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Resource Management, Quality and Profitability of Sachet Water in Nigeria

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Abstract
The paper examined the resource input and management of sachet pure water production and its profitability. The research design was both survey and analytical. The research used *statistical process control* to measure the current quality of the product (or process variability) and assess all resource inputs in the water factory of the Polytechnic Ibadan. All the inputs were quantified in monetary terms including depreciation and the indispensable waste. Profitability of the sachet water production in the academic environment were analysed on the basis of per kilogram of the poly-film, a piece of parking nylon, man-hour of human and facilities resources, packaging, distribution, transportation, fueling etc using *Gross/Net Operating Profit to Net Revenue Ratio and Return on Capital* respectively. Necessary consideration was given to NAFDAC requirements and regulatory framework with respect to hygienity of the product and the working environment, dressing codes, cleanliness, storage, water processing by competent and qualified personnel and using the correct machines. The result revealed that there was significant relationship between quality and profitability in sachet water production. It found out that the production process is in control since none of the samples fell outside the upper and lower control limits of 50.90 and 50.07 of the mean and 2.3674 and 0.2926 for the range respectively and after when the samples were subjected to all quality characteristics and measurements. The result also revealed that the factory was able to break-even and make profit in the first financial year of the factory operations. Marginal profit was recorded outside the depreciation of some infrastructures. The operating environment dense with students' population not-withstanding, the factory recorded higher profit during the dry season which is peculiar to tropical region than in rainy season.The outcome of this research suggests that packaged (sachet) water business is a viable one if all resources are well managed, especially in an academic community of this type. A gross profit of N4,587,530($20,852) was earned in the 2014 financial year with net operating income of N1,342,754= ($6,103). It will also add value to the quality of training given to Polytechnic graduates on the platform of Entrepreneurship Development as well as good source of internally generated revenue. The institution water factory is a litmus for all untreated and contaminated pure water factories within the environment and yardstick for NAFDAC re-assessment, validation of licenses and or prohibitions.
Keywords: Resource Management; Quality; Profitability; Packaged Pure Water (Sachet), Production Process Analysis.

Introduction

Water is very important to human existence. In fact, the society has accepted that no water no life. Water is all encompassing, there is hardly any facet of human endeavour that do not require the use of water. If water is for human consumption, the standard requirement is that it should be potable. The portability of water means that it should be clean, free of impurities, drinkable, tasteless, colorless, and odorless and at balanced pH level - neither acidic nor basic. Cydney Walker (2011) emphasized that the human body is primarily water. In infants, up to 70% of the body system is water while it is about 60% in adults and less by 5% in female.

Water provides the medium to make the body system function as required and simultaneously remove waste from every cell. It is required that one 64ounces (2litres) of water should be taken daily to replace what is lost through metabolism. This is however dependent on physical activity and the geographic region in which one live.

Water is indeed useful in many other ways such as in body system hydration, circulation of electrolytes, acid-base balancing, temperature regulation, in food digestion, etc. It is therefore rated second to oxygen.

A reliable supply of clean or portable water is crucial to healthy living among inhabitants of a well defined geographical region (Mustapha and Adam 1999).If this is the case, there is need to make the provision of portable water a priority in order to reduce the high consequence and risk of spending more than triple cost to healthy living. The WHO estimated that more than one billion (precisely 1.2billion) people are still without improved drinking water and 2.6 billion on without improved sanitation. In Sub-Saharan Africa (mostly developing countries like Nigeria) about 280million people are without access to portable water let alone for cooking, washing or other uses - (Third World Water Forum, 2002). Whereas, total world water need stand at 3.1 billion as at 2010. This is because world population tripled in the 20th century and the use of renewable water resources grown six-fold. This environmental water crisis is a global problem. Narrowing it down to Nigeria, the supply or provision of public drinking water is not reliable. This has adversely affected the good health of Nigerians especially in the dry season. (Adesunkanmi and Ajao 1986). Whereas, the two major sources of drinking water-ground and pipe borne are no more safe for human consumption - (Ogunbajo, 2004, Tijani, 2003 and Olaposi, 2009).

The good example of locally developed alternative safe water is sachet and plastic bottle water and in the business aspect of it, the cost is reasonable at #5 for sachet of 50cl and #50 for bottle. How profitable will it be, if one venture into it considering all the resources needed and if well managed.

There are however, many brands of sachet water whose quality and tastes do not worth to be sold at the above stated price let alone for human consumption and profit making. Whereas pure water factories were established for the purpose of making profits by the provider or owners of the enterprise at affordable prices, under hygiene environment and packaged with care and security (i.e.) NAFDAC controlled.

