Ogbe, my hometown in the very late 1950's From there I proceeded to the prestigious Titcombe College, Egbe, popularly known as (TC) which was one of the best secondary schools in the then Northern region of Nigeria. I was also one of the pioneering students of Kwara State College of Technology, by which time we had only School of Basic Studies.. We were affiliated to Cambridge University for our Advanced Level Certificate. I attended the Premier University, the University of Ibadan for both my B.Sc. and M.Sc. It was at the University of Ibadan, an Indian lecturer, Dr. Subrahmanya taught us a course on Statistical Quality Control from where I picked interest in being a Quality Statistician.

In October 1978, I resumed as a Graduate Assistant at the University of Ilorin at where I had University of Ilorin Staff Development Grant for my PhD in Statistical Quality Control at the University of Essex, Colchester, UK, after my Masters Program at the University of Ibadan.

Mr. Vice Chancellor Sir, this inaugural lecture is about QUALITY BLENDED STATISTICS – A VERITABLE TOOL FOR UNIVERSAL BREAKTHROUGH. It is presented in eleven sections:

1. Statistics and Quality
2. Process Analysis and Quality Improvement Techniques
3. Statistical Quality Control
4. The Role of Statistics in National Sustainable Development
5. My Major Academic Contributions
6. My Contributions through Consultancy Engagements, Capacity Building and Guest Speaker at Important Events
7. Summary and Conclusion
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STATISTICS AND QUALITY

Statistics

Introduction

The term **statistics** is ultimately derived from the New Latin statisticum collegium (council of state) and the Italian word statista (statesman or politician). Thus, the original principal purpose of Statistik was data to be used by governmental and (often centralized) administrative bodies. During the ancient times, statistics was called a science of state, or the science of kings, as it was used by the states or kings. It may be said to have its origin in census counts taken thousands of years ago; as a distinct scientific discipline. However, it was developed in the early 19th century as the study of populations, economies, and moral actions and later in that century as the mathematical tool for analyzing such numbers.

The modern field of statistics emerged in the late 19th and early 20th century in three stages. The first wave, at the turn of the century, was led by the work of Francis Galton and Karl Pearson, who transformed statistics into a rigorous mathematical discipline used for analysis, not just in science, but in industries and politics as well.

The second wave in the 1910s and 20s was initiated by William Sealy Gosset, and reached its culmination in the insights of ***Ronald Fisher***, who wrote textbooks that were to define the academic discipline in Universities around the world.

The final wave, which mainly saw the refinement and expansion of earlier developments, emerged from the collaborative work between Egon Pearson and ***Jerzy Neyman*** in the 1930s. They introduced the concepts of "*Type II*" error, power of a test and confidence intervals.

Today, statistical methods are applied in all fields that involve decision making, for making accurate inferences from a collated body of data and for making decisions in the face of uncertainty based on statistical methodology. The use of modern computers has expedited large-scale statistical computations and has also made possible new methods that are impractical to

perform manually. Statistics continues to be an area of active research for example on the problem of how to analyze big data.

Fundamental Ideas in the Field of Statistics

The two fundamental ideas in the field of statistics are uncertainty and variation. There are many situations that we encounter generally in life in which the outcome is uncertain. In some cases the uncertainty is because the outcome in question is not determined yet while in other cases the uncertainty is because although the outcome has been determined already we are not aware.

On the other hand, variation is the difference between an ideal and an actual situation. Variation or variability is most often encountered as a change in data, expected outcomes, or slight changes in production quality.

Uses of Statistics in Our Day- to- Day Activities

Predictions:

The figures help us make predictions about something that is going to happen in the future based on what we face in our daily lives. How accurate this prediction is will depend on many factors which must take into account the external or internal factors that may affect our future. Doctors, Engineers, Artists, and Practitioners all use statistics to make predictions about future events.

Quality Testing:

On a day-to-day basis, we conduct quality tests to ensure that our purchase is correct and get the best results from what we spend. We do a sample test of what we expect to buy to get the best. If the sample test passes the quality test, we want to buy it.

Weather Forecasts:

Statistics play a crucial role in weather forecasting and how the government does it. Computer is used in weather forecasting

based on the set of statistics functions to compare the weather condition with the pre-recorded seasons and conditions

Emergency Preparedness:
With the help of statistics, we can predict any natural disaster that may happen shortly, get prepared for the emergency and rescue team prepare to rescue the life of the people who are in danger.

Predicting Diseases:
Statistics is even playing a role in the medical field. It helps us to know the numbers of people suffering from a disease, how many people are infected and the number of deaths from the disease.

Political Campaigns:
Statistics are crucial in a political campaign as no one can run a political campaign with perfection without it. It helps them to have an idea about how much chances they have to win an election in a particular area. Statistics also helps the news channel to predict the winner of the election and the political parties to know how many candidates are in their support in a particular voting zone.

Insurance:
Insurance is a vast industry with hundreds of insurance policies i.e. car insurance, bike, life insurance, and many more. The premium of insurance is based on the statistics and Insurance companies use the statistics that are collected from various homeowners, drivers, vehicle registration office, and many more to decide the premium amount.

Consumer Goods:
The business use statistics to calculate which consumer goods are available in the store or not and to find out which store needs the consumer goods and when to ship the products.

Financial Market:
The financial market completely relies on the financial statistics as all the stock prices are calculated with the help of statistics. It also helps the investors to take the decision of investment in the particular stock.

Sports:
Every sport requires statistics to make the sport more effective as it help the sport person to get the idea about his/her performance in the particular sports.

Functions of Statistics

Statistical knowledge helps the use of proper methods to collect the data, employ the correct analyses, and effectively present the results. Statistics is also a crucial process behind how we make discoveries in science, make decisions based on data, and make predictions.

Some specific functions include:
Present facts in Definite Form:

We can represent the things in their true form with the help of figures. Without a statistical study, our ideas would be vague and indefinite as results given in numbers are more convincing than those expressed qualitatively.

Precision to the Facts:
Statistics are presented in a definite form so they also help in condensing the data into important figures and its methods and present meaningful information that helps in simplifying complex data to make it simple and understandable.

Comparisons:
After simplifying the data, it can be correlated as well as compared. The relationship between groups is best represented by certain mathematical quantities like average or coefficients etc**.**

Formulation and Testing of Hypothesis

Statistical methods help in formulating and testing the hypothesis or a new theory.

Policy Making:

With the help of statistics we can frame favorable policies, for example the amount of food required to be imported in 2022 depends on the food-production in 2021 and the demand for food in 2022 without which we cannot estimate the amount of imports.

It Enlarges Knowledge:

Whipple rightly remarks that "Statistics enables one to enlarge his horizon". When a person goes through various procedures of statistics, it widens his knowledge pattern, widens his thinking and reasoning power and helps him to reach to a rational conclusion.

Measure Uncertainty:

Future is uncertain, but statistics help the various authorities in all the phenomenon of the world to make correct estimation by taking and analyzing the various data of the part so that uncertainty could be decreased.

Importance of Statistics in Different Fields

Statistics plays a vital role in every field of human activity. For example it helps in determining the existing position of per capita income, unemployment, population growth rates, housing, schooling medical facilities, etc. It holds a central position in almost every field, including - industry, commerce, trade, physics, chemistry, economics, mathematics, biology, botany, psychology, astronomy, etc., so the application of statistics is very wide. Some of the important fields in which statistics is commonly applied include:

Business:
A successful businessman must be very quick and accurate in decision making as he should knows what his customers want, know what to produce and sell and in what quantities which requires statistics. Statistics helps businessmen to plan production according to the taste of the customers, and the quality of the products can also be checked more efficiently by using statistical methods. Thus, it can be seen that all business activities are based on statistical information.

Economics:
Economics largely depends upon statistics. National income accounts for example, are multipurpose indicators for economists and administrators, and statistical methods are used to prepare these accounts. In economics research, statistical methods are used to collect and analyze the data and test hypotheses.

Banking:
Statistics plays an important role in banking. Banks make use of statistics for a number of purposes. They work on the principle that everyone who deposits their money with the banks does not withdraw it at the same time and earns profits out of these deposits by lending it to others on interest. Bankers use statistical approaches based on probability to estimate the number of deposits and their claims for a certain day.

State Management (Administration):
Statistics is essential to a country as governmental policies are based on it and statistical data are now widely used in making all administrative decisions. Federal and State government budgets preparation mainly depends upon statistics because it helps in estimating the expected expenditures and revenue from different sources. Statistics are the eyes of the administration of the state.

Accounting and Auditing:
Accounting is impossible without exactness. However, for decision making purposes, so much precision is not essential; the decision may be made on the basis of approximation, known as statistics. In auditing, sampling techniques are commonly used. An auditor determines the sample size to be audited on the basis of error.

Natural and Social Sciences:
Statistics plays a vital role in almost all the natural and social sciences as their methods are commonly used for analyzing experiments results, and testing their significance in biology, physics, chemistry, mathematics, meteorology, research, chambers of commerce, sociology, business, public administration, communications and information technology, etc.

Astronomy:
Astronomy is one of the oldest branches of statistical study; it deals with the measurement of distance, and sizes, masses and densities of heavenly bodies by means of observations. During these measurements, errors are unavoidable, so the most probable measurements are found by using statistical methods.

Applications of Statistic
Applied Statistics, Theoretical Statistics and Mathematical Statistics

While Applied Statistics comprises descriptive statistics and the application of inferential statistics, Theoretical Statistics is concerned with the logical arguments underlying justification of approaches to statistical inference. On the other hand, Mathematical Statistics includes not only the manipulation of probability distributions necessary for deriving results related to methods of estimation and inference, but also various aspects of computational statistics and the design of experiments. Some of these applications include:

Machine Learning and Data Mining
Machine learning models are statistical and probabilistic models that capture patterns in the data through use of computational algorithms.

Statistics in Academy
Statistics is applicable to a wide variety of academic disciplines, including natural and social sciences, government, and business. Business statistics applies statistical methods in econometrics, auditing and production and operations, including services improvement and marketing research.

Statistical Computing
The computer revolution has implications for the future of statistics with a new emphasis on "experimental" and "empirical" statistics. A large number of both general and special purpose statistical software are now available. Examples of available software capable of complex statistical computation include programs such SAS, SPSS, and R.

Statistics Applied to Mathematics or the Arts
What was once considered a dry subject, taken in many fields as a degree-requirement, is now viewed enthusiastically. Initially derided by some mathematical purists, it is now considered essential methodology in certain areas: In number theory, scatter plots of data generated by a distribution function may be transformed with familiar tools used in statistics to reveal underlying patterns, which may then lead to hypotheses.

Specialized Disciplines
Statistical techniques are used in a wide range of types of scientific and social research, including: biostatistics, computational biology, computational sociology, network biology, social science, sociology and social research. These disciplines include:

- Actuarial Science in Insurance

- Astrostatistics (statistical evaluation of astronomical data)
- Biostatistics
- Chemo metrics (for analysis of data from chemistry)
- Data mining (applying statistics and pattern recognition to discover knowledge from data)
- Demography (statistical study of populations)
- Econometrics (statistical analysis of economic data)
- Energy statistics
- Engineering statistics
- Epidemiology (statistical analysis of disease)
- Geography and geographic information systems, specifically in spatial analysis
- Image processing
- Jurimetrics (law)
- Medical statistics
- Reliability engineering

Misuse of Statistics and its Remedy

Mr. Vice Chancellor Sir, as important and useful as Statistics is, it can produce subtle but serious errors in description and interpretation—subtle in the sense that even experienced professionals make such errors, and serious in the sense that they can lead to devastating decision errors. For instance, social policy, medical practice, and the reliability of structures like bridges all rely on the proper use of statistics.

It therefore becomes imperative that, people who deal with information in their everyday life should be statistically literate, that is, have some basic statistical skill. Statistics represent a common method of presenting information helping us to understand what the data are telling us. Descriptive (or summary) statistics summarizes the raw data and allow data users to interpret a dataset more easily.

Quality

Quality- An Overview

Quality can be defined simply as conformance to the requirements, need, expectation and anticipation of the customers.

This has been expressed in many ways by quality philosophers, institutions and other authors as follows:

- Quality is conformance to requirements
- Quality is fitness for use
- Good quality means a predictable degree of uniformity and dependability with a quality standard suitable to the customer
- Quality is the degree of which performance meets expectation
- Quality defines an excellence in goods and services, especially to the degree they conform to requirements and satisfy customers

Importance of Quality

- Quality is critical to satisfied customers
- Quality is critical to satisfying your customers and retaining their loyalty so they continue to buy from you in the future.
- Quality products make an important contribution to long-term revenue and profitability. They also enable you to charge and maintain higher price

Purpose of Quality

- Quality means meeting a standard.
- A quality product or service is one that has preset measurable specifications for its performance and meets them.
- Quality system strives to make things that meet the standards set for them.
- A business is successful when your customers are gained and kept

Description of High Quality

- Excellent.
- Extremely good or impressive in a way that is unusual.
- High-grade.
- Extremely good.
- Superb.
- Polished.
- Wonderful

Customer

A customer is anybody impacted by our process. Customers are important because they drive revenues; without them, businesses have nothing to offer. Most public-facing businesses compete with other companies to attract customers, either by aggressively advertising their products or by lowering prices to expand their customer bases.

Categories of Customers

External to an organization is a customer who is not directly connected to that organization.

Internal customer however, is a customer who is directly connected to an organization, and is usually internal to the organization.

