



## **Advances in Research**

**15(1): 1-11, 2018; Article no.AIR.40484**  
**ISSN: 2348-0394, NLM ID: 101666096**

# **Lean Accounting and Waste Management in Brewery Industry in Nigeria**

**Daferighe, Emmanuel Emeakponuzo<sup>1\*</sup>, James, Emmanuel Eno<sup>1</sup>  
and Offiong, Patience Etim<sup>1</sup>**

<sup>1</sup>*Department of Accounting, Faculty of Business Administration, University of Uyo, Nigeria.*

### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author DEE designed the study and managed the literature searches. Author JEE wrote the first draft of the manuscript. All authors carried out the statistical analyses of the study, read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/AIR/2018/40484

#### Editor(s):

(1) Simone Domenico Scagnelli, Department of Management, University of Torino, Italy.

#### Reviewers:

(1) SrinivasaRao Kasisomayajula, Madanapalle Institute of Technology and Science, India.

(2) Sergey A. Surkov, International Institute of Management LINK, Russia.

(3) James A. Adeniran, Babcock University, Nigeria.

(4) Marlon Soliman, Federal University of Rio Grande do Sul, Brazil.

(5) C. S. Chethan Kumar, M S Ramaiah Institute of Technology, India.

Complete Peer review History: <http://www.sciencedomain.org/review-history/24697>

**Received 23<sup>rd</sup> February 2018**

**Accepted 1<sup>st</sup> May 2018**

**Published 19<sup>th</sup> May 2018**

**Original Research Article**

## **ABSTRACT**

The failure of conventional cost reduction techniques to yield the expected result brought about the thinking toward the implementation of Lean Accounting principles. Boston Consulting Group claims that practical application of Lean Accounting principles and tools significantly reduces process waste and its associated cost. This study was carried out to examine the influence of the practice of Lean Accounting on waste management in Brewery Industry in Nigeria. A survey research design was adopted in this study. The primary source of data was primary data collected through a structured questionnaire administered to 50 workers in Champion Breweries. The data collected were analysed with Chi-Square statistic. The result of the assumption tested revealed that the practice of Lean Accounting does not significantly influence waste management in Brewery Industry in Nigeria. This is because the industry in Nigeria is yet to embrace the concept fully. From the result, it was concluded that there is no significant influence of the practice of Lean Accounting on waste management in Brewery Industry in Nigeria. However, given the numerous benefits of the practice

\*Corresponding author: E-mail: [daferighe2e@yahoo.com](mailto:daferighe2e@yahoo.com);

of the Lean Accounting, it was recommended that management in the industry should undertake to train their staff on the Lean principles and practice of Lean Accounting and ensure its full incorporation into the production process. This will lead to effective and efficient management of waste to provide good quality of their products which will ultimately add value to all stakeholders in the long run.

*Keywords: Lean accounting; lean manufacturing; waste management; cost reduction; Brewery.*

## 1. INTRODUCTION

A prime objective of the firm has remained maximisation of shareholders' wealth. Maximization of the wealth of shareholders implies maximising profits consistent with long-term stability. One way of ensuring maximisation of profits consistent with long-term stability has been the application of cost reduction techniques. In recent times, however, conventional cost reduction techniques have failed to yield the expected results owing mostly to high inflationary trend in Nigeria [1].

From available data, Nigeria had inflation rates of 16.5%, 23.8%, 11.5% and 15.1% in 2001, 2003, 2005 and 2008 respectively [2]. In 2015, the rate averaged 16.5%, thus making nonsense of nearly all cost reduction efforts including those applied in the Brewery Industry. This has brought to the fore new thinking and orientation toward the implementation of the concept of Lean Accounting.