The crux of the matter is that, can sachet portable water be produced and packaged under hygienic condition and at affordable price while quantity does not matter to quality in making profit with all resources meticulously managed? The Polytechnic Ibadan Water Factory under the watch dog of NAFDAC (the quality control agency) started the production of portable sachet water on 3rd December, 2013. The factory was established by the Vocational Skills and Entrepreneurship Study Center (VSESC). The sachet water has NAFDAC registration number and all necessary resources are available at optimum stock control and economic management.

The Polytechnic, Ibadan VSESC sachets pure water factory was established with a sum of #30 million naira. It operates using a mechanical process under hygienic environment with the use of reserve osmosis, composite silos machines UV diagnostic machines and four sachet water producing machines. Although the water factory is for both training and profit making, it is not at the expense of quality and profitability. Hence the objective of this paper is to investigate whether Polytechnic Ibadan sachet pure water is making profit or not. What is the viability of this alternative packaged pure water business in an academic community of this nature? Could the viability add to the internally generated revenue for the institution? This paper will also determine how the use of the combined resources are being processed and managed to produce the expected portable water under-guided by NAFDAC requirements.

Literature Review.

The processing of water into packaged sachet pure water is capital intensive and technology driven. Resources have to be prudently managed to transform inputs into outputs at any particular time. The production functions encompass all efficient technical methods as well as its processing control. This is such that if during the production process, a defect is found such that the required quality or portability of water will not be guaranteed, a control action has to be instituted immediately. A production process is considered to be better than another if less resources are utilized and the same result is achieved. This tends to explain that there are efficient and inefficient technical methods of production. Olayemi, (2004) therefore reiterated that the basic theory of production concentrates only on efficient method that entrepreneurs are expected to be engaged with. If the selection of an efficient technical production or utilization of quality resources well utilized and effectively managed, this will only yield better result and expected output satisfying standard requirement. In essence, input-process control-output should be monitored for total quality of all resources in any manufacturing set-up. That is for a production level of packaged water or anything human beings consume, a continuous and comprehensive approach to resources and organizational management should seek to improve the quality of products and services in adherence to established standards.

Sachet Water Production in Nigeria

Water vending has probably existed as long as society itself and the issues surrounding vended water in the developing world have received contemporary review elsewhere (Samson 2004, Kjellen and Mc Granallin, 2006).

Packaged (Bottled/Sachet) water production in Nigeria could be traced back to 1990 under the present civilian administration. This became necessary in view of the fact that water is one of the most essential and common infrastructures for the survival of all lives. The market for sachet and bottle water is national and with the estimated drinking water need all over the world, it should be made available at door steps of the citizenry.

Sachet water production and proliferation of water manufacturing firms in the urban centres are on the increase day-in day-out, yet the required water need are yet to be met. It should be mentioned however, that though the market is there especially in the dry season, the quality of the product determines its market share. The quality has to be assessed in line with regulatory standards and body given such approval.

In Nigeria, the regulatory body of packaged water is the National Agency for Food and Control. (NAFDAC). The body is not only assessing the quality, but regulates, from time to time, its status as well as its ingenious proliferation.

Sachet and bottle water is consumed on daily basis by all and sundry irrespective of age, social class or religion. The major raw material for the production of sachet water is water either from well or borehole, while the other factors of production or resources like land, capital, labor, machines and other complementary materials (films, packaging nylon etc) also comes to play.

In the production of sachet pure (pure water), two most important equipment required for production are the water treatment plant and the sachet water filling machine. The treatment plant consists of the water tanks in three stages: Raw water Pre-treated and Potable water. The plant also has the composite silos unit and the Reverse Osmosis/Manual Chlorination Unit. Before the potable water is transferred to the water filling machine a sterilizer machine is put just above the machine. Just as the name implies, it is to sterilize the water before it passes on to where it is going to be packaged in sachet or bottle.

All the four factors of production or rather the "4Ms" (Man, Machine, Materials and Money) are vital in any production process were put in place. The concern of this paper is to determine the profitability index of producing water within the immediate environment of an academic community and which is expected to satisfy NAFDAC requirement as well as being potable despite pure water proliferation in the society.

Sachet Water Quality, Management and Regulatory Framework in Nigeria

Omoniyi and Abu (2012) has emphasized that the quality of a product determines its market share and consequent increase or decrease in volume demanded. Hence, quality should be the concern priority of the promoter\producers or even managers of any manufacturing set-up (Buffa and Sarin 2003). Issues bothering quality of a product is vital to packaged food or water production since it affects human health directly or may even cause death if compromised (Omoniyi & Abu 2012). Quality or Total Quality Management is therefore very essential in any food manufacturing organization.