Aspects of Quality

There are two aspects of quality which are the quality of design and quality of conformance.

Quality of Design is a measure of how well the product or service is designed to achieve its stated purpose.

Quality of Conformance is the extent to which the product or service achieves the specified design.

Dimensions of Quality:

Performance: Performance refers to a product's primary operating characteristics.

Features: Features are additional characteristics that enhance the appeal of the product or service to the user.

Reliability: Reliability is the likelihood that a product will not fail within a specific time period.

Conformance: Conformance is the precision with which the product or service meets the specified standards.

Durability: Durability measures the length of a product's life.

Serviceability: Serviceability is the speed with which the product can be put into service when it breaks down, as well as the competence and the behavior of the service person.

Aesthetics: Aesthetics is the subjective dimension indicating the kind of response a user has to a product. It represents the individual's personal preference.

Perceived Quality: Perceived Quality is the quality attributed to a good or service based on indirect measure.

Service Quality Dimensions

Tangibles-Appearance of physical facilities, equipment, personnel, and communication materials

Reliability-Ability to perform the promised service dependably and accurately

Responsiveness-Willingness to help customers and provide prompt service

Assurance-Knowledge and courtesy of employees and their ability to convey trust and confidence

Empathy-Caring, individualized attention the firm provides its customers.

Quality Philosophers **and their Contributions**

Walter A Shewhart

Walter Shewhart was concerned with statistical theory serving the needs of industry and in ways that are predictable and exhibited the restlessness of one looking for a better way.

Kaoru Ishikawa

Kaoru Ishikawa is best known for Ishikawa Diagram also known as Cause-and-effect Diagram or Fishbone Diagram. He also introduced the concept of Quality Circles.

Genichi Taguchi

Genichi Taguchi is best known for Taguchi Loss Function Design of Experiments.

Edwards Deming

Edward Deming is best known for the 14 Points of Managing, the Deming Cycle, and the System of Profound Knowledge.

Philip Crosby

Philip Crosby is best known for Quality is Free, Zero Defects and Four Absolutes of Quality.

Joseph Juran

Joseph Juran is best known for Quality Control Handbook, Juran's Trilogy, Cost of Quality, and application of Pareto Principle in Quality.

Quality Culture

Quality culture is a set of group values that guide how improvements are made to everyday working practices and consequent outputs.. A true quality culture is an environment where team members genuinely care about the quality of their work, and make decisions based on achieving that level of quality.

Quality Management

Quality management is the act of overseeing different activities and tasks to ensure that products and services offered are consistent and help to achieve and maintain a desired level of quality.

The Four Key Components

Quality Planning–

Identifying the quality standards relevant to the project and deciding how to meet them.

Quality Improvement –
Purposeful changes of a process to improve the confidence or reliability of the outcome.
Quality Control –
The efforts made to uphold a process's integrity and reliability in achieving an outcome.
Quality Assurance –
Systematic or planned actions necessary for sufficient reliability to enable a particular service or product will meet the specified requirements.

Principles of Quality Management
Customer Focus-The primary focus of any organization should be to meet and exceed the customers' expectations and needs.
Leadership-Leadership traits refer to personal qualities that define effective leaders which are the ability of an individual or an organization to guide individuals, teams, or organizations toward the fulfillment of goals and objectives.
Engagement of People-The management engages staff in creating and delivering value whether they are full-time, part-time, outsourced, or in-house.
Process Approach- Emphasis is on achieving efficiency and effectiveness in the processes and entails an understanding that good processes result in improved consistency, quicker activities, reduced costs, waste removal, and continuous improvement
Continuous Improvement- Businesses that improve continually experience improved performance, organizational flexibility, and increased ability to embrace new opportunities and should be able to create new processes continually and adapt to new market situations.
Evidence-Based Decision Making- Decisions based on verified and analyzed data have an improved understanding and are able to perform tasks that produce desired results and justify their past decisions.

Relationship Management- Supply chain process should be well managed to promote better relationship and optimize the impact on performance.

Benefits of Quality Management

- It helps to achieve greater consistency in tasks and activities that are involved in the production of products and services.
- It increases efficiency in processes, reduces wastage, and improves the use of time and other resources.
- It helps improve customer satisfaction.
- It enables businesses to market their business effectively and exploit new markets.
- It makes it easier to integrate new employees, and thus helps managing growth more seamlessly.
- It enables continuous improvement of products, processes, and services.

Total Quality Management

Total Quality Management is:

- The way of managing organization to achieve excellence
- Total – everything
- Quality – degree of excellence
- Management – art, act, or way of organizing, controlling, planning, directing to achieve certain goals

Definition of TQM

A management philosophy that embraces all activities through which the needs and expectations of the customer and community, and the objectives of the organization are satisfied in the most efficient and cost effective manner by maximizing the potential of all employees in a continuing drive for improvement.

Effect of TQM (Quality Improvement)

Improve Quality (Product/Service)

↓

Increase Productivity (less rejects, faster job)

↓

Lower Costs and Higher Profit

↓

Business Growth, Competitive, Jobs, Investment

Mr. Vice Chancellor sir, Ladies and Gentle men you will agree with me that there is just no way any organization, public or private or even individuals will not make a breakthrough if all these doctrine of Quality is imbibed.

Data Quality

The US Census Bureau defined data as fit for use if it has the following three attributes:

Utility: the usefulness of the information for its internal users

Objectivity: whether information is accurate, reliable and unbiased and is presented in an accurate, clear and unbiased manner.

Integrity: the security protection of information from authorized access or revision.

Juran, a quality philosopher defined data as having high quality if they are fit for intended uses in operational, decision making and planning. Data quality means that data are relevant to their intended uses and are of sufficient detail, quality, with high degree of accuracy and completeness, consistent with other sources and presented in appropriate ways.

Dimensions of Data Quality

The dimensions of data quality include; Relevancy, Accuracy, Timeliness, Accessibility, Transparency, Consistency, Comprehensiveness, Currency, Granularity and Precision.

Relevance – The degree to which our data products produce information that meet our customer's needs

Accuracy – The difference between an estimate of the parameter and its true value.
Timeliness – The length of time between reference period of the information and when we deliver the data product to customer.
Accessibility – The ease with which customers can identify, obtain and use the information in our data.
Interpretability – The availability of documentation to customers in understanding and using the data.
Transparency – Providing documentation to customer in understanding and using our data.
Consistency – Reliability of data and the same across applications.
Comprehensiveness –inclusiveness of all required data to ensure scope of data is collected and documented.
Currency – Being up-to-date
Granularity – Attributes and values of data defined at current level of detail.
Precision – Data value being large enough to support the application or process.

Causes of Poor Data Quality
Technical Aspect

- Inaccurate measurement or counting devise
- Error in data storing process
- Poor quality data scanner
- Missing data field

Human Aspect

- Unintentional errors in data entry
- Lack of understanding
- Poor training
- Intentional, malicious, incorrect data entry
- Poorly defined or out of date data collection
- Multiple level of data entry

Organizational

- merging of data base – merger and acquisition
- Non-merging of data bases

- Scattering of data bases through different departments in organizations
- Lack of awareness of data quality issues
- Obsession with technology
- Old (legacy) data base

Effect of Poor Quality Data

- Data is not fit for purpose it is intended
- Decrease in reputation
- Impedes decision making
- Incorrect result
- Data base unusable.

Aligning with Data Revolution and Big Data - A necessity for Sustainable Development

Introduction

The report by the UN Secretary General's Independent Expert Advisory Group (IEAG) in 2014 and that of PARIS21 in 2015 put emphasis on the fact that the data revolution should increase the use and impact of data on outcomes.

To enable this increase in use and impact of data, the strategies of National Statistical Systems where possible must therefore include new data sources and increased engagement with new actors, such as the private sector, non-profits organizations and the academia.

It is the access and use of these new data sources in a new data ecosystem of data users, owners, producers and legislators that will enable policy makers, civil society organizations and citizens to monitor development progress, hold governments accountable and foster sustainable development.

Furthermore, all organizations either public or private require quality data for policy and decisions making and utilizing Big Data is pivotal for driving organization extract value from a large amount of data. Big Data is a method and technique to retrieve, collect, manage and analyze a very huge volume of both structured and unstructured data that is difficult to process using

traditional database which entail new technologies and technique to analyze them.

Data Revolution

A Data Revolution for Development requires a leap forward in the quality and availability of information that is used for decision making at all levels that combine both evolution and revolution.

This is geared towards:

More and Better Data:

The revolution requires major improvements in the number, quality and reach of traditional statistical systems, such as censuses, civil registration and vital statistics, administrative data from government run programs and household surveys, as well as the generation and use of data from new innovative sources (e.g., consumer transactions, satellite imagery, patterns of social networking).

Data that is used for Action and Accountability:

A partnership that draws on the best assets of public and private sectors would engender a change in the collective understanding of the value of data, its disclosure to the public in useable formats, and the importance of ethical data capture and use. It could transform the enabling environment for using the best available data for sound decisions, and accountability for those decisions, ultimately improving social and economic outcomes globally.

Principles for Sustained Improvements and Maximizing Value of Development Data

Maximizing Value from the Data Produced:

Data that is collected needs to be the most relevant for decision making and available in a format that can be easily used for multiple purposes. It should be open, disaggregated and interoperable. Governments, civil society, and the private sector

need technical capacity and the means necessary to use data for planning, measurement and accountability.

Continuously Improve Data Production and Use:

Continual improvement requires strengthening the capacity of traditional actors and welcoming new partners, including the private sectors and citizens/non-profit organizations.

Ensuring Improvements are sustained:

Predictable resources from Governments and International Institutions are required and should be used to support country systems, to produce data that can make a difference at the National and State levels. Funds should be invested in new cost-effective ways to produce the essential data Nigeria needs to make basic development decisions, and people need to hold Governments accountable.

Balancing Technological Innovations with Institutional Change:

A technology revolution alone will not be sufficient to produce more timely data for effective policy use. Changing institutional structures and mind-sets of decision makers to take account of new kinds of information will be critical. Concerns regarding ethics and privacy should be addressed as data revolution should not be a new extractive industry.

All National Strategy for Development of Statistics (NSDS) Stages should respond to these new demands by considering:

- Further developing administrative data systems to produce reliable and robust population estimates to rebase population based data and anchor new data sources.
- Complementing traditional data collection with new data sources.

- Undertaking due process in evaluating cost effective substitution of existing data sources.
- Budgeting for staff/ human resources in the emerging field of data science.
- Plan should be developed to build new partnerships, either by building links with different actors within the private sector, tapping into the network of trusted data consultancies or leveraging National Statistical Systems to facilitate access to large multilaterals.
- Establishing strong links with National Strategy for the Development of Statistics (NSDS) to combine national resources in centers of knowledge and excellence.

Reviewing the Existing Statistical Business Processes:

The New Data Sources and National Statistical Systems Mobilizing the Data Revolution

i. Sensor and Geospatial data. Example: Using satellite imagery to estimate poverty levels
ii. Telecom data. Example: Using call-detail records to estimate poverty and wealth
iii. Commercial transactions, including scanner data, credit card data, etc. Example: Using scanner data for the Consumer Price Index.
iv. Web crawling, scraping, search and analysis. Example: Using online job board posting
v. To estimate unemployment or LinkedIn data to estimate changes in job categories.
vi. Social media - using Google Trends and Sentiment Analysis to measure subjective wellbeing.

Benefits and Complementarities

Cost effectiveness:

Public-private partnerships – defined as voluntary, collaborative agreements aimed at increasing an NSS' capacity to provide new or better statistics – can help NSSs save resources by both sharing data and avoiding high upfront costs in infrastructure for data management.

Timelines:

Since unprocessed mobile metadata is available quasi-instantaneously, Call Detail Records
(CDRs) from mobile phone operators, for example, can yield near-real-time statistics.

Granularity:

Private sector data –CDRs and Geospatial data in particular – can display great temporal, spatial, and thematic and unit granularity. This is useful for the evaluation of short term policies, and the production of statistics at National and State levels.

Data in New Areas:

Big Data in particular has the potential of supporting the generation of new indicators, previously not compiled by National Bureau of Statistics (NBS), such as the measurement of inequalities, which are especially relevant within the framework of the SDGs.

Increased Responsiveness:

New data sources will equip NBS with the capacity to address new topics quickly and help academics to respond to as necessary.

New Forms of Partnerships

Access to new data sources requires new forms of partnerships. In recent years, we have seen the emergence of several successful cooperative structures, which often link different actors within the private sector. These public-private

partnerships (PPPs) for statistics have three distinguishing features from PPPs in other sectors:

i. They need to be formulated a long-term agreements, as there is often a need for longitudinal data and, at the same time, few alternative suppliers exist – for instance, phone logs are only held by a limited number of Mobile Network Operators.
ii. Proprietary and privacy risks play a central role in PPPs for statistics, whereas in other sectors, for example, in infrastructure, risks are mainly linked to Value for Money and Return on Investment.
iii. PPPs for statistics can cover any stage of the data value chain, including data collection, processing, analysis, dissemination. To be solid, these partnerships can take time to build..

Big Data

Big Data Defined

Big Data is a collection of data that is huge in volume, yet growing exponentially with time. It is a data with so large size and complexity that none of traditional data management tools can store or process efficiently.

Types of Big Data

Big Data can either be structured, unstructured or semi-structured.