The objectives of this paper are to:

- (i) Determine the level of awareness of the usefulness of Lean Accounting principles in managing process waste in Brewery industry in Nigeria; and
- (ii) Examine the influence of Lean Accounting principles in the management of waste in the Brewery industry in Nigeria

The application of Lean manufacturing and by implication, lean accounting and its impact in the brewery industry in Nigeria has rarely been expounded in the literature. As an evolving concept, there is a need for scholars and researchers to study and report its benefits and challenges. Lean Accounting is beneficial in process innovation; it is in line with the new philosophy of lean thinking; which is about customer value and business growth. This new thinking on implementation of Lean Accounting will open the frontier for further research for scholars and researchers. The underlying assumption of this study is that there is a

significant influence of the practice of Lean Accounting on Waste Management in the Brewery Industry in Nigeria.

This study is an attempt to explore Lean Accounting and waste management in the Brewery industry in Nigeria. It is hoped that the study will advance existing knowledge on Lean Accounting and add to the literature on this concept, thus contributing to the financial accounting and performance and control processes of the Brewery industry in Nigeria.

### 1.1 The Brewery Industry in Nigeria

The Brewery Industry belongs to the manufacturing sector under the Nigerian Stock Exchange. The industry dates back to over six decades with the birth of the pioneer company; Nigerian Breweries in 1949 with Star Beer, followed by Guinness Nigeria in 1962 with Guinness Stout [3]. Ownership of firms in the industry is either public with or without foreign partnership. The primary products in the Brewery Industry are beer, stout and non- alcoholic drinks, while their principal activities include; production, packaging and sales of alcoholic and malt beverages. This Industry has evolved from purely bottling activities to a diversified industry involved in the production of canned drinks and the use of tetra packs. The Industry had an estimated production capacity of 1.3 billion liters as at 2002 but currently producing about 1.1 billion liters. The drag in the volume growth is due to a huge amount of pressure on consumer spending given the uncertainties in the economy witnessed in the last two year. The volume of their production translates to total revenue of over ₦128 billion representing approximately one percent of nominal Gross Domestic Product (GDP) [4]. The Brewery Industry currently employs more than 500,000 persons and has about 50,000 distribution outlets in the country made up of wholesalers, hotels and clubs. However, challenges of the industry include; high operational cost due to the importance of expert-skilled labour, maintenance of machinery and equipment and waste management [4].

## 2. LITERATURE REVIEW

### 2.1 The Concept of Lean Accounting

Lean Accounting is a new accounting approach that emerged with the rise of business interest to embrace the lean thinking culture [5]. It aims to measure the monetary impact of implementing Lean improvement project to business processes. [6] describe Lean accounting to include simple accounting, visual performance measures, value stream boards, value stream costing, target costing, visual management, and box scores for decision making.

Lean accounting is the general term used for the changes required in a company's accounting, control, measurement, and management processes to support lean manufacturing and lean thinking [7]. The concept is still evolving but [8] had earlier indicated its elements in a Just-In-Time (JIT) environment. The authors describe accounting systems in a JIT environment as emphasizing direct traceability of costs, a reduction in the number of cost pools with less emphasis on traditional material, labour and overhead variances and a reduction in the frequency and detail involved in reporting purchases and deliveries.

Kennedy and Brewer [7] illustrate two Lean accounting concepts, namely: (a) value stream cost analysis and (b) a Lean income statement. According to the authors, a value stream includes all the value added activities involved in providing specific products and services to customers; a value stream cost analysis consists of identifying areas of waste, bottlenecks, and opportunities to more effectively manage capacity. A Lean income statement shows the inventory change effect (hidden in traditional statements), actual costs (without confusing variance adjustments from standard to actual) and emphasizes the performance of each value stream [9].

Lean Accounting requires managers to stop thinking about production improvement in terms of short-term cost reduction, but to start thinking about customer value and business growth. The question of how large cost will be saved turns to how best to utilize newly-created capacity to increase customers' value and make more money. Lean accounting aims at measuring the monetary impact of implementing Lean improvement projects to business processes [5] It is a new accounting approach that emerged

with the rise of business interest to embrace lean thinking culture. But Lean accounting strives well in a Lean manufacturing environment.