Quality, in manufacturing is a measure of excellence or a state of being free from defects deficiencies and significant variations. It is brought about by strict and consistent commitment to certain standards that achieve uniformity of a product in order to satisfy specific customer or user requirements. The ISO-8402 of 1986 defines quality as ''the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs.'' If an auto mobile company finds a defect in one of their cars and makes product recall customer reliability will decrease because trust in the product (car) quality must have been lost (www.businessdictionary. com). Mutually exclusive total quality of all resources is expected to be introduced and implemented in the production process. Total Quality is a description of the culture, altitude and organization of a company that strives to provide customers with products and services that satisfy their needs. The culture requires quality in all aspects of the company's operations, with processes being done right from first time and defect/waste eradicated from operations (www. Isixsigma.com). Management on the other side consists of the interlocking functions of creating corporate policy and organizing, planning, controlling, and directing an organization's resources in order to achieve the organisational objectives. Total Quality Management (TQM) is therefore a method by which management and employees (resource management) can become involved in the continuous improvement of the production of goods and services. It is a combination of quality and management tools aimed at increasing business and reducing losses due to wasteful practices. The simple objective of TQM therefore is ''Do the right things, right the first time, every time". With respect to the pure water production, total quality is expected to be embedded right from the procurement of all machinery and materials to the final output. This is determined by the degree of compliance regulatory bodies or agencies. In the case of Nigeria, NAFDAC is the agency responsible for this "quality watch". Apart from this, quality of any drinking water must satisfy customer rating by assessment in terms of physical parameter such as colour, taste, odour and presence of particles (Mendie, 2005)and quality assessment which certify that the water is safe for drinking by meeting physical, chemical and microbiological parameter (Wikipedia, 2007 in Omoniyi & Abu, 2005).

In essence, potable water for drinking must meet acceptable standard and guidelines set by NAFDAC (EID/003/2000) as well as by World Health Organization (WHO).

The guidelines of NAFDAC include the regulatory framework on Organization and Personnel, Buildings, Cloak Room, Packaging, Material Store, Production Room, Finished Production Store, Facilities and Equipment Tanks and Reservoir, Taps /Pipes and Water Treatment Process. Others are Sanitation and Standard Operating Procedures.

The simple fact that sachet or packaged water is being proliferated every nook and corner of this country makes it mandatory for NAFDAC to always enforce the simple laws related to the above framework. These simple laws include the laws of hygiene, cleanliness, proper storage of water, proper mode of transportation and employment of correct personnel. News was here and there in print and electronic media about contaminated water not safe for drinking. For instance Silver Bird Television states that in Niger State alone, 54 sachet water factories were closed down (www.silverbirdtv.com, 2013). In River State 10 similar sachet water companies were shut down, (www.legisreporting.com, 2013). This is in addition to another 10 illegal sachet water firms earlier reported in March 2012. They were found to have committed an offence under section 25 (1) of the NAFDAC Act Cap1. Law of the Federation of Nigeria, 2004 and punishable under section

25 (1) of same act- they were not registered with NAFDAC and operating under unhygienic conditions. (Punch Newspaper: www.punchng.com March, 8, 2012).

Water Quality Testing
There is no measure that constitutes good water quality; it depends on its use. Water quality is defined by analyzing it in terms of its:
a) Chemical Content: Hardness (calcium + magnesium), metals (iron etc), nutrients (nitrogen and phosphorus), chloride, sodium, organic compounds etc.
b) Physical Content: Turbidity, colour, odour etc.
c) Biological Content: Fecal coli form, total coli form, viruses etc.

Good quality (portable) drinking water is free from disease-causing organisms, harmful chemical substances and radioactive matter tastes good, is aesthetically appealing and is free from objectionable colour or odour. It should be emphasized however, that there is a difference between "pure water" and "safe drinking water". Pure water is often defined as water containing no minerals or chemicals which do not exist ordinarily and naturally in the environment. Safe drinking water on the other hand, may contain naturally occurring minerals and chemical such as calcium, potassium, sodium or fluorine which are actually beneficial to human health. These will impart a taste to the water that may take someone getting used to. It is recommended however that to have a safe portable water sampling, water should undergo this process:

After a new water well (borehole) is completed or when the quality of a water supply is suspect (because of turbid water, unusual colour, taste or smell), water samples should be collected and analyzed chemically and bacterially. If possible, local health officials should check the water for purity and contamination. When the proper authority has pronounced it safe to drink, it may be used by the community.

Recommended Test Methods for Water Purity.
Water samples should be taken in the following manner:

1. Pump water from the well for about three minutes. While the water is still flowing, immerse a **nitrate** test strip in the stream for one second and withdraw the strip and allow the colour to develop for 60 seconds. Compare the colour against the enclosed colour strip and record the result. Do the same with a **pH** strip.
2. Collect a sample in a clean clear glass vial or bottle; and
   - make visual observations concerning the **turbidity**.
   - make statements about any **odours** observed in the water.
3. With the sample in the clear glass, measure the **TDS** with a TDS pocket meter (if available). Record the number in ppm using the appropriate multiplier.
4. Bacteria tests must be carefully performed to obtain meaningful results. The pipe from the pump should be briefly scorched with a match to insure that any detected bacteria are from the water itself and not the pump surfaces. Then the water should flow for 2-3 minutes before a sample is obtained. Fill the sterile plastic sample bag; take care that the inner surface of the bag is not touched by anything (including hands).