Structured

Any data that can be stored, accessed and processed in the form of fixed format is termed as a structured data. An 'Employee' table in a database is an example of structured data which contain name, ID number, gender, department, rank, salary etc.

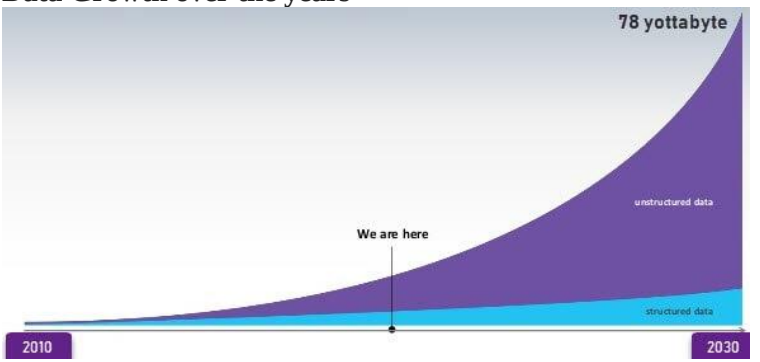
Unstructured

Any data with unknown form or the structure is classified as unstructured data. A typical example of unstructured data is a heterogeneous data source containing a combination of simple text files, images, videos etc.

Semi-structured

Semi-structured data can contain both the forms of data. Example of semi-structured data is a data represented in an XML file.

Data Growth over the years



Characteristics of Big Data

Big data can be described by its Volume, Variety, Velocity and Variability.

Volume

Organizations collect data from a variety of sources, including business transactions, social media and information from sensor or machine-to-machine data.

Velocity

The term 'velocity' refers to the speed atwhich data flows in from sources like business processes, application logs, networks and social media sites, sensors, mobile devices, etc.

Variety

Variety refers to heterogeneous sources and the nature of data, both structured and unstructured. During earlier days, spreadsheets and databases were the only sources of data considered by most of the applications but now days, data in the form of emails, photos, videos, monitoring devices, PDFs, audio, etc. is also being considered in the analysis applications.

Variability

This refers to the inconsistency which can be shown by the data at times, thus hampering the process of being able to handle and manage the data effectively.

Benefits of Big Data Processing

Ability to process 'Big Data' brings in multiple benefits, such as

- Can utilize outside intelligence while taking decisions
- Improved customer service
- Early identification of risk to the product/services, if any
- Better operational efficiency

Big data offers opportunity in the following sectors among others:

- Banking and security
- Communication Media and Services
- Education
- Government
- Healthcare providers
- Insurance
- Manufacturing and natural resources
- Transportation
- Various Traders such as: Retail, wholesalers Government Sector being the highest among them offers wide range of opportunities for big data analyst and researchers.

Big Data Handling

Need for Handling Big Data

The huge amount of data collected has the potential to reveal useful trends and patterns and hence the need to preserve and process.

Big Data Handling Techniques:

Handling of Big Data is another major concern. Below are some emerging technologies that are helping users cope with and handle Big Data in a cost-effective manner.

Big data handling can be done with respect to following aspects-

Processing Big Data: Map Reduce, Hadoop is an integrated framework for processing and storing Big data

Analysis and Querying of Data: WibiData, PLATFORA, PIG Business Intelligence: Hive

Storage: Cloud storage, Column-oriented databases, schema-less databases

Machine Learning: Apache Mahout, SkyTree.

Big Data Challenges

Size of Data:

Big data which is typically of the size petabyte or terabyte is bound to be confronted with many theoretical, technical, technological and practical challenges. Serious research efforts are being invested in order to improve the efficiency of storage, processing and analysis of Big Data. The following are the various challenges faced while handling Big Data.

Data Acquisition and Recording:

It is important to capture the context into which data has been generated, filter out the noise during pre-processing of the data and compress data. In view of the complexity of pre-processing of such data, there is need for innovation of new technologies and architectures, designed to efficiently extract value from very large volumes of a wide variety of data to enable high velocity capture, discovery and/or analysis.

Information Extraction and Cleaning:

Often data needs to be transformed in order to extract information from it to enable expressing this information in a form that is suitable for analysis.

Data Integration Aggregation and Representation:

Data might not be homogenous and may have different metadata. Different data aggregation and representation strategies may therefore be needed for different data analysis tasks.

Query, Processing, and Analysis:

Methods suitable for big data need to be discovered and evaluated for efficiency so that they are able to deal with noisy, dynamic, heterogeneous, untrustworthy data.

Mr. Vice Chancellor Sir, enabling increase in use and impact of data is now a necessity and National Statistical Systems' strategies must therefore include new data sources and increased engagement with new actors, such as the private sector, non-profits organizations and the academia.

PROCESS ANALYSIS AND QUALITY IMPROVEMENT TECHNIQUES

2.1 Process Analysis and Statistical Thinking

2.1.1 Process

A process is the transformation of a set of inputs, which can include materials, actions, methods and operations into desired outputs, in the form of products, information, services or generally results. In each area or function of an organization there will be many processes taking place. Each process may be analyzed by an examination of the inputs and outputs which will determine the action necessary to improve quality.

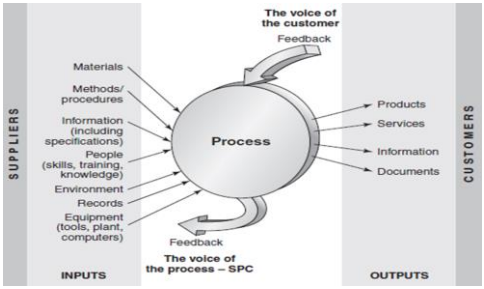
Examples of Process

- Opening a Bank Account
- Making a Bank Draft
- Preparing Soup
- Admission Process

- Serving Customers
- Data Entry
- Delivering a Lecture
- Storing a Product
- Preparing breakfast

Four Major Elements of a Process:

- Steps and decisions -the flowchart of series of steps and decisions describing the way work is completed.
- Variability of processing time and flow - the pattern of processing times.
- Timing and interdependence - when the arrivals happen, when people work, etc.
- Assignment of resources - how many and where are they assigned.



Process Analysis

It is the action of conducting a review and gaining an understanding of processes. It involves reviewing the components of a process, including inputs, outputs, procedures, controls, actors, applications, data, technologies and their interactions to produce results.

Importance of Process Analysis Process analysis helps to identify individual processes, to describe them, to visualize them and to discover the links that exist between them. It serves as a

tool for the understanding, improvement and management of business processes.

Three Basic Steps of Analysis Process and Tools

These steps and many others fall into three stages of the data analysis process

- Evaluate
- Clean
- Summarize.

The tools for process management include: Flow Charts, Process Maps, Program Evaluation and Review Techniques (PERT), Critical Path Methods, Stem-and-Leaf Plots, Box plots, written procedures, and work instructions are tools used for process analysis and documentation

How to Carryout Process Analysis for Improvement
Questions that need to be asked;

The purpose for which
The place for which
The sequence for which
The people through which
The method for which

→ activities are undertaken

Statistical Thinking

Statistical Thinking is the mindset that all works is a series of interconnected processes and that, variation exists in processes and understanding and reducing variation are keys to success. It is called statistical thinking because statisticians developed it or came naturally by it as a logical consequence of their art. It is a way of thinking, behaving, working, talking, acting and interacting with others.

It is not by accident that most of the quality philosophers referred to themselves as statisticians – Edward Deming, Joseph Juran, Philips Crosby, Ellis Ott, Walter Shewhat, Brian Joiner to mention a few. This is because they share a mindset in statistical thinking.

Concepts of Statistical Thinking

- Process and system thinking
- Variation
- Analysis increase knowledge
- Taking action
- Improvement

Benefits of Statistical Thinking

- Better business decision
- Increased success in implementing programs
- Better human relation.

Working in Teams, Problem Solving and Quality Improvement Tools and Techniques

Working in Teams

A team is a collection of individuals, who have one or two common form of characteristics.

There are four types of Quality Improvement team in accordance Edward Deming model which are:

Quality Task Force

- Quality Departmental Team
- Quality Circles
- Quality Improvement Team

Problem Solving

Problem solving is the act of defining a problem, determining the cause of the problem, identifying, prioritizing, selecting alternatives for a solution and implementing a solution. The following method known as seven step method for problem solving is a related technique that in proper management setting can accelerate improvement. It leads the team through logical steps that force a thorough analysis of problem, causes and possible solution.

Step 1 – Define the Project

The importance of the project must be shown an why energy, time, and resources should be spent justified.

Step 2 – Study Current Situation

Use data to narrow down the focus and reframe from jumping to possible inaccurate solution.

Step 3 – Analyze the Potential Causes

Find the root cause of the problem to narrow the focus in order to change most fundamental cause that can be changed

Step 4 – Develop Solutions

Find the best possible plan to be implemented and implement it on a small scale.

Step 5 – Check the Result

Determine whether the preferred solution is effective and decide whether to standardize the solution or return to the earlier step.

Step 6 – Standardize the Improvement

Ensure that the improvement stay fixed.

Step 7 – Standardize Future Plan

Establish whether more work need to done on the problem and promote the practice of continuous improvement in terms of organizational or team effectiveness.

Quality Improvement Tools and Techniques

Brainstorming

Brainstorming is a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members. All the ideas are noted down without criticism and after the brainstorming session the ideas are evaluated.

Purpose of Brainstorming

Brainstorming is a way to generate ideas within a group setting. It is usually used in the beginning stages of a project, where the possibilities for the project are not clearly understood or defined.

Benefits of Brainstorming

- Outside Input- Brainstorms allow for others to freely propose ideas.
- Idea Building- Each idea that is brought up does not have to stand on its own.
- Breaks Routine- Brainstorming session can get us out of a normal routine in particular where there are no apparent issues to be solved with how things are operating.
- Generating List of Ideas-Each session should have at least one person writing ideas down so that no idea is lost.
- Teamwork- It creates a team atmosphere as it does not happen without people.

Flow Diagram

A Flow Diagram otherwise known a Flow Chart is a diagram that uses symbols to depict nature and graphical flow of the steps needed to produce some output which can be physical product, a service, information or combination of the three.

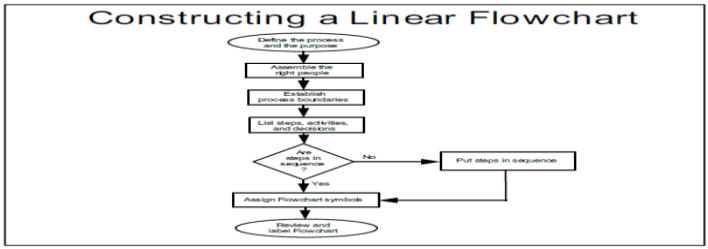
Uses of Flow Diagrams

- To promote understanding by explaining the steps pictorially
- To provide a tool for training employees
- To identify problem areas and opportunities for process improvement
- Depict customer-supplier relationships which help workers to understand who their customer are and how to satisfy them

Purpose and Benefits

- To document a process for better understanding, quality control and training of employees.
- To standardize a process for optimal efficiency and repeatability.
- To study a process for efficiency and improvement.
- To model a better process or create a brand-new one.
- To communicate and collaborate with diagrams speak to various roles in the organization or outside of it.

Example of Flow Diagram



How to flow chart

Cause and Effect Diagram

A Cause-and-Effect Diagram is a tool that helps identify, sort, and display possible causes of a specific problem or quality characteristic. It graphically illustrates the relationship between the outcome and the factors influencing it. It is otherwise known as Fishbone Diagram or Ishikawa Diagram. .

Uses of Cause and Effect Diagram

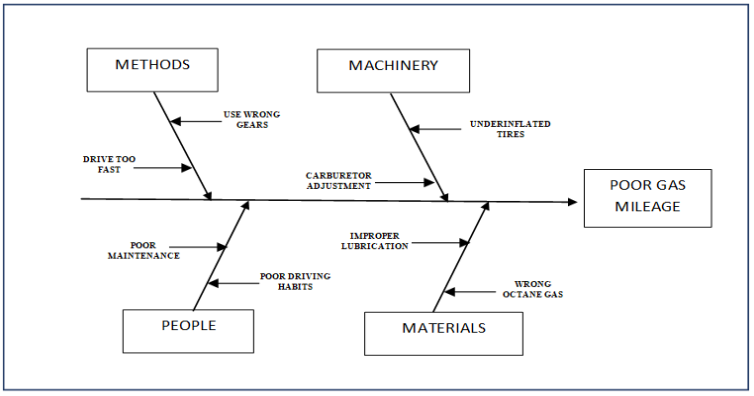
- To get the big picture
- To identify the root cause, the basic reason for the effect of problem or condition

- To sort out and relate some of the interactions among the factor affecting a particular process or condition
- Analyze existing problem so that corrective action can be taken

Purpose

The purpose of the cause-and-effect diagram is to determine how various phenomena are related.