Lean manufacturing (LM) consists of process innovation. According to [10], process innovation is the implementation of new or significantly improved production or delivery method including significant changes in techniques, equipment and /or software; intended to decreasing logistics or production costs, increase quality of products; deliver new or significantly improved products. Lean Manufacturing aims at reducing waste in human effort, inventory, time to market and manufacturing space in order to become highly responsive to customer demand, while delivering quality products efficiently. It is a good example of process innovation in companies having continuous improvement as one of its corner stone [11].

The [12,13] have advocated the implementation of Lean principles in the food industry for aiming at or staying competitive, simplifying processes, increasing percentage of value-adding activities and improving operational performance. Effective application of LM principles and tools significantly reduces non-value added time, waste and associated costs, thereby improving customer service and obtaining higher satisfaction levels [11].

Woehrlé and Abou- Shady [5] have observed that many businesses have found Lean philosophy to be the potential solution over other improvement methodologies and approaches for businesses trying to focus on waste elimination and producing products that meet customer expectations in terms of quality and on-time delivery. In financial terms, the application of Lean concept eliminates waste in the area of inventory management; it eliminates excess inventory.

However, a lower inventory level negatively affects the bottom line of the income statement and leaves a misleading impression of Lean principles; that it does not improve the business and thus should not be adopted. The foregoing portrays a disconnect between the operational view and financial view of the lean concept. [5] posit that the differences between traditional manufacturing and LM are in employee management, plant layout, material and information flow system, and production scheduling control methods. They emphasize that these differences make it difficult for

organizations that have historically relied on traditional manufacturing methods to predict the magnitude of the benefits achievable by implementing Lean principles.

Most of the literature on the benefits of Lean manufacturing agrees that Lean helps in eliminating waste and reducing cost [5].

## 2.2 Concept of Waste Management

Waste consists of all activities that do not add value from the customer's point of view. Waste management is a crucial aspect of modern entities given its impact on the quality of product or service. [4,14,15], have identified as summarized below, the sources of waste as:

- (i) Defect – making mistakes in the production process that result in generating reworked or scrapped products;
- (ii) Inventory – the building-up of excessive inventory in the form of raw materials, work in-progress and finished items;
- (iii) Motion – unnecessary movements of workers or machine before, after or during processing;
- (iv) Over-processing - unnecessary and non-value added usage of equipment, tools, and materials; over-production (producing more than required quantities of products);
- (v) Transportation – unnecessary and excessive movement of materials or parts within the production line, the warehouse, or the storage area; and waiting (parts or materials waiting) in queues to be processed.

According to Taiichi Ohno's categorization there are seven major wastes typically found in mass production:

- (i) Overproduction: Producing ahead of what's actually needed by the next process or customer. The worst form of waste because it contributes to the other six.
- (ii) Waiting: Operators standing idle as machines cycle, equipment fails, needed parts fail to arrive, and so on.
- (iii) Conveyance: Moving parts and products unnecessarily, such as from a processing step to a warehouse to a subsequent processing step when the second step instead could be located immediately adjacent to the first step.

- (iv) Processing: Performing unnecessary or incorrect processing, typically from poor tool or product design.
- (v) Inventory: Having more than the minimum stocks necessary for a precisely controlled pull system.
- (vi) Motion: Operators making movements that are straining or unnecessary, such as looking for parts, tools, documents, and so on.
- (vii) Correction: Inspection, rework, and scrap.

Irrespective of the source of waste, its effect remains the same; that is; increased operating cost and low-quality products. Waste management; through the application of Lean principles; in the Brewery industry is to remove all forms of waste in the production process, to ensure good quality, and reduce lead time through the transformation process. According to [16], Lean Manufacturing is aimed at reducing waste in human effort, inventory, time to market the products and manufacturing space; and to become highly responsive to customer demand while delivering quality products efficiently. This requires an understanding of how waste arises in the brewery industry.