For **total coli form,** carefully pour water into the sample vials until the liquid level reaches the fill-line (the LaMonte test requires 5 vials; the COLI-MOR test uses 1 jar with a red liquid media). Ensuring that the lip of the vials and the inner surface of the cap do not touch anything, place the cap back on. Place the vials upright in the provided box and set aside for 24-36 hours. Record colour changes, gas formation and position of the thimble in the vials. After the test, carefully remove the lids, rinse the vials with bleach and then crush and bury them 2 feet in the ground where children cannot find them and play with (they contain potentially dangerous bacteria).
Aerobic and sulphate-reducing bacteria tests indicate that if bacteria are present it can cause problems ranging from slime formation, turbidity, taste, odour and corrosion through to greater hygiene risks (hydrogen sulphide-producing bacteria have been shown to be associated with the presence of fecal contamination). Although these tests serve as simple indicators, it is recommended that, where a problem is found, further tests be conducted to more precisely determine the nature of the microbial problem.
Test Result Interpretation/Response
If the water is turbid or cloudy, contaminated surface run-off may be entering the aquifer through cracks in the casing or the cement pump pad or through surrounding soil which is very permeable. While turbidity is not dangerous, it reduces the effectiveness of disinfection and indicates the presence of other conditions that need to be further investigated.

Odours should not be present in the drinking water. If present, potentially harmful substances may be entering the water from households (washing activities), agricultural sources (animal fecal matter) and other natural sources (sulphates from springs or aquifers, etc).

If total dissolved solids (TDS) exceed 500 mg/l, objectionable taste may drive people to use unsanitary water supplies. Increasing TDS concentrations over time indicates that the well is drawing groundwater from deeper in the earth or that contaminants (such as salt water if the well is near the ocean) are leaching into the aquifer. Serious TDS changes over time will require reducing pumping volumes and/or drilling a new well (likely at a higher elevation).

Readings of pH should be in the range of 5.5 to 8.5 for well waters. If readings are outside this range, the source and corrections may be difficult. The worse effect may be premature corrosion of metal surfaces contacting the water. The average of this range being the best pH level required.

Nitrate concentrations above 10 mg/L can cause blood disorders in infants (blue baby disease). Elevated levels indicate that manure, sewage, or nitrogen fertilizers are reaching the water source. One elevated test reading (greater than 50 mg/l nitrate) must be followed up with more frequent testing (weekly). If nitrate levels above 45 mg/l (10 mg/l nitrate as nitrogen) persist, the source of the nitrate (animal confinement areas, privies etc) should be determined and relocated.

Nitrite readings (can be measured with the same test strip) should always be less than 1 mg/l. If nitrite concentrations are above 1 mg/l, the water must not be given to infants and a different source (boiled for disinfection) must be used.

Specific disease-producing organisms are difficult to identify in water. Therefore, while total coli form and aerobic/anaerobic bacteria are themselves not harmful, their presence signals that bacterial contamination from either human or animal fecal sources may be present. If total coli form and/or active aerobic or anaerobic bacteria are found, the water supply should be re-tested with extra careful attention given to all the sampling details.

If bacteria problems are still found, try to get local health professionals to conduct more thorough testing of the water supply. In addition, the well and surrounding area should be carefully examined to determine possible entry points for contaminated water. Note that the same sources that cause nitrate problems are probably responsible for bacterial contamination. However, bacterial contamination can also indicate a cracked well casing. Each circumstance will require its unique solution to improve the water quality. If problems persist and cannot be corrected, each individual user should disinfect the water they need for drinking, cooking, brushing teeth. (http://www.lifewater.ca/drill_manual/Section_16.htm)

Profitability

It is pertinent at this point to discuss about profitability in the packaged water industry while managing all resources and ensuring total quality is enshrined in all aspect. Many authors have defined profitability in different ways to connote either accounting profits or economic profits. Don Hofstrand (2009) (www.extension.iastate.edu.) - Iowa State University defined profitability as the primary goal of all business ventures. That without it, the business will not survive in the long run. He stressed further that the concept is measured with income and expenses. Income being money generated from the activities of the business and expenses being the cost of resources used up or consumed by the activities of the business. Profitability looks at the relationship between the revenues (income) and expenses to see how well a company is performing and the future potential growth a company might have. If the net income (accounting profits) is extended on a long-term to another venture, it is described as economic profits.