Example of Cause and Effect Diagram



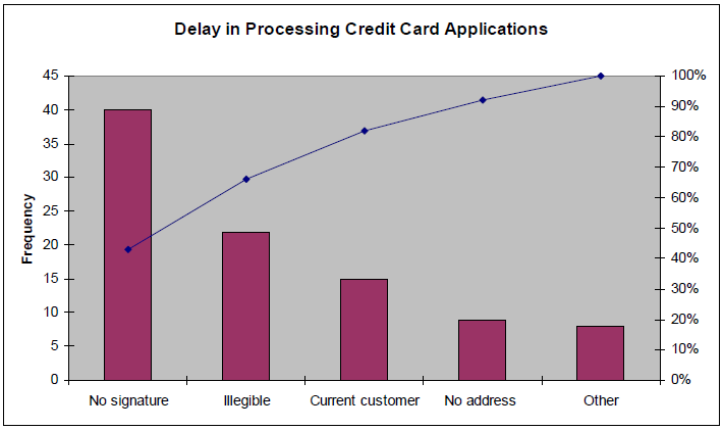
Pareto Diagram

A Pareto diagram is a simple bar chart that ranks related measures in decreasing order of occurrence. It was developed by Vilfredo Pareto, an Italian economist and sociologist who postulated that a large share of wealth is owned by a small percentage of the population by the study he conducted in Europe in the early 1900's referred to as 80-20 rule. The 80-20 rule is an aphorism which asserts that 80% of outcomes (or outputs) result from 20% of all causes (or inputs) for any given event.

Uses of Pareto Diagram

A Pareto chart is a basic quality tool that helps identify the most frequent defects, complaints, or any other factor you can count

Example: Pareto chart



STATISTICAL QUALITY CONTROL

An Overview of Statistical Quality Control

This is the use of statistical methods in the monitoring and maintaining quality of products and services. There are three major areas useful in quality improvement, which are: Design of Experiment, Statistical Process Control and Acceptance Inspection.

Design of Experiments

It is extremely helpful in discovering the key variables influencing the quality characteristics of interest in the process. A designed experiment is an approach to systematically vary the controllable input factors in the process and determine the effect these factors have on the output product parameters.

My focus however is on Statistical Process Control and Acceptance Inspection where I have concentrated in my research works.

Statistical Process Control

Statistical Process Control Defined

Statistical process control (SPC) is defined as the use of statistical techniques to control a process or production method.

Objectives of Statistical Process Control

The aim of SPC is to establish a controlled process by the use of statistical techniques to reduce process variation. A decrease in variation will lead to: better quality; lower costs (waste, scrap, rework, claims, etc.);

Basic Principle of SPC

- A process that is operating with only chance cause of variation is said to be in statistical control and that operating in the presence of assignable causes is out of control.
- The eventual goal of SPC is the estimation of variability in the process
- Most processes do not operate in a state of control.
- Routine and attentive use of control charts will identify assignable causes
- The control chart only detects assignable causes

Types of Control Chart

Variable Control Charts

These are applied to data that follow a continuous distribution e.g., weight, speed, length tensile strength etc. Examples are:

- X-bar chart to control central tendency
- R-chart to control the dispersion

Attributes Control Charts

These are applied to data that follows discrete distribution in the form of good/bad, acceptable/unacceptable, yes/no, defective/non-defective etc. Measurement is typically counting defects.

Examples are:

- Percent defective (p-chart)
- Number of defects (C-chart)

A control chart always has

- Central line (CL) that presents the average value of the quality characteristic corresponding to the in-control state,
- Upper line for the upper control limit (UCL)
- Lower line for the lower control limit (LCL)

General Model for a Control Chart

$UCL = \mu + k\sigma$

$CL = \mu$

$LCL = \mu - k\sigma$

where μ is the mean of the variable, and σ is the standard deviation of the variable.

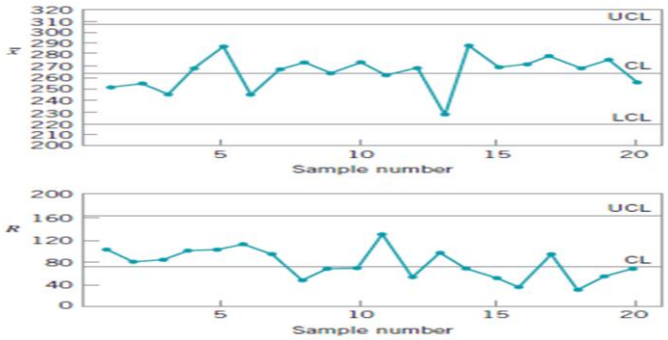
UCL = Upper Control Limit;

LCL = Lower Control Limit;

CL = Center Line.

k is the distance of the control limits from the center line, expressed in terms of standard deviation units. When k is set to 3, we speak of 3-sigma control charts.

Historically, k = 3 has become an accepted standard in industry.



Statistical Process Control Charts for Variables

Variables control charts

X-bar and R chart (also called Averages and Range Chart)

X-bar and S-charts

Moving Average-Moving Range Chart (also called MA–MR chart)

CUSUM (Cumulative Sum) Chart
EWMA (Exponentially Weighted Moving Average Chart)
Multivariate chart

Acceptance Sampling Plan
An Overview of Acceptance Sampling

Concerned with inspection and decision making regarding products but not used to estimate lot quality. It is used to decide whether to accept or reject lot based on adherence to standard. Sometimes we refer to this decision as lot sentencing and which is used as an audit tool.

When to use Acceptance Sampling

- When the cost of 100% inspection is extremely high
- When 100% inspection is not technologically feasible or would require so much calendar time that production scheduling would be seriously impacted
- When there are many items to be inspected and the inspection error rate is sufficiently high that 100% inspection might cause a higher percentage of defective units to be passed than would occur with the use of a sampling plan
- When the supplier has an excellent quality history, and some reduction in inspection from 100% is desired, but the supplier‘s process capability is sufficiently low as to make no inspection an unsatisfactory alternative
- When there are potentially serious product liability risks, and although the supplier‘s process is satisfactory, a program for continuously monitoring the product is necessary
- testing is destructive

Sampling Plans
Types of Measurement

- Attributes are quality characteristics that are expressed o n a “go/ no-go”, “conforming/nonconforming” basis.

- Variables –are quality characteristics that are measured on a numerical scale

Sampling Schemes

- Single sampling
- Double Sampling
- Multiple Sampling

Acceptance Sampling Plan for Attributes

Single Sampling Plan

From a homogenous lot of size N, take a random sample of n items. If the number of defectives found in the sample, d, exceeds the allowable number of defectives, c, the lot is rejected otherwise accept the lot

Double Sampling Plan

In double-sampling plan, under certain circumstances, a second sample is required before the lot can be sentenced.

A double-sampling plan is defined by four parameters.

n_1 = sample size on the first sample

c_1 = acceptance number of the first saple

n_2 = sample size on the second sample

c_2 = acceptance number for both sample

THE ROLE OF QUALITY STATISTICS IN NATIONAL SUSTAINABLE DEVELOPMENT

Introduction

Timely, reliable, comparable and available information on social, demographic, economic and environmental conditions are key factors for planning the National Development and the basis for this information is production of statistics at the National and Sub-national levels. Statistics provide the information, or the evidence needed for government daily administration and policy analysis, policy makers' planning; private sector, business decisions and citizens possibility to hold their government accountable. In summary, statistics provide the basis evidence-based policy decisions and a democratic society.

Some Relevant Quotations:

"Statistics are the eyes of policy makers"

Director of Economic Affairs Uganda Ministry of Finance

"Sound data represent the key weapon in the battle against poverty"

Tado Chiko, President, Asian Development Bank

"If you can't measure it, you can't manage it"

Robert Kaplan

"An essential component of any development planning is data; without data, a state 's effort to plan growth and welfare of the people cannot be grounded in reality and therefore may be severely flawed" Hon. Prof. Anyang Nyongo 'o, Minister for Planning and National Development, Kenya

"Data is the oxygen; it's what moves the world"

Jay Nath, Head of Innovation for the City of San Francisco

"Data is not only the new oil; it is oxygen for digital economy"

2007, also sponsored by the World Bank which is suppose to have been domesticated by every State but Mukesh Ambani, the richest man in India,

Statistics and Good Governance

Governance nowadays does not only occupy a central stage in the development of any country but can be said to be crucial element which needs to be incorporated in the development strategy.

Governance

Definitions of Governance:

United Nations Development Program (UNDP) defined governance as the exercise of economic, political and administrative authority to manage a country's affairs at all levels.. It ensures that political, social and economic priorities are based on broad consensus in society and that the voices of

the poorest and the most vulnerable are heard in decision-making over the allocation of development resources.

The World Bank on the other hand defined governance as the manner in which power is exercised in the management of a country's economic and social resources for development.

The Roles of Quality Statistics in Good Governance:

Every country needs to describe its social, demographic, economic and environmental conditions to provide information that will create knowledge which is a prerequisite for forming opinions and making political decisions on a sound basis. Reliable, independent and trustworthy information on all aspects of society is therefore needed to enable policy-makers make evidence-based planning and policy decisions, researchers analyze society, and citizens form opinions and hold governments accountable for their policies.

Easy accessible statistics can help citizens hold their government accountable. Availability of free information which people can trust is a crucial element for good governance and democracy will result to:

- Citizens being able to hold their government accountable by either being able to analyze data themselves or learn through the support of independent media which build their work on reliable information.
- Civil society also being able to use freely and easily accessible information as a sound basis for their advocacy work.
- Information on society being made free, user-friendly, and easily accessible for everyone

Evidence–Based Policy and Decision Making:

It is a systematic and rational approach to researching and analyzing available evidence to inform the policy making process.

Advantages

- Helps ensure that policies respond to people's need resulting into better outcomes.
- Highlight urgency of issues or problems which require immediate attention
- Enable information sharing among people to realize which policy works.
- Can reduce government/organization expenditure which may otherwise be directed into ineffective policy.
- Can produce an acceptable return on financial investment for public programs by developing service delivery and outcome

How Quality Statistics can enhance the Decision Making Process

Stage 1 – Identify an issue and understanding the issue. Statistics can assist policy makers to identify existing economic, social or environmental issues that need addressing.

Stage 2 – Set the agenda. Statistics provide a valuable source of evidence to support the initiation of new policy or the alliterating of an existing policy or program. It can highlight the relevance and severity of the issue in numerical terms, and thus demonstrate the importance of developing policy or programs to address the issue as quickly as possible.

Stage 3 – Formulate policy. This stage requires careful and rigorous statistical analysis and through consultation with key stakeholders to establish a clear understanding of the true extent of the problem. This enables determination of the most appropriate policy and program options to address the issue and the best strategy for implementing them.

Stage 4 – Monitor and Evaluate Policy. It is essential that the progress of policy program be regularly monitored and evaluated to determine if it is effective. Evaluation of the sources of the policy program in quantifiable terms, can be measured as the benchmark which when established at an earlier stage accurately measure progress.

Use of Statistics for Making Evidence-Based Decision

A level of statistical literacy is however required in order to understand and interpret data correctly. Statistical literacy can be measured by the following criteria which are vital for the informed use of statistics:

Data Awareness:

- Know what data is appropriate for your need
- Know what type of data are available
- Assess appropriate data sets – ensure data availability are fit for purpose
- Assess the quality of available data.

Use of Statistics in Private Sector

The private sector needs reliable information on how society develops to make decisions; in particular when companies invest. Information providing a true picture on the economic situation now and prospect for future makes them more confident in investing. More investment will lead to employment creation and income generation thus paving way for poverty reduction and improvement of people's lives.

Mr. Vice Chancellor Sir, it had been established that no nation can have sustainable develop without good statistics

MAJOR ACADEMIC CONTRIBUTIONS

Sapling Inspection Plans by Attributes

Chain-Deferred Inspection Plans – **Osanaiye P. A.** (1983) Journal of the Royal Statistical Society, Series (Applied Statistics), Vol. 32, No. 1

When carrying out costly or destructive tests using attribute data, where each sample unit is simply classified as good or bad, the common procedure is to use low acceptance numbers and a small sample to keep the cost low. This motivated the idea of "Deferred Sentencing" which was conceived and applied by Searly (1943) and Spalding (1945). Dodge (1955) also developed "Chain Sampling Plans", which use sample

information under certain conditions from the past lots in sentencing the current lot. After Dodge's plan, many other similar procedures were developed which use sample information from previous or subsequent lots.

A general shortcoming of the chain plans is that, since they use sample information from previous lots in making decisions, there is a greater tendency to reject a lot of given good quality when the process quality is improving or accept a lot of given bad quality when the process quality is deteriorating. Similar criticisms (in reverse) may be made of deferred plans.

This study proposes plans that improve on existing chain and deferred sampling plans. The plans are mixed in the sense that they combine elements from both chain and deferred plans. This combination gives an operating characteristic curve closer to that of the traditional double sampling plan than either the simple chain or the simple deferred inspection plan when there is a trend in process quality. The plans also require fewer items to be sampled than the traditional double sampling plans and have a delay in the decision only where there are indications that quality is poor. The relative ease with which these plans can be made compatible with the double sampling plans in the MIL-STD-105D and some other similar schemes is also an added advantage.