Several technological advances in the last 20 years have provided the brewery industry huge services by lowering generation of by-products in the process. However, certain wastes inherent to beverage production hardly have the quantities formed reduced, such as brewer spent grains, residual brewing yeast and trub; due to the necessity of grain processing, the characteristics of chemical composition and treatment of raw materials used, and the need for microbial activity during fermentation [17]. These three residues, called wet brewery waste, are responsible for the loss of approximately 20L per 100L of water used in the brewing process, especially because of the high water content of those residues, between 80% and 90%. This promoted great drag of work and loss of extract, as well as beer, depending on which step the residues are generated, leading to significant amounts of effluent formation [17]. A fourth brewery residue is Diatomaceous earth, used in the filtration of final product to improve its brightness. The production of this waste can be avoided by using other filter media or even commercializing unfiltered beer, naturally cloudy, typically consumed in the form of special or handmade beers. The water generated in the process presents a high content of organic substances and, therefore, a wide variety of

potential applications in feed, food and industrial biotechnology.

The steps for implementing Lean in a beer factory according to [18] are as follows: (i) Find a change agent. This could be you or anyone of the organization: the key is that this must be a leader who will take personal responsibility for the Lean transformation. (ii) Get the Lean knowledge. It is important to draw from a true and thorough source of Lean, whether from an ex-Toyota sensei or some other reputable source, so your internal change agents should master Lean thinking to the point where it becomes second nature; and always implement lean techniques as part of a system, not as isolated programs. (iii) Find or create a crisis. Unfortunately, few, if any, firms will not take the necessary steps to adopt lean thinking across the board unless they are facing a crisis. (iv) Forget grand strategy for the moment. Start by simply eliminating waste everywhere possible. (v) Map the value streams, beginning with the current state of how material and information flow now, then drawing a leaner future state of how they should flow and creating an implementation plan with timetable beginning as soon as possible with an important and visible activity. (vi) Demand immediate results. As soon as you've got momentum, expand your scope. Link improvements in the value streams and move beyond the shop floor to office processes. Practice kaizen, or constant improvement, relentlessly.

### **2.3 Lean Manufacturing and Lean Accounting**

Lean Manufacturing (LM) originated from the automotive industry but has now been applied in several other sectors and even extended beyond production environments, showing impressive gains [16,19]. [1] asserts that one of the limitations and challenges experienced by Lean manufacturing practitioners is the difficulty encountered in the measurement of the benefits flowing from lean manufacturing implementation. In Enoch's opinion, such organizations should involve accounting and finance department personnel in carrying out a cost-benefit-analysis before and after the implementation to determine the level of improvement in their established performance matrices.

Lean Manufacturing methodology introduces techniques which are not compatible with conventional cost and management accounting methods; thus necessitating the search for

accounting practices, principles and tools that will adequately fill the gap. Lean Manufacturer thus negates traditional cost and management accounting system which according to [5] ignores tangible non-financial performance measurements, such as on-time delivery and customer satisfaction. Consequently, Lean Accounting evolves to fill the gap between traditional accounting practices and Lean thinking.

Lean Accounting thus aims at measuring the monetary impact of implementing lean improvement projects to business process. [5] illustrate the gap between the operational and financial views of the improvements that Lean accounting can bring in Table 1.

The only way to effectively resolve this problem is through the adoption and implementation of Lean accounting methods as Lean thinking applies to every aspect of an organization, including finance and accounting processes [1]. The application of lean principles in the Brewery Industry is to remove all forms of waste in the production process, to ensure good quality and reduce lead time through the transformation process while Lean accounting operates to recognize the operational improvements created thereof.

### **2.4 Lean Accounting and Waste Management**

Seven areas of waste reduction that lean accounting focuses on have been identified in the literature [18,5] as over production, waiting time, transportation, over-processing, inventory, motion, and scrap. According to [6], improvements emerge in reduction of operating cost, productivity, and quality and on-time delivery of products owing to waste reduction. [20] have posited five basic principles for cost reduction through waste elimination in the application of lean philosophy:

- (i) specifying value by determining the customer values in a product or service,
- (ii) defining the values stream for a specific product or product family along a value stream and eliminating Non-value-Added Activities (NVA) as perceived by the customer so that the product or service is delivered to the customer in the most efficient way,
- (iii) getting the product or service to flow by creating continuous flow for the Value-

- Added Activities (VAA) and replacing "batch and queue" with single piece flow.
- (iv) creating a pull mechanism from the customer by making what the customer wants and when they want it by establishing take up time, and regulating inventories
  - (v) Striving for perfection through continuous lean journey.