Profitability is used in analysising financial statement and performance of a company while it should not be construed with efficiency, solvency, and market prospects. Investors, Creditors and Managers use these key concepts to analyze how well a company is doing and the future potential it could have if operations and resources were managed properly. (www.myaccountingcourse.com 2014).

Theoretical Framework - Analysis of Profitability of Sachet Water

Having understood the concept of profitability, the right question to ask is whether the profit earned through sales of sachet water in the pure water factory is satisfactory or not and does it marry resources being qualitatively managed? What rate of return does this profit making ventures represent in the overall production cost plus added value or are there any factor(s) affecting the profit variation in the production line. In order evaluate the profitability of sachet water and to answer the above questions, one major profitability analysis relative to resources and how they are being managed was undertaken. This is financial ratio. It consists of *Gross Profit to Net Revenue Ratio; Net Operating Profit to Net Revenue Ratio and Return on Capital Employed Ratio.* In addition to the above ratio analysis, both start-up and running costs- procurement of materials (polyfilms with producer's name and logo, parking nylon etc) as well as overhead (Production Manager, Marketing Manager, Machine Operators, Drivers, Parkers, Loaders, Cleaners, Lighting etc) and depreciation of infrastructures were considered. All revenue and transactions document in the last 12 months were used for this purpose, i.e. March, 2014 to February, 2015.

Methodology

The population for this study consists of a production batch of 1kg of sachet water per machine. There are four sachet water machines at the Polytechnic Ibadan Water Factory and all in good working conditions. 1kilogram of polyfilm is used to produce minimum of 22 bags i.e. 440 pieces of sachet water with required volume of 50cl. This translates to a total population of 1760 pieces of sachet water. If the working population is 1760, the author used the sampling determination formula for known population as developed by Taro Yamane (1964) as follows:

$$n = \frac{N}{1+N(e)^2}$$

n = the sample size.
N = the population size (1760).
e = the level of precision (+or-3percent)
I = constant value.

Substituting in the above equation, we have

$$n = \frac{1760}{1+1760(0.03)^2}$$

$$= \frac{1760}{1+1.584}$$

$$= \frac{1760}{2.584}$$

= 681
= 681 samples.

Out of these samples and because of the total cost of the above quantities, ten samples from each of the machines were randomly taken and paid. They are randomly selected for and statistical process control analysis.

For the purpose of this paper, three activities of data gathering were involved: evaluation of water properties and quality testing in line with NAFDAC requirements; weighting and recording the 40 samples of sachet water to precision and subjecting the measurement to Statistical Process Control method together with the use of the three-sigma table for Quality Control of Material. In this table, the factors for the mean and range that correspond to the number of sample observation were read and used. The third activity was the analysis of financial statement between March, 2014 and February, 2015 inclusive. The basic elements of financial statement were considered. These are capital introduced, current liability and assets. All resources were economically used considering the state of inventory and maintenance.

Data Presentation, Analysis and Interpretation

a) Water Properties and Quality Testing: The 40 samples of sachet water were tested and analyzed with respect to the chemical, physical and biological content given adequate consideration to NAFDAC requirements. The factory satisfied the physical and material resources and environmental factors as laid down by NAFDAC. The water factory constructed was standard with the production processing area separated from the plant area. As at the time of this research, the little structural defects around the water factory building was been amended to taste. As mentioned earlier, the raw water was mechanically-processed. That the popular manual method of applying chemicals (such as chlorine) to treat water was not used. The Composite and Reverse Osmosis were being used to treat the water and transfer to the sachet water filling machine (intercepted by ultra-violent bulbs machine). Thus, the production of sachet water in piecemeal at an average rate of 40 sachets per minute (machine production efficiency being noted). This translates to cumulative of 22 bags (440 sachets) from 1kilogram of the polyfilm.

The mechanical process employed in the sachet water production using the Reverse Osmosis Machine and the Automatic Sachet Water Filling and Sealing machines indicated higher efficiency and productivity. Notwithstanding, the Water Quality Test (WQT) was carried out using the samples earlier bought. The WQT was carried out at the IITA laboratories Ibadan.

The result indicated that the sachet water appearance is colorless, transparent with slightly tint and blue crystalline content. It was also found that the sachet water is odorless and tasteless. The Pure water has neutral pH and the average measurement was pH = 6.99. This is approximately 7 which implied that the sachet water is neither acidic nor basic. The 0.01 difference was due to machine precision and calibration and not related to the content in any way. Mutually exclusives, it was advised at the testing laboratory that the factory management should watch out for pollution infection around the factory because it (pollution) can change water pH to be acidic or basic (Water pH is a measure of how acidic/basic water is: The range goes from 0-14, with 7 being neutral. pHs of less than 7 is acidity, while of pH of greater than 7 is a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic).