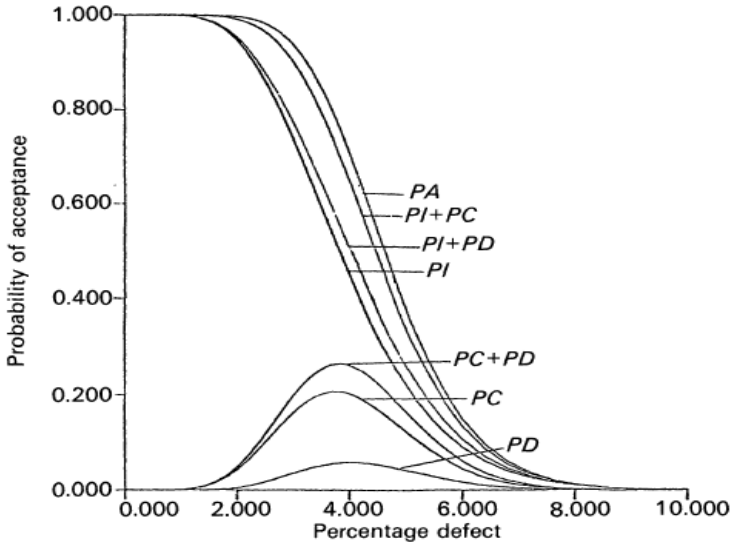
Procedures

- Take a sample of size n from lot i and determine the number of defective items, d_i.
- Accept lot i if $d_i \leq A$
- Reject lot i if $d_i \geq R_1$.
- If $A < d_i < R_1$, then results from the adjacent lots are considered before sentencing the i^{th} lot. These results influence the decision as follows:
- If i=1, the decision is deferred until the result from lot 2 is known and then the first lot is accepted if $d_1 + d_2 < R_2$, otherwise, it is rejected.

- If i> 1 and $d_i \leq C$, then the i^{th} lot is accepted if $d_i + d_{i-1} < R_2$, otherwise it is rejected (chain)
- If i> 1 and $d_i > C$, then the i^{th} lot is accepted if $d_i + d_{i+1} < R_2$, otherwise it isrejected (deferred)

Plan Evaluation

The Operating Characteristic curve for this plan is shown in the figure below, where PA is the total probability of acceptance. The curve labeled PI is the probability of immediate acceptance, the one labeled PC is the probability of acceptance using the chain sample result and PD is the probability of acceptance using the deferred sample result. From these component probabilities, the different contributions to the total probability of acceptance can be seen particularly with respect to variation in process quality. For example, the two curves PC and PD peak in the neighborhood of 4 per cent defective and are negligible below 1 per cent defective.



General OC CDP (200, 7, 9, 11, 19).

Compatibility with Double Sampling Plans in Mil-Std-105d and Similar Schemes:

Another attractive feature which the plans possess is compatibility with the double sampling plans given in the MIL-STD-105D and similar schemes. The double sampling plans can be transformed to chain-deferred inspection plans by inserting the additional parameter C into each of the plans

Findings:

The plans require fewer items to be sampled than the traditional double sampling plans and have a delay in the decision only where there are indications that the quality is poor. The relative ease with which these plans can be made compatible with the double sampling plans in the MIL-STD-105D and some other similar schemes is an additional advantage.

Multiple Chain-Deferred Inspection Plans and their Compatibility with the Multiple Plans in MIL-STD-105D and Equivalent Schemes- Osanaiye P. A. (1985) Journal of Applied Statistics, Vol.12, No1

This research work is on multiple sample extension of the chain-deferred plans by the author (1983). These plans are similar to the traditional multiple plans except that they use information from, at most, four surrounding lots when sentencing the current lot. When compared with existing plans, the new proposals either reduce the cost of the decision procedure or reduce the possible length of the queue of un-sentenced lots and at the same time give an equivalent overall protection.

The number of stages in these multiple plans is reduced from the seven stages in MIL STD 105D plans to five. This is partly to simplify the sentencing exercise as the plans utilize information from neighboring lots and also partly because the contributions to the probability of acceptance at the sixth and seventh stages of the traditional multiple plans are normally small. The curtailment is, however, compensated for in these

plans by an increase in their acceptance number at the fifth stage. The plans are developed using three methods for switching between preceding and subsequent lots thus:

Method 1:
The method utilizes the neighboring lots to provide information in an alternating sequence, that is, if the decision is not reached with the current sample they take the preceding lot followed by the subsequent lot succeeding it in case a decision has not been reached. Thereafter, the lot before this preceding lot, and finally the lot after the succeeding lot.

Method 2:
The method starts with the current lot, then if necessary utilizes the two preceding lots to provide sample information (one at a time) and if there is a further deferment of decision, the two subsequent lots are utilized to provide information (one at a time).

General Concept Assumption

The plans assume that the product to be inspected comprises a series of individual units produced essentially by a continuous process so that results of recent, past and future lots are indicative of the same process. Also, inspection is by the method of attributes and a constant sample size, n is taken from each lot. The plans, however, do not require the assumption of a constant process quality over a long period of time and we shall examine their behavior under non-uniform conditions.

Operating Procedures:

Procedure of Methods 1

1. Take a sample of size n from lot j and set T_1 equal to d_j, the number of defectives in lot j.
    - Accept the lot if $T_1 \leq A_1$.
    - Reject it if $T_1 \geq R_1$
    - If $A_1 < T_1 < R_1$ continue as in step 2.

2. Combine T_1 with the number defectives obtained from the preceding lot d_{j-1}, to give
   - $T_2 = T_1 + d_{j-1}$
   - Accept the lot if $T_2 \leq A_2$
   - Reject it if $T_2 \geq R_2$
   - If $A_2 < T_2 < R_2$ continue as in step 3.
3. Defer the decision until a sample is taken from the subsequent lot whose number defectives, d_{j+1}, is combined with to give $T_3 = T_2 + d_{j+1}$
   - Accept the lot if $T_3 \leq A_3$
   - Reject the lot if $T_3 \geq R_3$
   - If $A_3 < T_3 < R_3$, continue as in step 4
4. Combine the number defectives obtained from the next preceding lot d_{j-2} with T_3 to give
   - $T_4 = T_3 + d_{j-2}$
   - Accept the lot if $T_4 \leq A_4$.
   - Reject it if $T_4 \geq R_4$.
   - If $A_4 < T_4 < R_4$ continue as in step 5.
5. Defer the decision until a sample is taken from the next subsequent lot which is combine with T_4 to give $T_5 = T_4 + d_{j+2}$
   - Accept the lot if $T_5 \leq A_5$, otherwise reject the lot.

Procedure of Method 2

The procedure for this method is like that of method 1 except that the order of the samples is j, j- 1, j-2, j+l, j+2; that is, it first makes use of the information in preceding lots before that in subsequent lots. Hence $T_l = d_j$ $T_2 = T_1 + d_{j-1}$, $T_3 = T_2 + d_{j-2}$, $T_4 = T_3 + d_{j+1}$, $T_5 = T_4 + d_{j+2}$, but otherwise A_i and R_i remain unchanged.

The plans are compatible with the first four stages of the multiple plans in MILSTD-IO5D and equivalent schemes. At the fifth stage, which is the final stage of the plan, the acceptance numbers of the multiple chain-deferred plans are increased to one less than the corresponding rejection number at that stage.

Findings:

The multiple chain-deferred sampling plans present an appealing alternative to the traditional multiple sampling plans under certain conditions. This is as a result of their relatively low sampling cost, particularly when sampling is costly or destructive.

An Economic Choice of Sampling Inspection Plans under Varying Process Quality- Osanaiye P. A. (1989) Journal of the Royal Statistical Society. Series C (Applied Statistics), Vol. 38, No.2

To promote sound procedure in commercial practice, it is worthwhile to compare sampling inspection plans under various process quality models to identify which sampling plan is the most suitable under a given process quality model. This is because in practice process quality may not be constant over a long period of time but may follow various types of process quality models. The process quality models considered in this study are as follows.

Linear trend in process quality:

This model assumes a gradual shift in either an upward (deteriorating trend) or a downward (improving trend) direction

Autoregressive process:

This is a stochastic model for the representation of a process oscillating under its own internal forces.

Inert process:

In this model, the process remains at a given process quality level until a shock moves it to a new (poorer) quality level at which it tends to remain.

It is universally recognized that installing a sampling procedure is an economics problem and should therefore be solved by considering the costs involved. In this study, the costs of orthodox sampling plans, namely single-sampling, double-

sampling and multiple sampling plans together with some plans that utilize neighboring batch information, i.e. the dependent double- and deferred double-sampling plans of Baker and Brobst, chain-deferred sampling and multiple-chain-deferred sampling plans of Osanaiye(1985), are compared.

Weibull's Cost Model

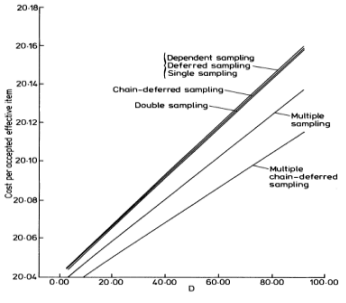
Weibull (1951) obtained the mean cost per accepted effective item, C, for rectifying inspection as follows:.

Also define I as the cost of sampling inspection, H as the cost of 100% inspection per item, D as the cost of damage due to an undetected defective item and R as the opportunity cost due to a rejected item.

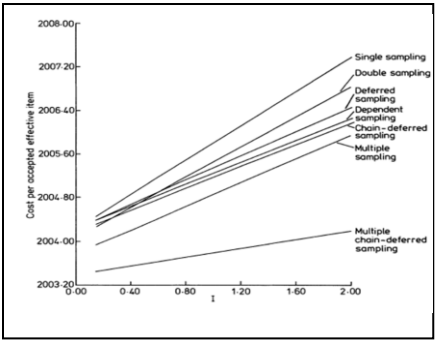
$$C = \frac{n\bar{I} + (N-n)p_{da}D + (N-n)p_{r}H + Np_{dr}R}{N(1-p_{da})}$$

where, N is the lot size and n is the sample size.

The effects of D and I



Effect of a change in D



Effect of a change in I

Findings:

If sampling is to be installed on an economic basis, the multiple-sampling plans should be used. However, if the multiple-sampling plans are not to be used, however, then the plans that utilize the surrounding batches, preferably the chain-

deferred sampling plan, should be used if the inspection costs is high, while the single- or double-sampling plan should be used in situation of high cost of damage due to accepted defective items or opportunity cost due to rejected items.

Effects of Industrial Inspection Errors on Some Plans that Utilize the Surrounding Lot Information - Osanaiye P. A. and Alebiosu S. A. (1988) Journal of Applied Statistics, Vol.15 No. 3.

During an inspection exercise in a manufacturing industry, it is usually assumed that the inspector is perfect neglecting the possibility of his committing errors. Such errors include categorizing a non-defective item as defective which can be termed as type I error or categorizing a defective item as non-defective which can be termed as type I1 error. These errors are not only restricted to the inspector's imperfection but can be caused by electronic test equipment, chemical indicators and simple go/no-go gauges.

In this study the effect of the inspector's accuracy on types I and I1 errors on the Dependent double, Deferred double and Chain-deferred plans are examined to see which one of them is more robust to such errors. The proportions that are non-defective but rejected and those that are defective but accepted due to sorting errors are computed and compared. Furthermore, in most real life situations, process quality may not remain constant over a long period of time and as an illustration of the possible process models, a linear trend in process quality is adopted for this work.

Findings:

The Chain-deferred plan is most efficient in reducing defective items in the accepted lots. Although the plan has relatively higher proportion of production that is good but rejected, this is not very significantly different from those of the Dependent double and Deferred double sampling plans. Furthermore, when sorting is restricted to the accepted parts at it

is mainly practiced; the chain-deferred plan has the least proportion of defective item that is accepted under an improving or deteriorating trend in process quality.

Reliability Life Acceptance Plan

The following two factors are considered in acceptance sampling for testing the quality of lots of products:

- High cost of production and testing
- Destructive nature of some tests

The characteristics of the Product Life Distributions in Reliability Engineering could follow any of any of Weibull, Raleigh, Generalized Exponential, Marshall Okin's Generalized, Exponential, Lomax, Burr Type XII, Log- Logistic among others each of which has its behavioral peculiarities in life tests.

One of the works we did in this area is to **Design Time Truncated Single Acceptance Sampling Plan Based on Rayleigh Distribution as a Product Life using R Software** - Braimah J. O. and **Osanaiye P. A.** (2019), African Journal of Computing ICT, Vol. 8 No. 4

The developed reliability sampling plan assumes that lifetimes of items follow compound Rayleigh distribution and the life test terminates at a pre-fixed time, t_o. The plan is aimed at determining an optimal sample size which provides desired levels of protection for both consumer as well as the producer when the tested unit follows a compound Rayleigh distribution.
Note that life data refers to measurements of product life which can be measured in hours, miles, cycles or any other metric that applies to the period of successful operation of a product and often called times-to-failure.

Procedure of the Plan

A random sample is selected and put on tests.

- It is run for a pre-decided experiment time t_0.
- If the number defectives, d are less than a predetermined acceptance number, c before the specified t_o, the test is truncated.

- If more than c defectives are recorded by the end of the experimental time t_o, the lot is rejected.

Determination of Minimum Sample Size (n)

Suppose the probability of accepting a bad lot, the consumer's risk, β is fixed for which the true mean life is below the specified mean life say , does not exceed .

This approximation was discussed by several authors and was modified by several authors including Muhammad et al (2012)

On using the relationship between the gamma and random variables, we derived a modified formula given by

$$n \approx \left[\frac{\chi^2_{2c+2,\,p^*}}{2F(t;\mu)}\right] + 1$$

where $F(t;\ \mu)$ is the cumulative distribution function of the assumed distribution.

Here $\chi^2_{2c+1,\ p^*}$ denotes the percentage point of a variable with $2c+2$ degree of freedom. In order to ensure accuracy in our computation, the software (GRETL) was used.