The brewery industry has the potential to generate a significant amount of waste owing to its nature of production process and the inputs thereof. [21] stated that water and wastewater management constitute a practical problem for the food and beverage industry. According to the authors, the brewery sector holds a strategic economic position with the annual world beer production exceeding 1.34 billion hectoliters in 2002. During production, beer alternately goes through three chemical and biochemical reactions (mashing) boiling, fermentation and maturation and three solid liquid separations (Wort separation, Wort clarification and rough beer clarification). Consequently, water consumption, wastewater and solid - liquid separation constitute real economic opportunities for improvements in brewing. Brewers are very concerned that the techniques they use are the best in terms of product quality and cost effectiveness. How then can Lean accounting facilitate waste reduction and ensures cost effectiveness in the brewery industry? A company has to evaluate its financial results on a weekly basis using 'box scores'; the company also has to calculate direct cost of products and conversion costs. With the conversion cost by hour, any company, irrespective of size, will be able to calculate real cost (conversion cost per unit plus direct material cost) on a daily basis regardless of the mix or complexity. According to [22], the goals of lean accounting can be attained by fundamentally changing the accounting process and motivating lean changes, improving and providing information suitable for control and decision making by value stream managers, encouraging understanding of customers' value, and correctly assessing the financial impact of lean improvement.

### 3. METHODOLOGY

The researchers adopted a survey research design in this study. The main source of data for the study was primary data collected through a structured questionnaire. A total of 50 copies of the questionnaire were administered to senior

and middle level managers in Champion Breweries. Ten copies each to staff of Production, Research & Development, Purchasing, Marketing, and Accounting & Finance Departments. Champion Breweries Plc, formerly Champion Breweries Limited, is a Nigeria-based company, which is engaged in brewing business. The Company's principal activity is to carry on the business of brewing and marketing of alcoholic and non-alcoholic beverages in Nigeria, as well as provide contract brewing and packaging services to Nigerian Breweries Plc. The Company is involved in the brewing and marketing of Champion Lager Beer and Champ Malta. The Company operates in the Nigeria geographical segment. Its Champ Malta is a flavored beer with a golden color and aroma. The Company's Champ Malta is available in approximately 60 centiliters (cl) bottles (12 Bottles per Crate). The Company is a subsidiary of The Raysun Nigeria Limited.

The respondents completed and returned the 50 copies of questionnaire in a useable form, giving a response rate of 100%. The questions were closed-ended based on Lean Accounting and waste management framework, and structured on a five point Likert scale response options as follows: Strongly Agree, Agree, Disagree, Strongly Disagree and Undecided. Data collected were analysed using Chi-Square at 5% significant level.

### 4. DATA ANALYSIS AND PRESENTATION

The awareness and usefulness of the principles of Lean Accounting in managing waste in Brewery industry in Nigeria were evaluated using Questions 4, 6, 8, 10 and 12 of the questionnaire. These questions are in respectively in the following respect, that:

- (i) Water consumption, waste water and solid waste separation constitute real economic opportunities for improvement in the industry
- (ii) Lean Accounting evolves to fill the gap between accounting practices and Lean thinking
- (iii) Implementation of Lean principles in Brewery industry improves operational performance; and
- (iv) Effective application of Lean Accounting principles and tools significantly reduce waste and associated costs.