The laboratory technician also advised that both the raw and treated tanks should be covered on top with film net although the ultra-violent bulb machines installed to each Automatic Sealing Machine is to detect any foreign and contaminating particles.

The produced water samples examined has normal temperatures and flow rate and there was no trace of nasty stuff of bacteria- that is no fecal coli form was present in all the samples. Finally when we checked for turbidity (measure of the cloudiness of water), all the samples were crystal clear. The over-all laboratory assessment indicated that the sachet pure water produced at the Polytechnic Ibadan is portable and safe for drinking.

b) Process Control Analysis of Sachet Water at the Polytechnic Ibadan.

The Statistical Process Control (SPC) method is a method of quality control which uses statistical methods. It is a management philosophy that relies on straightforward statistical tools to identify and solve process problems. It is also used in manufacturing to measure whether processes and products conform to design specifications and to improve productivity while reducing waste. SPC is vital for measuring the current quality of products or services or in detecting whether the process itself has changed in a way that will affect quality. In SPC, control charts for variables are used to monitor the mean and the variability of the process distribution. Commonly used charts are the Range (R) and Mean (X) charts. The Range Chart or Variability Chart is used to measure process variability while the X chart is used to measure the mean when assignable causes of process variability have been identified and the process variability is in statistical control.

The control limits for R-charts are (i) Upper Control Limit $(UCL)_R = D_4R$ and (ii) The Lower Control Limit $(LCL)_R = D_3R$ where R= average of the several past R values that the central line of the control chart and D_3 and D_4= constraints that provide the standard deviation limit for a given sample size. Values for D_3 and D_4 are shown in the ASTM table.

It should be noted, however, that the spread between the controls limits narrows as sample size increases. This change is a consequence of having more information on which to base an estimate for the process change.

Also, in the X chart we construct. An X –chart to control the process average. The control limit for the X – chart are:

(i) Upper Control Limit $(UCL)_x = X + A_2 R$
(ii) Lower Control Limit $(LCL)_x = X - A_2 R$

Where

$\overline{\overline{X}}$= central line of the chart and the average of past sample means or a value set for the process.

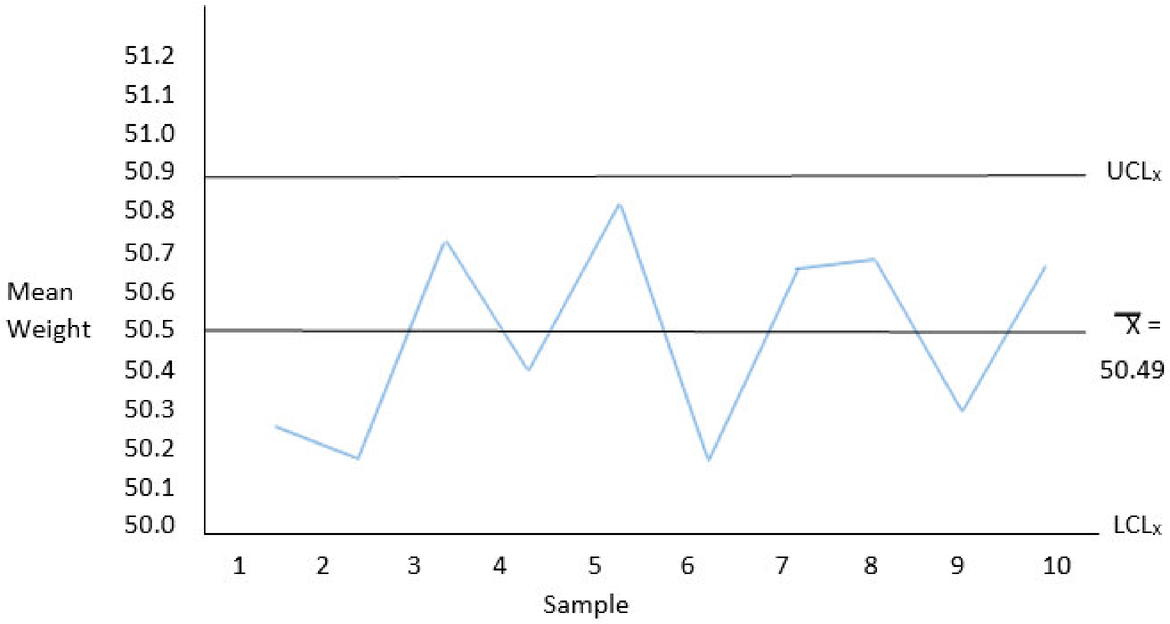
The values of A_2 are as contained in the table of ASTM manual on Quality Control of Materials (2013).