Findings:

If both the confidence level and acceptance number are fixed, the minimum sample size required to reach the decision reduces as the experimental time ratio increases. Also when acceptance number is fixed and experiment time ratio varied, the minimum sample size required to reach a decision is uniformly higher as the confidence level is increased. Furthermore, the probability of acceptance uniformly decreases with increased confidence level when the mean ratio is varied and the experiment time ratio is fixed.

We also developed **Isolated Truncated Chain Deferred Sampling Plan (ITCDSP)** - Braimah J. O. and Osanaiye P. A. (2019) Braimah J. O. and Osanaiye P. A. J. Phys.: Conf. Ser.1366 012127

Assumptions:

- The cost of destructive test is such that small sample size is required.
- The products to be inspected consist of a series of successive lots produced by a continuing process.
- Lots are expected to be of essentially the same quality.

Operating procedure

- Select a sample of n units from each lot and test each unit for conformance to the specified attribute requirements.
- Accept the current lot if the defective items (d) is zero in the n-sample units;
- Reject the lot, if $d > 1$.
- If $d = 1$, then wait for the next lot and test for number of defectives;
- Accept the lot with $d = 1$, known as current lot if no defectives are found in the immediately preceding 'i' samples and succeeding 'j' samples
- Reject the current lot if the number of defectives in the succeeding lot is 1.

Research Methods using Weibull Distribution:

The Weibull distribution is commonly applied in failure situations and has since been used in acceptance sampling inspection and reliability studies.

Determination of the Minimum Sample Size (n)

Putting all the necessary constraints, the minimum sample size was derived.

Findings:

The developed sample sizes were smaller and will be economically preferred when the test is destructive, thereby saving both cost and time of testing.

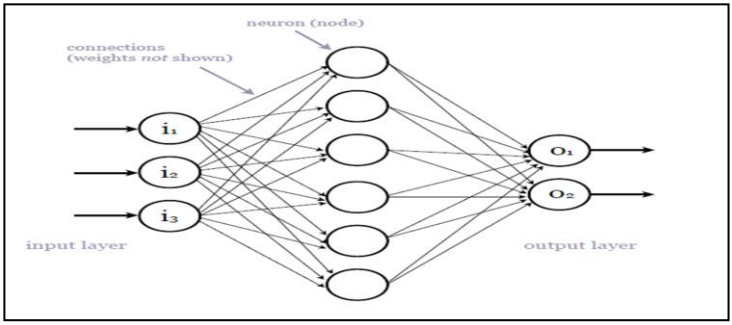
USE OF ARTIFICIAL NEURAL NETWORK TO MONITOR PROCESSES

An artificial neural network (ANN) is the piece of a computing system designed to simulate the way the human brain analyzes and processes information. It is the foundation of artificial intelligence (AI) and solves problems that would prove impossible or difficult by human or statistical standards.

The Artificial Neural Network receives the input signal from the external world in the form of a pattern and image in vector form with each input multiplied by its corresponding weights.

Artificial Neural Networks can be best described as the biologically inspired simulations that are on the carried on the computer to do a certain specific set of tasks like clustering, classification, pattern recognition etc. In general, Artificial Neural Networks is a biologically inspired network of neurons (which are artificial in nature) configured to perform a specific set of tasks..

Architecture of Artificial Neural Networks:



The architecture of an artificial neural network contains a large number of artificial neurons which are termed units arranged in a series of layers with the following different kinds of layers:

Input layer:
The input layers contain those artificial neurons (termed as units) which are to receive input from the outside world.

Output layer:
The output layers contain units that respond to the information that is fed into the system and also whether it learned any task or not.

Hidden layer:
The hidden layers are hidden in between input layers and the output layers.
Several multivariate charts are used to monitor processes which include Hotelling T^2 (Hotelling, 1947), MEWMA (Lowry et al., 1992); Pignatiello and Runger, 1990) and MCUSUM (Woodall and Ncube, 1985; Healy, 1987; Crosier, 1988) and many other recent authors.

To further improve on the performance of existing multivariate control chart, ANN is used. However, one of the most important problems that neural network designers face is an appropriate network size as well as appropriate percentages of dataset allocation into training, validation and testing for a given application.

This we addressed by carrying out **Performance Analysis of ANN on Dataset Allocations for Pattern Recognition of Bivariate Process** - Adeoti O, A. and **Osanaiye P. A.** (2012) Mathematical Theory and Modeling Vol. 2 No 10

The percentages of dataset allocation for training ANN, different percentages of dataset allocation have been suggested in the literature but there are no mathematical rules for the determination of the required sizes of the various subsets. Looney (1996) recommends 65% of the dataset to be used for training, 25% for testing and 10% for validation (cited in Basheer and Hajmeer, 2000), whereas Demuth et al., (1998) proposed 60% for training, 20% for validation and 20% for testing. In this study, we examined the performance of ANN on

different percentages of dataset allocation into training, validation and testing levels using six different training algorithms.
MATLAB M-files were developed for the training and diagnosis performance of the network using the MATLAB Neural network toolbox software.
The trained ANN model was evaluated to obtain the recognition accuracy once the training stopped. The mean square error for the dataset allocation were observed and the dataset allocation that gives the minimum mean square error and maximum recognition accuracy for the ANN model was considered the best for pattern recognition of the bivariate process

Findings:

The dataset allocation into 80% (Training), 10% (Validation) and 10% (Testing) trained with Levenberg-Marquardt algorithm is identified to be the best allocation for the problem because it has good recognition accuracy and minimum mean square error compared to other dataset allocation.

Another study undertaken is the **Effect of Training Algorithms on the Performance of ANN for Pattern Recognition of Bivariate Process-**Adeoti O, A. and **Osanaiye P. A.** (2013) International Journal of Computer Applications Vol. 69 No 30

In this study, the effect of three training algorithms namely Resilient back propagation (trainrp), Quasi-Newton (trainbfg) and Levenberg-Marquardt (trainlm), on the performance of ANN models for pattern recognition of bivariate process was investigated. The outputs of the networks of the three ANN training algorithms were compared with a pre-specified target output to enable minimizing the differences between the network actual output and target output through adjusting the weights and biases. This is with a view of obtaining the best algorithm that produces ANN with high recognition accuracy, least global error and faster training for the pattern recognition of bivariate manufacturing process.

MATLAB M-files programming codes were written using the MATLAB Neural network toolbox software for the three selected training algorithms.

Mean Recognition accuracy of Training.

S/N	Training Algorithms	Recognition Accuracy
1	Trainlm	87.78182
2	Trainrp	79.17273
3	Trainbfg	81.20909

Findings:

The performance of trainlm is identified to be the best algorithm for pattern recognition of bivariate manufacturing process in terms of recognition accuracy. It is better in terms of speed and mean square error performance.

NON-PARAMETRIC CHANGE-POINT APPROACH FOR MONITORING SHIFTS IN PROCESS

The normality assumption for monitoring shifts in process may not be satisfied in some real-life situations. As a result of that Lepage (1971) developed a non-parametric two-sample test for testing equality of the location and scale parameters against the alternative that at least one of the parameters' equality does not hold, generally known as the Lepage test statistic. It is a combination of the Wilcoxon-Mann-Whitney and the Ansari-Bradley test statistics (Rublik, 2005). A version of this two-sample Lepage test which combines Wilcoxon-Mann-Whitney and Mood test statistics introduced by Rublik (2009) would be referred to as Lepage-type

This study is focused on, a **Non-Parametric Change-Point Approach for Monitoring Shifts in Process Location and Variability –** Afolabi R. F. and **Osanaiye P. A** (2015) International Journal of Quality Engineering and Technology, Vol.5 No 1

In the study, the non-parametric Lepage-type change-point (LCP) control chart for jointly detecting process shifts in mean and variance, under non-normality was investigated. Comparison was made between it and the generalized likelihood ratio (GLR)-based by simulating data that follow normal and Laplace distributions and their performances assessed through their Average Run Lengths.

Methods of Analysis

GLR-based control chart by Hawkins and Zamba

Consider a random and normally distributed process observations X_i defines as

$$X_i \sim \begin{cases} N(\mu_1, \sigma_1^2), & \text{if } i \le \tau \\ N(\mu_2, \sigma_2^2) & \text{if } i > \tau \end{cases}$$

where X_1, X_2,…,X_j, are the successive process readings; μ_1 and σ_1^2 are the in-control true mean and variance respectively; μ_2 and σ_2^2 are respectively the out of control values to which the process mean and variance shifts, and τ is the change-point. The mean, the variance, or both could shift when the process exceeds the change point, τ.

The non-parametric Lepage-type change-point (LCP) approach to Statistical Process Control (which combines the Wilcoxon and the Mood statistics) test for shift in process location and variability respectively is used. Suppose the Lepage-type change-point at the independent process observations $\{x_1, x_2, x_n\}$ comes from a continuous cumulative distribution function F (x; μ_i, σ_i), where μ_i and σ_i are the location and variability parameters respectively. Also, consider the existence of time τ (change-point) when there is a shift in mean and/or in standard deviation of the process. The process reading, paralleling Hawkins and Zamba **(2005b),** can be modeled by:

$$X_i \sim \begin{cases} F(x;\mu_1,\sigma_1), & \text{if } i \le \tau \\ F(x;\mu_2,\sigma_2), & \text{if } i > \tau \end{cases}$$

Performance Assessment and Comparison of Methods

The Average run length (ARL) is a popular measure of control chart performance. It is the expected value of the run length distribution (the number of samples or subgroups that need to be collected before the first out of control (OOC) signal is given by a chart). It is the mean of the run length distribution which is actually the average number of observations needed for a control chart to signal (Ghute and Shirke, 2012; Hawkins and Zamba, 2005b). It is used more often in the literature because it is conceptually easy to understand.

After carrying out appropriate simulation exercise, the result is as in the table below:

Table of In-control ARLs for GLR and LCP by the change-point values and the distributions considered

Distribution	Methods	Change Points				
		20	50	100	250	500
Normal	GLR	493	496	485	490	488
	LCP	497	497	499	500	489
Laplace	GLR	154	152	150	145	148
	LCP	499	488	496	497	484

Findings:

The LCP competes favorably with the GLR in a normal distribution setting by minimizing the frequency of false alarms and rapidly detecting the process shift. As the magnitude of shift increases (in mean, variance or both), there is increased sensitivity to the shift. It however outperformed the GLR in case of heavy-tailed symmetric distribution considered. We therefore

recommend the new approach for short-run situations where the underlying distributions are unknown.

We also applied the **Lepage-type Change-point Control Charts Applied to Monitoring Acute Mal-nutrition in Under-5 Children in Nigeria** - Afolabi R. F. , O noja M. O. and **Osanaiye P. A.** (2017) American Journal of Public Health Research, 2017, Vol. 5, No. 6,

Malnutrition has been identified as a critical risk factor for stunted growth and poor psychosocial development in under-5 children and identification of the most affected age is an important statistical contribution to monitoring nutritional problems among children. Previous studies have demonstrated that monitoring processes' parameters (mean and variability) individually or simultaneously could provide some insights but no application has been related to monitoring proportion of wasting in under-5 children.

Method

The 2013 Nigeria Demographic Health and Survey data was used for the study, which was cross-sectional in design and involved a nationally representative sample aimed at providing population and health indicator estimates. Data was extracted on relevant variables including child age (in months), sex, mothers' wealth category, mothers' educational status, parity, birth order, delivery by caesarean section, mother's marital status, breastfeeding status, resident, region, and weight-for-height.

Let X_i be the percentage of acutely malnourished under-5 children (the outcome variable) in the data set. Assuming X_i is normally distributed and conditioned on the parameter τ, called the "change-point" which is unknown a priori. Furthermore, let the parameters μ_1 and μ_2 be the unknown in- and out-of-control means (respectively) while σ_1^2 and σ_2^2 are unknown constants describing the variability in the in- and out-of-control observations in which the process mean and variance have shifted, and τ is the change-point. The distribution of such

observation can be monitored effectively using generalized likelihood ratio (GLR) change-point control charts

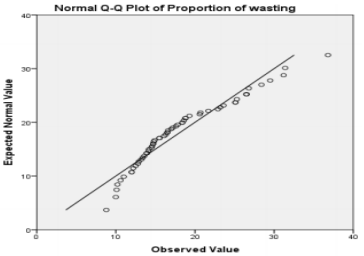
However, in this case Lepage-type change-point control charts (LCP) for simultaneously monitoring change in location and variability parameters is used, μ and σ are the unknown parameters describing the location and variability inherent in the process data being monitored

Shift in the location parameter occurs if $\mu_1 \neq \mu_2$ while shift in variability occurs if $\delta_1 \neq \delta_2$ and in principle, either or both of these shifts could occur in the observation process

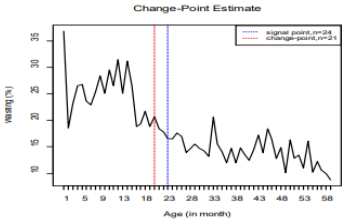
The $LCC_{max,n}$ is then plotted against sample number on a control chart. Whenever there is a shift in the percentage of acute malnutrition, the LCP chart would issue an out-of -control signal and identify the parameter(s) that has shifted. Suppose that a process shift is detected at time t, corresponding to the value of 'd' which maximized $LCC_{max,n}$, the accrued observations can be partitioned into the subsets $\{Y_1,\ldots..,Y_d\}$ and $\{Y_{d+}1,\ldots\ldots,Y_t\}$.