**Table 1. Operational Improvement vs. Financial View**

	<b>Operational Improvement</b>	<b>Financial View</b>
1	Lead time reduction	Not recognized
2	Quality Improvement	Not recognized
3	On-time delivery improvement	Not recognized
4	Reduction in floor space	Not recognized
5	Increase in inventory turns	Decrease in operating profitability

Source: [5]

**Table 2. Result of analysis of questionnaire on the awareness and usefulness of the principles of lean accounting in managing waste in Brewery Industry in Nigeria**

Question	Observation (o)	Expected observation (e)	o-e	(o-e) <sup>2</sup>	o-e <sup>2</sup> /e
4	139	200	-61	3721	18.605
6	127	200	-73	5329	26.645
8	121	200	-79	6241	31.205
10	126	200	-74	5476	27.38
12	110	200	-90	8100	40.5
				$\Sigma =$	144.355

Source: Authors' computation

**Table 3. Result of Analysis of questionnaire on the influence of the practice of Lean Accounting on Waste Management in Brewing Industry in Nigeria**

Question	Observation (o)	Expected observation (e)	o-e	(o-e) <sup>2</sup>	o-e <sup>2</sup> /e
1	156	200	-50	2500	12.50
2	149	200	-51	2601	13.00
3	134	200	-66	4356	21.78
4	139	200	-61	3721	18.60
5	110	200	-90	8100	40.50
6	127	200	-73	5329	26.64
7	115	200	-85	7225	36.12
8	121	200	-79	6241	31.20
9	142	200	-58	3364	16.82
10	126	200	-74	5476	27.38
11	93	200	-107	11449	57.24
12	110	200	-90	8100	40.50
13	88	200	-112	12544	62.72
14	117	200	-83	6889	34.44
16	119	200	-81	6561	32.80
17	110	200	-90	8100	40.50
				$\Sigma =$	512.74

Source: Authors' computation

Presented in Table 2 is the result of analysis of questionnaire on the awareness and usefulness of the principles of Lean Accounting in Brewery Industry in Nigeria. The Chi-Square Statistic was employed to test the level of awareness and usefulness of the principles of Lean Accounting in the Brewery Industry. The computed Chi-Square value of 144.355 was greater than the critical Chi-Square value of 33.93 at 5% level of significance (d.f 49). From this result, it is discovered that the level of awareness and usefulness of the principles of Lean Accounting in managing waste is still very low in the Industry.

Also, analysis of the responses to the questionnaire shows that 55% of the loss of water in the brewing process is from wet brewing waste, while 58.5% indicate that long implementation period and lack of adequate skills and knowledge limit the application of Lean Accounting in the industry in Nigeria.

Presented in Table 3 is the result of analysis of questionnaire on the influence of Lean Accounting on waste management in Nigeria Brewery Industry. The Chi-Square Statistic was employed to test the basic assumption of the study. The computed Chi-Square value of

512.74 was greater than the critical Chi-Square value of 33.93 at 5% level of significance (d.f 49). The basic assumption that the practice of Lean Accounting significantly influences waste management in Brewery Industry in Nigeria was rejected. This is not unconnected with the fact the concept of Lean Accounting has not been fully embraced by the Industry in Nigeria.