The Polytechnic Ibadan produces sachet water to NAFDAC requirement from the four automatic sealing machines. The researcher randomly selected 10 samples from each of the machines to critically examine the quality control that would be used to determine whether the production process is in control. Normal volume as stipulated by the Standard Organization of Nigeria (SON) and in line with NAFDAC requirement is that a sachet of pure water should be 50cl. The volume content of all the 40 samples were weighed to precision. The recorded values of all the 40 samples are as shown in **Table 1** below for analysis. In this table the mean and the range values were calculated. The ASTM values used in checking the number of observations and factors for the mean (X) and range (R) are also presented in **Table 2** below.

TABLE 1 – SAMPLES OF SACHET WATER FOR PRODUCTION PROCESS ANALYSIS

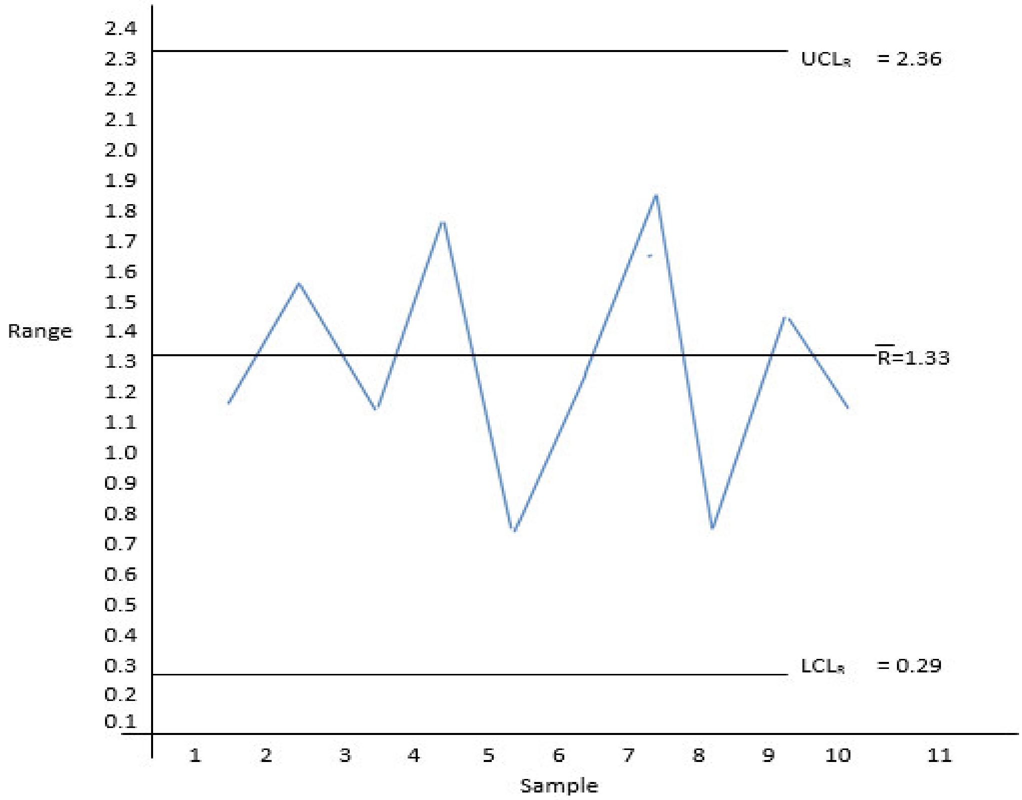
Automatic Sachet Water Filling and Sealing Machine (MC)	**SAMPLE**									
	1	2	3	4	5	6	7	8	9	10
MC 1	50.6	49.6	50.1	50.5	50.4	50.9	50.2	50.3	49.6	50.1
MC 2	50.0	50.3	51.2	49.6	51.0	50.2	49.7	50.9	50.1	51.3
MC 3	50.9	51.2	50.5	51.4	51.2	49.6	51.3	50.7	51.1	50.3
MC4	49.7	49.9	51.3	50.3	50.9	50.3	51.6	51.1	50.7	51.1
Range (R)	***1.2***	***1.6***	***1.2***	***1.8***	***0.8***	***1.3***	***1.9***	***0.8***	***1.5***	***1.2***
Mean (X)	***50.30***	***50.25***	***50.77***	***50.45***	***50.87***	***50.25***	***50.7***	***50.75***	***50.375***	***50.7***

n = 10



X - CHART

UPPER CONTROL LIMIT (UCL_X) = 50.90
LOWER CONTROL LIMIT (LCL_X) = 50.07



R - CHART

Table 2: ASTM Values For SPC Charts

Number of Observations in Subgroup, n	Factor for $\overline{X}$ chart, A_2	Lower Control Limit, D_3	Upper Control Limit, D_4
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
7	0.42	0.08	1.92
8	0.37	0.14	1.86
9	0.34	0.18	1.82
10	0.31	0.22	1.78
11	0.29	0.26	1.74
12	0.27	0.28	1.72

Source: ASTM Manual on Quality Control of Materials. American Society for Testing Materials

Based on the above data, the Range, R and $\overline{X}$ = Mean of the samples were respectively calculated as indicated on the table. The mean of the range ($\overline{R}$) i.e. (Central Line) and mean of the mean ($\overline{X}$) were also calculated as indicated.