A two-sample Wilcoxon-Mann-Whitney and Mood tests is then carried out on the two subsets, and the p-values evaluated and compared. The shift is most likely to constitute a location shift or variability shift if Wilcoxon-Mann–Whitney or Mood test respectively gives the lower p-value as well as the direction of the shift. All analyses were carried out using the R statistical package.

Result



Q-Q plot showing of proportion of acute malnutrition



LCP estimated change-point, along with its detection time of acute malnutrition of under-5 children nutritional status

Findings:

The prevalence rate of wasting among under-five as revealed by this analysis is high. The LCP demonstrated prompt detection of shift (both in mean and variability) in the proportion of wasted under-5 children that is not normally distributed. The point at which LCP signaled and its estimated change-point d help reduce to a large extent, the burden of wasting in under-5 children and can guide necessary policy and interventions directed towards ameliorating the situation. Since the distributions of similar data are usually unclear, we recommended that LCP control chart be used in monitoring such situations.

CUMMULATIVE SUM CHART (CUSUM) CONTROL CHART SCHEMES IMPORTANT APPLICATION

The cumulative sum charts conceived by Page (1954), which have been developed by many authors (e.g. Ewan et al., 1960; Johnson & Leone, 1962; Ewan, 1963; Page, 1964; Bissell, 1969; Lucas, 1976), have been proposed as an alternative to Shewart charts. They directly incorporate all of the information in the sequence of the sample values and detect small shifts in the process level more quickly. They are more meaningful graphically, as process shifts are often easy to detect and points of change can also be easily located. The principal feature of the CUSUM control scheme is that successive values, say X_i values, of a variable are compared with a predetermined target or reference value, k. The Cumulative Sum of the deviations from k, i.e.

$$S_N = \sum_{i-1}^{N} (X_i - k)$$

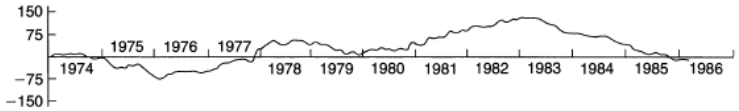
is plotted on a chart or shown in a tabulation. To monitor a shift from goal, the CUSUM statistic is used. The process is taken to be out of control if $S_i > h$.

Most of the early work done on CUSUM control charts was concerned with continuous variables and little had been done on the counted data version.

Our work is centered on **Some Non-Manufacturing Applications of Counted Data Cumulative Sum (CUSUM) Control Chart Schemes** – **Osanaiye P. A.** and Talabi C. O. (1989) Journal of the Royal Statistical Society, Series D (The Statistician), Vol. 38, No. 4.

The research is focused on detection of the outbreak of an epidemic to demonstrate the use of CUSUM chart in the non-manufacturing sector. The designed schemes was applied to the diabetic disease data collected from the University of Ibadan Teaching Hospital, Ibadan, Nigeria to illustrate the detection of outbreak of epidemic and the retrospective analysis also carried out to compute the local means.

The corresponding CUSUM chart is plotted over January 1974 to February 1986 (146 months) as shown in Figure below.



CUSUM chart for diabetic data (January 1974 to February 1986).

Applications:

CUSUM Chart

The Table below shows the diabetic data and the corresponding CUSUM statistics for the year 1977 implemented to detecting the outbreak of an epidemic.

CUSUM tabulation for the diabetic data (1977)

Month	X_i	$X_i - k$	$\Sigma(X_i - k)$	S_i
January	25	2	2	2
February	20	−3	−1	0
March	31	8	7	8
April	22	−1	6	7
May	15	−8	−2	0
June	26	3	1	3
July	21	−2	−1	1
August	23	0	−1	1
September	14	−9	−10	0
October	13	−10	−20	0
November	58	35	15	35*

* From the table, an out-of-control sign is given in November of that year.

Retrospective Analysis

The CUSUM chart has three segments:

- July 1974 (sample No. 7) to October 1977 (sample No. 45)
- November 1977 (sample No. 46) to August 1979 (sample No. 68)
- September 1979 (sample no. 69) to February 1986 (sample No. 146)

The 'Span' test tabulation is shown in the Table below, and all the three tests give statistically significant values of Vmax

'Span' test on CUSUM segments $\sigma=7{\cdot}5$ and $n=146$

Segments	Span m (sample)	V_{max}	V_{max}/σ	P (Fig. 2)	$\frac{m\alpha}{n}$
7–45	38	−84·89	11·32	<0·001	0·013
46–48	22	75·09	10·12	<0·001	0·008
69–146	77	126	168	<0·001	0·026

Computation of Local Means

The estimates of the Local Means are as in the Table below. The mean of the Local Means is approximately 18, the target value

Table of local means ($T=18$)

Segment (sample No.)		C_i	C_j	$j-i$	$T+\frac{C_j-C_i}{j-i}$
(i)	1–7	2	13	6	19
(ii)	7–24	13	−71	17	13
(iii)	24–45	−71	−16	21	21
(iv)	45–56	−16	55	11	25
(v)	56–58	55	7	12	14
(vi)	68–111	7	134	43	21
(vii)	111–146	134	−8	35	14

Findings:

The ability of the CUSUM control scheme to detect rapidly the outbreak of an epidemic demonstrates its importance and usefulness in the detection of some non- manufacturing problems. Appropriate actions can then be taken in good time

USE OF QUALITY TOOLS FOR ORGANISATIONS' PRO DUCTIVITY IMPROVEMENT

To be successful in today's economic climate, service organizations must be dedicated to continuing improvement in their customer satisfaction and seek some efficient ways that meet their needs.

Large organizations often perform the same activities at several sites, branches or local offices. The task of identifying the causes of variations may be complicated by this physical dispersion because the causes might differ from site to site. Also most organizations are now concerned with profit increasing strategies such as quality management process improvement or productivity improvement.

In this study we focused on **An Efficient And Cost-Effective Approach To NEPA's Quality Service Delivery of Power Supply Using Cluster Analysis and Some Other Quality Management Tools - Osanaiye P. A.** and Salihu (1999) Nigeria Journal of Science, Vol. 33, Pp. 215 -228.

The National Electricity power Authority's(NEPA) complaints in electricity power supply in Ilorin Metropolis was studied using cluster analysis and some quality management tools to analyze the reported faults. In those days, NEPA was in monopoly of power generation, distribution and marketing in Nigeria. Its service impacted on all sectors of the country being it individual, private or public institutions. In view of this it becomes imperative that NEPA delivers quality service and satisfy all her customers for the nation's productivity and socio-economic advancement.

Good customer service was therefore required in the supply of electricity because it impacts on every aspect of the nation. The customers of that service require uninterrupted electricity supply and prompt rectification of faults when reported by customers. The customers' complaints in electricity supply in Ilorin Metropolis was studied by using cluster analysis to classify the 21 zones into homogenous groups.

Method of Analysis:

Cluster Analysis

Cluster Analysis is a statistical procedure used for classifying a large number of disperse groups into homogenous groups based on a set of characteristics of their items.

Cluster analysis is now being used as a quality management tool to identify components of a system with similar characteristics or segments of a process that are affected by the same factors.

Other tools and techniques used in the research include Brainstorming, Cause-and Effect Diagram and Flow Diagram and Pareto Diagram which have been earlier discussed.

Cluster Analysis of the Faults Reported

Genstat 5 Computer Software Package was used to classify the 22 zones into clusters.

The faults were categorized into: Light Failure, (LF), Loose of Contact (LC), Wire Problem (WP), Voltage Fluctuation (VF) and others which cover every other fault.

Table of Clusters and Percentages of Types of Faults.

Cluster No	Zones in Cluster	L/F	L/C	W/P	V/F	OTHERS
1	1,17,19	68.44	14.07	9.81	2.56	5.12
2	18,3,4,2,22, 6,7,13, 9,10,20,12,11,21 ,14,8,16,5	73.51	4.68	11.21	7.51	3.09
3	15	70.52	6.94	10.12	8.09	4.34

Findings

Cluster1 made up of three zones is distinguished by its relatively high rate of voltage fluctuation and relatively high rate of loose of contact and others category. The second cluster which is the largest and made up of 18 zones is characterized by relatively high rate of light failures and high rate of loose contact

and others category. The third cluster, made of only one zone is characterized by relatively high rate of voltage fluctuation.

MY CONTRIBUTIONS THROUGH CONSULTACY ENGAGEMENTS, CAPACITY BUILDING AND GUEST SPEAKER AT IMPORTANT EVENTS

Introduction

My journey as a consultant in Statistics started in 1990 when I sold the idea of Statistical Capacity Building to the Department of Statistics in view of its importance of such facilities which were not many in Nigeria then. The Department then came up with such program tagged "Vacation Course in Statistics" which was run during the long vacation in 1990. I was made the Course Coordinator.

My responsibilities as the coordinator included preparation of Course Brochures for Advertisement, Marketing, Course materials preparation, making adequate arrangements for participants' accommodation, lecture venue and other necessary needs. We had 68 participants that year.

At the second year in 1991, the name of the course was changed to "Professional Courses in Statistics" and we had 98 participants.

In 2004, I was engaged with three other consultants by the National Bureau of Statistics to craft the Generic State Statistical Master Plan using six states representing each of the six geo-political zones of Nigeria at the Sub- national level to strengthen the Statistical Capacity which was sponsored by the World Bank.

Also in 2008, I was engaged with three other consultants to develop the National Strategy for the Development of Statistics (NSDS) in Nigeria which was sponsored by ECOWAS. In 2015, the EU SUFEGOR engaged me as a Senior Expert with other consultants at reviewing the NSDS. To review the NSDS in Nigeria

At the international level, I have been the Course Director of the Bilingual Course on Data Analysis for African

Development Planners, at the United Nations African Institute for Economic Development and Planning (IDEP), Dakar Senegal since 2011 to date.

In recognition of our annual performances as assessed by the participants, the UN Economic Commission for Africa (ECA) which oversees IDEP, in 2017 requested us to run a one week Retooling Course on Statistical Methods and Analysis for their staff at IDEP.

Summary of my Major Consultancy Engagements

Consultant, Nigeria Science and Technology Post Basic Education Studies for Federal Ministry of Education and Federal Ministry of Science and Technology – sponsored by World Bank and British Council. Sept-Nov. 2005

Consultant, Assessment of Statistical System at State Level and Development of State Level Statistical Master Plan for the Identified Pilot States and Production of a Generic Statistical Master Plan for the Sub-National Level in Nigeria under the Economic Reform and Governance Project financed by IBRD/FDA.

Consultant, Domestication of the Plateau State Statistical Master Plan, Sponsored by UNFPA, 2008

Consultant, Domestication of Kwara State Statistical Master Plans, 2012

Consultant, Designing/Updating National Strategy for the Development of Statistics (NSDS) for Nigeria under the Auspices of the Development of Research and Statistics of the ECOWAS Commission, Dec.2007

Senior Expert, Review of the National Strategy for the Development of Statistics (NSDS) in Nigeria under the auspices of European Union Support to Federal Governance Reform Programme (SUFEGOR) June – August 2015

Chief Facilitator: Rivers State Statistical Forum, organised by the Rivers State Government at Port Harcourt on 13th and 14th February, 2009.

Engagements with National Population Commission for 2005/2006 Census

- **Resource Person (Census)** for National Population Commission in charge of Kogi State, Oct. 2005-March 2006.
- **Resource Person** for Evaluation of Post Enumeration Survey Training of Enumerators and Supervisors – National Population Commission, Abuja, June 2006.
- **Independent Monitor** for Evaluation of the Post Enumeration Survey – National Population Commission, Abuja, June 2006.

Consultant: Public Expenditure Tracking Survey at Kaduna and Enugu States for the Millennium Development Goals and sponsored by World Bank; 2006.

Consultant: Nation Wide Farm Household and Agricultural Produce Survey for Federal Ministry of Agriculture and Rural Development, Abuja, 2008**.**

Consultant: National Information System and Agricultural Statistics for Food and Agriculture Organisation (FAO) of the United Nations, 2009

Consultant: Development of Nigerian Agricultural Data Collection, Analysis and Computerization for Agriculture and Rural Institution Support Project (ARISP) and sponsored by African Development Bank, October 2009

Consultant: Development of **Health in Nigeria (2005-2008),** a publication of the Federal Ministry of Health, sponsored by PATHS2, November 2009

Consultant: Upgrading the Curriculum of the NBS School of Statistics at Ibadan, Kaduna and Enugu, sponsored by the World Bank, 2006-2007.

Consultant, Implementation of UNDP – Assisted Programme for:

- Filling Capacity Gaps of the SSA to Process and Analyse Poverty Related Data and report on progress towards attaining MDGs and link its

- Data Base with Gender Disaggregated Data in the Line Ministries in Kogi State 2006-2007

Consultant: Restructuring of the Research &Statistics Department of National Insurance Commission (NAICOM), June- August, 2012.

Chief Facilitator: Implementation Workshop for the Restructuring of the Department of Research and Statistics of National Insurance Commission (NAICOM) May/June 2013

Reviewer and Resource Person to coordinate, Critique and Validate the Draft Revised Quantity Surveying Curricular for Degree and Higher National Programmes in Nigerian Universities and Polytechnics.

Reviewer and Resource Person at the Review of Niger State Statistical Year Book Template organised by Niger State Bureau of Statistics and sponsored by UNDP (November, 2012)

CAPACITY BUILDING

Statistics

Course Director: The United Nations African Institute for Economic Development and Planning (IDEP), Bilingual Course on Data Analysis for African Development Planners, Dakar, Senegal from 2011 to date.