## 5. CONCLUSION

Based on the findings of this study, it is concluded that: (i) there is low level of awareness and usefulness of the principles of Lean Accounting in managing waste in Brewery in Nigeria. (ii) the practice of Lean Accounting in Nigeria does not significantly influence waste management in Nigeria Brewery Industry given the current practice in the Industry. However, owing to the fact that Lean Accounting is a dependable waste management tool for promoting the goals of providing quality and better products, it is recommended that management of Breweries in Nigeria should undertake to train their staff on the application of Lean principles and practice of Lean Accounting, for effective and efficient management of waste in the production process to ensure good quality of their product; and reduce lead time. With this, more value will be added to the customers, measure of cash flow and other stakeholders in the long run. Also, Lean Accounting principles should be seen as highly useful tool for the Brewery industry where their operating processes give rise to waste which require effective and efficient management for removal.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Enoch OK. Lean Accounting and Lean business philosophy in Nigeria: An exploratory research. *International Journal of Economics, Finance and Management*. 2013;2(7):508-515.
2. NBS. National Bureau of Statistics; 2010.
3. Unah I, Umweni A. Nigeria Brewery Industry Report; 2017. Available: [www.businessdayonline.com](http://www.businessdayonline.com).
4. Adekoya F. Nigeria: Brewery Industry as Driver of Value-Chain Investment; 2016. Available: [allafrica.com/view/group/main/main/id/00058451.html](http://allafrica.com/view/group/main/main/id/00058451.html)
5. Woehrl S, Abou- Shady L. Using dynamic value stream mapping and Lean Accounting box scores support Lean implementation. *America Journal of Business*. 2010;3(8):67-75.
6. Maskell B, Baggaley B. *Practical Lean Accounting: A problem system for measuring and managing the lean Enterprises*. New York: Productivity Press; 2006.
7. Kennedy FA, Brewer PC. Lean accounting: What's it all about? *Strategic Finance* (February). 2005;26-33.
8. Foster G, Horngren CT. JIT: Cost Accounting and cost management issues. *Management Accounting* (June). 1987;19-25.
9. Kennedy F, Brewer P. The Lean enterprises traditional accounting: Is the Honey moon over? *Journal of Corporate Accounting and Finance*. 2006;17(6):63-74.
10. OECD The measurement of scientific and technological activities: Guidelines for collecting and interpreting innovation data: 3<sup>rd</sup> edition, Oslo Manual; 2005. Available: [www.oecd.org/sti/oslomanoal](http://www.oecd.org/sti/oslomanoal)
11. Lopes RB, Freitas F, Sousa. Application of Lean manufacturing tools in the food and beverage industries. *Journal of Technology Management and Innovation and Innovation*. 2015;10(3):120-130.
12. Boston Consulting Group. *Lean food and beverage manufacturing: Lower costs better products, improved sustainability*; 2015. Available: <http://www.big.com/documents/file49085.pdf>
13. Heymans B. *Lean manufacturing and the food industry*; 2015. Available: <http://www.flowmakers.com/articles/Articlesfoodindustryandkaizen.pdf>
14. MCS Media. *The Lean Pocket Guide XL: Tools for the elimination of waste*. Michigan: Arthur; 2006.
15. Narasimhan J, Parthasarathy L, Narayan, PS. Increasing the Effectiveness of value stream mapping using simulation tools in Engine Test Operations. *Proceedings of 18th IASTED International conference '07: Modelling and simulation*, Montreal, Quebec: Canada; 2007.
16. Womack JP, Jones DT, Roos D. *The Machine that changed the world*. New York: Macmillian; 1990.



17. Priest FG, Stewart GG. Handbook of Brewing, 2nd edition (Food Science and Technology), America: CRC Press; 2006.
18. El-Haik B, Al-Aomar R. Simulation – based Lean six-sigma and design for six-sigma. New Jersey: Wiley Interscience; 2006.
19. George MI. Lean six sigma for service: How to use lean speed and six sigma quality to improve services and transactions. London: McGraw. Hill; 2003.
20. Womack JP, Jones DT. Lean thinking: Banish Waste and Create Wealth in your Corporation. New York: Free Press. Magazine. 2003;22(1):35-43
21. Fillaudeau L, Blanpain-Aret P, Daufin G. Water, wastewater and waste management in brewing industries. Journal of Clearer Production. 2006;14(2006):463 - 471
22. Ed. Stenzel J. Lean Accounting: Best practices for sustainable integration. New York: Wiley; 2007.