We first calculate X for each of the sample and the central line of the chart ($\overline{X}$ = Mean of Mean).

From the table, the parameters for the UCL_X and LCL_X are calculated and then the construction of the Mean $\overline{X}$ - Chart. $\overline{X}$ = 50.49 and R = 1.33.

$UCL_X = \overline{\overline{X}} + A_2R$
= 50.49 + 0.31 x 1.33 (0.31 correspond to the factor for the number of observation (n=10))
= 50.49 + 0.4123
= 50.90

The $LCL_X = \overline{X} + A_2R$
= 50.49 – 0.31 x 1.33
= 50.49 – 0.4123
= 50.07.

Also, the UCL_R and LCL_R are also calculated as below:

$UCL_R = D_4R$
= 1.78 x 1.33
= 2.3674

$LCL_R = D_3\overline{R}$
= 0.22 x 0.133
= 0.2926

From the above and the corresponding charts, we can deduce that the production process is statistically in control in terms of process average and process variability. This is because both $\overline{X}$ and R values fall within the UCL and LCL. Otherwise the use of Total Quality Management (TQM tools or techniques (such as *cause and effect*, *pareto analysis*, or the *5W2H approach*) to find the cause.

In essence, both the quality and the production process are in control, hence the justification for establishing the water factory not only for making profit but to satisfy the requirements of NAFDAC and global drinkable water need.

c) Analysis of Profitability

Many factors were considered in analyzing the financial statement presented. As mentioned early, all the resources used including overhead were quantified in monetary terms and all income sources through sales, including waste sachet films and plastics rolls were noted. Sachet water at the factory remained N5.00 while a bag is sold for N60.00 and N55.00 to distributors. Increase to N70.00 or N80.00 could not be implemented during the dry season because of the sensitive of "aluta" among students and the institution's intervention to make it available and affordable within the operating environment.

In spite of this, analysis of the financial statement from March, 2014 to February, 2015 was okay. The analysis was carried out in line with the Nigerian-GAAP. The factory was able to break-even and reasonable profit was made at the end of the financial year. Analysis of this financial report took all the elements of financial statements into consideration at lower reliability and solvency. Also, the financial ratios were adopted to arrive at the profit made and projection. The breakdown of the sales of water sachet and the profit value was greatly dispersed by depreciation of all infrastructures in use – building structures and it various elements. At the end of the day, a gross profit of N4,587,530 ($20,852) was earned with a net operating income of N1,342,753 ($6,103)after deducting all operating expenses, tax inclusive.

Conclusion

Packaged pure water (sachet) is a viable business in a developing country like Nigeria if one considers that majority of the citizenry are not having access to safe and portable drinking water

The proliferation of sachet water has become a growing concern in Nigeria. It is not only in resolving water crisis and making profit that were of concern, but efforts were not concerted towards the type of water in quality that could solve the matter. If water production resources are pulled together and carefully managed, NAFDAC or regulatory framework strictly followed, it is expected that potable and safe drinking water would be made available at an arithmetic rate of profit making has been organized at the Polytechnic, Ibadan. This sachet water production in this institution thus serves as "litmus" to other water factories that could be evaluated and sanctioned as appropriate. It follows simply that it is not the quantity but the quality.

This paper therefore conclude that sachet pure water should be produced in line with NAFDAC requirement and that all production processes should be strictly followed in producing quality sachet water that is potable and safe for human consumption at no sporadic or fat profit at once.

References

Mojekeh, M.O and Eze, Peace A.O. (2011) *The Environmental Impact of Production and Sales of Sachet Water in Nigeria.* African Research Review (IMJ) Vol. 5(4 pp 479-492.

Nwanya, S.C, Onah, P.O, and Onyia, I.E. Process Optimization of Resources for packaged water factories in Nigeria. *11th Global Conference on Sustainable Manufacturing*.

Omoniyi, Benjamin B. and Abu, Zekeri. The economic analysis of the profitability of small-scale pure water production in Nigeria. *Afro Asian Journal of Social Sciences* 3 (3.4) Quarter IV, 2012.

Sachet Water (Pure Water) Production in Nigeria: A viable Business Opportunity. www:http://wealthranks.blogspot.com

Statistical Process Control (S.P.C) Analysis: Control charts: http://services.byu.edu

Water Chemistry: http://imnh.isu.edu\digitalatlas\

www:http://lifewater.ca/drill_manual/Section_16.htm

www:http://myaccountingcourse.com

http://www.businessdictionary.com/definition/management