Course Director: Retooling Course on Statistical Methods and Analysis for the Staff of the United Nations Economic Commission for Africa (ECA) at IDEP Dakar Senegal, September 2017

Coordinator: Professional Courses in Statistics, a capacity building course for Statisticians and enumerators, Researchers and Quality Control Managers in the manufacturing sector organised by the Faculty of Science in conjunction with the University of Ilorin Consultancy Unit, 1990-1991

Consultant: Worksop on Statistics in Governance for the Lagos State Statisticians (1993)

Consultant: Workshop on Statistics in Agriculture for the Officers of the Federal Ministry of Agriculture Abuja and Sponsored by UNDP at Circular Hotels Ilorin (September 1997)

Consultant: Workshop on Sample Survey Techniques and Operations for the Staff of the Kogi State Statistical Agency and PRS Departments of Line Ministries and Parastatals Sponsored by UNDP (February 1998).
Consultant: Workshop on Capacity Building in Survey and Monitoring on Governance and Anti-Corruption for the Technical Unit on Governance and Anti-Corruption Reforms, the Presidency, Federal Republic of Nigeria, sponsored by the World Bank, June 2008.
Consultant: Workshop on Non-Response in Surveys for Central Bank of Nigeria, October 2011

Statistical Quality Control

Sterling Health Plc
Berger Paints Plc
Nigeria Bottling Company Plc
Seven-Up Plc
Cadbury Nigeria Plc
Van Leer Containers
West African Batteries Plc
Hoechst Nigerian Plc
Oluwa Glass Plc

Quality Management and Productivity Improvement Skills

Nigerian French Insurance Company, Lagos (1992)
NICON Plc, Lagos (1993)
Kwara State Agricultural Development Project, Ilorin (1994)
National Electricity Power Authority (NEPA), Northern Zone, Jos (1996)
Michael Imodu Institute for Labour Relations, Ilorin (1997)
Managers of Union Bank Plc, Lagos (2000)

Workshop on Statistics as a Tool for Good Governance and Sustainable Development, for the Niger State Permanent Secretaries, Directors of PRSD and MDAs, Sponsored by UNDP, July 2013.

Workshop on Quality, Process Control and Acceptance Sampling for NAFDAC Staff at NAFDAC Laboratory Oshodi, Lagos, July, 2016.

Workshop on **Insurance Data Quality Management, Research Methodology and Evidence Based Policy/ Decision Making** for Staff of NICOM at Keffi, December 2018.

Workshop on Leadership in Quality, Work Ethics and Attitudinal Change for Improved Productivity for the staff of NICOM at Uyo, September, 2019.

Workshop on Creative Strategic Management and Strategies for the staff of NICOM at Kaduna, November, 2019.

GUEST SPEAKER AT CONFERENCES AND RETREATS IMPORTANT EVENTS

Lead Speaker, Nigerian Statistical Association WEBINAR on **Statistics, Covid-19 and Good Governance,** December 2020

Sterling Health (Nig) Plant Conference Held at Gate Way Hotel, Otta(October 1990)

- Statistical Quality Control in Pharmaceutical Industries

Insurance Institute of Nigeria's Conference at Gate Way Hotel, Otta (1992)

- Statistical Technology for Insurance Business
- Total Quality Management and Insurance Industry

First National Seminar on Total Quality Management organized by Federal Office of Statistics and Sponsored by UNDP at Gate Way Hotel Abeokuta

- Quality Improvement Techniques
- Statistical Thinking and Quality Control

Total Quality Awareness Seminar for the Kwara State Executive Council Organized by Federal Office of Statistics at Kwara Hotel, Ilorin (November 1997).

Chief Facilitator, National Workshop on the Role of Statistics and Total Quality Management as Planning and Development

Tools in the Fourth Republic organized by Federal Office of Statistics.

Retreat of the Department of Statistics of Central Bank of Nigeria (CBN) at Hamdala Hotel Kaduna, 2010

- Statistics as a Tool for National Development.

Retreat of the Directorate of Economic Policy of the Central Bank of Nigeria at Abuja(2011):

- Building Synergy and Facilitating Information Flow within the Directorate and External Stakeholders

Retreat of the Statistics Department of Central Bank of Nigeria at GINI Holiday Inn, Akwanga, Nasarawa state, 2012.

- Data Quality and Integrity

African Statistics' Day held at the Headquarters of Bureau of Statistics, Abuja(2015):

- Better Data Better Lives- Harnessing Modern Technology to enhance National Statistical System

OTHER CONTRIBUTIONS

National President, Ogbe Progressive Union Ogbe, West Yagba LGA, Kogi State, 1984-2000

- Gave an effective leadership in the community development activities that made Kabiyesi of Ogbe, Oba Ampitan Kolade Orebiyi to give me the chieftaincy title: **OTUNBA OF OGBE** in 2014

Chairman, Agba Dam Eastern Valley Community, Tanke, Ilorin, 2004 to date

Chairman, Board of Governors, Nursery/Primary School, 2007-2017.

Chairman, Elders' Electoral Committee 2nd ECWA Amilegbe Ilorin, 2011 to date.

5 Introduced formal electoral process as practiced in government elections.

SUMMARY AND CONCLUSION

The fundamental idea of Statistics has its bases from Uncertainty and Variation. In real life, there are many situations whose outcome is uncertain and in all processes variation is inevitable.

Statistics is used in our day by day activities like predictions, quality testing, forecasting among many other things. Its functions include presentation of facts in a definite form, comparisons, policy making and measure of uncertainty and holds central positions in every field of life

As useful, functional and applicable statistics is, however, misuse of it can produce subtle but serious errors in description and interpretation; people who deal with information in their everyday life should therefore be statistically literate, that is, have some basic statistical skill.

There are many definitions of quality by the Quality philosophers which can be summarized as conformance to the requirements, needs and expectation and even anticipation of a customer, customer being anybody impacted by our process who can be internal or external.

Quality management is the act of overseeing different activities and tasks to ensure that products and services offered are consistent and help to achieve and maintain a desired level of quality.

It is however imperative that all Government and private organizations align with Data Revolution and Big Data necessary for sustainable development.

Process is the transformation of a set of input into results which can be in form of product, information or service and quality improvement is conventionally carried out through problem solving by constituting effective Quality Group using Quality tools.

Statistical Quality Control which is my primary domain is the use of statistical methods in monitoring and maintaining the quality of products and services.

Statistics provides information needed for Government at all levels daily administration and policy analysis, policy making, planning, monitoring and evaluation and private sector business decisions.

My major research contributions cover the areas Sampling Inspection where I developed two acceptance inspection plans and established their relevance and robustness in real life varying situations and also in reliability test plans. Furthermore, in the area of Statistical Process Control we introduced the use of Artificial Neural Network (ANN) at detecting shift in process quality level, used Non-Parametric approach at detecting process changes and also applied the use of some charts and quality improvement techniques for quality and productivity improvement in many facets of life.

By the Special Grace of Almighty God, I have made some contributions through consultancy engagements both nationally and internationally, capacity building and Guest speaker in many important events.

All these which are paths to success and breakthrough in all facets of life, require well blended quality statistics as a necessity and hence the title of my lecture:

QUALITY BLENDED STATISTICS - A VERITABLE TOOL FOR UNIVERSAL BREAKTHROUGH

RECOMMENDATIONS

FEDERAL AND STATE GOVERNMENTS

An immediate review of the National and State Statistics Master Plans to strengthen and modernize the National Statistical System

Every country needs timely, reliable, independent, trustworthy comparable and available statistics to describe its social, demographic, economic and environmental conditions which create knowledge for planning and development that is nationally produced.

Many National Strategies had been put in place in the past for Strengthening Statistical Capacity in Nigeria supported by World Bank, ECOWAS, EU and other Development Partners at the National and Sub- National Levels under many Reforms However, despite all these attempts to improve statistics delivery at all levels, many of the Statistics Offices are still plagued with such bottlenecks as: Weak infrastructure, inadequate human resources, insufficient financial resources, duplication of data sources, and poor coordination among data users, producers and other stakeholders among others. In addition to that there is current need for the National Statistical System to key into the new era of Data Revolution and use of Big data which are currently a necessity for Sustainable Development.

All Policy/Decision makers, Planners, Officers involved in monitoring and evaluation and other officers who use statistics in their day to day work should be made to be statistically literate to enable its efficient use.

Evidence-based policy decision making is a process that is transparent, rigorous and tested to meet designed objectives. The advantages of evidence-based policy/decision making include among others: ensures policy respond to the need of the people; highlight the urgency of the development issues or problems; enable information sharing in regard to what works or not; reduce expenditures; and ensure decisions are characterized by transparency and accountability

Misuse of statistics can produce subtle but serious errors in description and interpretation-subtle in the sense that even experienced professionals make such errors, and serious in the sense that they can lead to devastating decision errors.

It therefore becomes necessary that, people involved in policy decision making, planning, monitoring and evaluation or generally information users in their everyday life functions should be statistically literate.

NATIONAL BUREAU OF STATISTICS

NBS should align with Data Revolution and Big Data which has currently become a necessity for Sustainable Development

The National Strategy for Development of Statistics (NSDS) stages should respond to these new demands by considering further development of administrative data systems to produce reliable and robust population estimates. There is also need to **c**omplement traditional data collection with new data sources based on reviews of cost, ease of collection, quality of data obtained through new processes and sustainability of the processes.

Specifically:

i. NBS should establish new partnerships by building links with different actors within the private sector, non-profits organizations and the academia.

ii. Put in place trusted data consultancies or leveraging National Statistical Systems to facilitate access to large multilaterals the cover the data

iii. Facilitate access to new data sources which requires new forms of partnerships linking NSDS to combining National and Donors resources in centers of knowledge and excellence to enable the capacity and resources to adapt through public- private partnership (PPP).

iv. In the case of Big Data special technical handling should be put in place in its processing, analysis, queried of data and machine learning.

PUBLICAND PRIVATE ORGANIZATIONS AND CIVIL SOCIETIES

All officers involved in handling data management in their day to day activities in the public and private sectors, being it manufacturing, service, Civil Societies, NGOs or any other type of organization should essentially be literate in Quality and Statistics.

ACKNOWLEDGEMENT

To God be the honor, glory and adoration for taking me this far in my journey of life. I thank Him for His love, mercy, undeserved favor, protection, joy and peace. It is by His grace that I have the privilege to present this inaugural lecture today which is very special to me in my life.

My appreciation goes to my parents both of who are late; Pa Enock Abu Osanaiye and Mama Deborah Iyelola Osanaiye for their love, endurance, sacrifice, support, and prayers. I can recall that my father notwithstanding the fact that he was a peasant farmer was able to sponsor me and my senior brother and sister in standard and reputable schools. May their souls continue to rest in perfect peace. I also appreciate my brothers and sisters- Elder Samson Dele Osanaiye, Mrs. E. F. Agunbiade, Mr. Adesanya Osanaiye, Mrs. Folasade Iwalaiye, Mr. Oluyori Osanaiye and Mrs. Junmoke Olukotun for their brotherly and sisterly love and concern for me.

My gratitude also goes to the University of Ilorin for sponsoring me through the Staff Development Grant for my PhD. at University of Essex, Colchester, England. I appreciate the Vice Chancellor, Prof. S. A. Abdulkareem particularly for his goodwill at enabling University of Ilorin ASUU's to return to the National ASUU mainstream and I also thank him for obliging my special request. My appreciation also goes to the immediate past Vice Chancellor, Prof. A. Ambali, for his impact on me during his tenure.

I appreciate the Department of Statistics which I call my second home in particular our ogas, Emeritus Professor O. S.

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I acknowledge my Kabiyesi, HRH Oba, Ampitan Kolade Orebiyi for his cooperation and support to me when I was the president of Ogbe Progressive Union (OPU) for about sixteen years and the chieftaincy title, Otunba of Ogbe he conferred on me in recognition of my contributions to the development of Ogbe community. I appreciate Chief D.I. Asala, Elder S. A. Osasona, the President of Ogbe Progressive Union and many others who cooperate and support me towards our community development.

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I appreciate all members of Kogi Forum, University of Ilorin and must not fail to appreciate the members of my immediate community, Agba Dam Eastern Reservoir Community (ADEVCO) where I have been the Chairman since 2004, for their cooperation, support at providing security and welfare to the community and facilitating improvement of the community's infrastructures; in particular, I acknowledge the contributions of Alhaji I. Gold, Engr B. A. Lawal, Engr M. K. Aborisade, Engr. Yahaya, Arch. T. Kusa, Chief & Mrs G. A. Adeyemi, Mrs. R. Owolabi, Mr. Gbenga Okeowo, Alhaji A. Tijani, Dr. Atanda, Mrs. Akintola, Mr.Yusuf, Engr.Gbenedio,

Lawyer Rowland Otaru(SAN), Engr. Udoji, Prof. Tayo Dosumu, Alhaja S.Abdulrahman Alhaji Shehu, Mr. Frienco and all the other good people of the community.

I recognize my set at Titcombe College Egbe, TC CLUB 67-71 Set, Baba Dr. J. A.Adewumi and all graduates of Titcombe College here today.

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Finally I thank everybody here today for honoring my invitation to attend this lecture, I appreciate you all. It is my prayer that those who have travelled from afar will get back to their destinations safely in Jesus name.

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