**APPENDIX**

**ANALYSIS OF RESPONSES TO QUESTIONNAIRE**

Question Nos.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q16	Q17
Questionnaire																
1	3	4	4	3	0	4	4	0	4	3	0	0	4	4	3	4
2	3	3	4	3	0	0	3	4	3	0	2	4	0	3	4	0
3	0	3	4	3	4	2	4	3	4	0	0	4	3	3	0	0
4	4	4	0	0	4	4	3	4	3	0	3	0	3	3	4	0
5	2	2	3	3	4	4	4	3	0	3	3	0	2	3	4	3
6	4	3	0	0	0	4	3	3	4	3	0	3	4	4	3	4
7	3	4	3	4	0	4	4	3	4	0	0	3	1	3	4	0
8	4	3	4	0	4	3	4	0	0	4	3	4	3	2	4	3
9	4	4	0	3	3	4	3	4	3	0	3	0	1	0	0	0
10	3	0	3	4	1	0	4	0	0	4	1	4	0	4	0	4
11	4	3	3	4	3	0	4	3	4	4	0	4	4	0	0	2
12	3	3	4	4	3	3	4	4	3	3	3	0	4	1	0	4
13	4	4	4	3	3	3	3	3	3	3	1	3	0	3	4	0
14	4	4	4	4	4	3	4	4	3	0	0	3	3	3	0	0
15	4	4	3	3	4	0	4	4	3	3	3	4	4	3	4	0
16	3	3	3	3	0	5	0	4	4	3	3	4	2	4	3	4
17	4	4	3	3	1	4	4	3	4	3	3	3	0	4	3	3
18	3	3	3	3	0	4	4	4	3	0	3	0	3	3	3	4
19	3	3	4	4	2	4	4	4	3	4	3	4	0	3	0	4
20	3	3	4	3	0	3	3	3	3	4	3	4	0	4	4	4
21	1	4	4	3	3	4	4	3	3	3	0	3	0	3	4	1
22	1	1	0	0	0	2	4	4	4	1	3	1	1	3	0	3
23	4	3	3	3	4	1	0	2	2	1	3	1	0	3	0	3
24	3	3	0	0	0	2	2	0	3	3	1	1	0	1	1	2
25	3	4	1	3	3	3	0	0	3	3	1	1	0	4	2	2
26	3	3	1	3	3	4	0	3	4	3	1	2	2	1	1	1
27	4	3	1	1	0	0	2	2	2	2	3	0	2	4	0	1
28	1	1	3	3	3	1	3	3	4	1	2	3	3	1	3	2
29	4	1	3	3	4	0	2	2	3	3	1	3	0	0	4	1

Question Nos.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q16	Q17
30	1	3	1	3	0	2	1	4	3	0	1	3	1	1	3	3
31	3	1	1	3	3	4	4	4	3	3	0	1	3	4	0	4
32	1	1	3	3	4	4	0	4	4	3	1	3	0	3	3	3
33	4	1	0	0	4	1	0	0	4	3	3	1	1	1	3	1
34	4	3	4	3	3	4	3	4	4	3	1	1	1	1	4	1
35	3	4	4	3	4	1	0	0	4	4	3	0	0	1	4	4
36	3	3	4	4	1	1	0	0	4	4	3	1	4	1	3	0
37	4	3	3	4	1	2	4	3	3	4	1	1	0	3	4	3
38	4	3	3	4	1	3	0	1	1	0	3	4	4	0	4	1
39	3	4	1	3	3	4	0	0	3	4	3	3	3	1	3	4
40	4	1	1	3	3	1	0	0	3	3	1	4	1	3	4	4
41	3	4	4	3	3	4	0	0	4	3	3	4	3	3	4	1
42	3	4	4	3	0	4	0	3	3	4	1	0	1	1	1	1
43	3	4	4	3	0	4	0	0	3	3	3	4	3	1	0	3
44	4	3	4	3	0	0	0	2	0	4	3	0	0	4	4	4
45	2	3	4	4	3	0	2	2	0	3	3	4	4	3	4	3
46	4	3	0	3	4	3	2	2	3	0	0	3	4	4	2	3
47	4	3	3	4	3	0	3	3	4	3	0	0	0	2	0	4
48	3	4	4	4	3	3	3	3	0	4	3	0	2	3	0	4
49	4	4	3	3	4	3	2	4	0	3	3	4	0	0	4	0
50	3	3	3	0	3	4	4	3	3	4	2	3	4	0	3	0
<b>Total</b>	<b>156</b>	<b>149</b>	<b>134</b>	<b>139</b>	<b>110</b>	<b>127</b>	<b>115</b>	<b>121</b>	<b>142</b>	<b>126</b>	<b>93</b>	<b>110</b>	<b>88</b>	<b>117</b>	<b>119</b>	<b>110</b>

© 2018 Emeakponuzo et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:  
 The peer review history for this paper can be accessed here:  
<http://www.sciencedomain.org/review-history/24697>