Implementation of Quality Management Systems: An Empirical Study of Selected Laboratories in Port Harcourt, Nigeria.

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Abstract
This study aims to determine the implementation of quality management system in selected laboratories in Rivers State, Nigeria. Questionnaire was used to collect sample from 600 laboratory personnel from university, medical and other analytical industries. The results showed that there was below 75% in the extent of quality management system implementation (59.64±6.72); this was below the optimum research use. Therefore, laboratory quality management system implementation in Port Harcourt, Nigeria should be improved by concerted effort of all laboratory stakeholders. This can be achieved through trainings, re-trainings, advocacy, good quality assurance, proficiency testing, and supply chain/inventory management, establishment of continual improvement plans and adequate information management through document control, control of records and clients confidentiality.

Introduction

Globally, the possession of a business competitive edge has compelled organizations to establish, practice and adopt total quality management (TQM) systems. To select an analytical laboratory that will provide the best quality services is of utmost importance in every analytical project. In today's business world, many laboratories worldwide have engaged in a great competition for survival; this has driven these laboratories to constantly desire to improve the quality of their products and services in the most effective and efficient manner.

Literature Review

The importance of quality management (QM) systems to improve the quality of laboratory services has long been recognized due to the growing interest in the globalization of industrial activities and the market economy and also due to great concern for risk and safety factors. Today, QM systems are established in nearly all kinds of industrial activities, in measurement and testing laboratories and also in areas such as "operating theatres" or sales departments (Cammann & Kleiböhmer, 1998). During the last few years there have been ever

increasing interest in the development of a more general strategy for applying QM systems in research and development activities in research laboratories or institutions.

Process improvement is essential for organization because customer loyalty is driven by delivered value, delivered value is created by business processes, sustained success in competitive markets requires a business to continuously improve delivered value and to continuously improve value creation ability, and business must continuously improve its value creation processes (Evans and Lindsay, 2011). According to Fulga (2013), quality management and accreditation in the analytical laboratory setting are developing rapidly and becoming the standard worldwide. Delivering reliable laboratory results has long been considered a priority, as the data produced in laboratory have the potential to influence critical decision making. Until recently, most attention on laboratory quality has been focused on the analytic stage of the workflow (McCay, Lemer and Wu, 2009).

There has been extensive research on laboratory quality management system implementation globally, but there is still little known about laboratory quality practice in developing countries especially Rivers State, Nigeria and so the reason for this study. This study will address the following key objectives:

1. What is the extent of total quality management practice based on the quality assurance of results?
2. What is the extent of total quality management practice based on of supplies/inventories management?
3. What is the extent of total quality management practice based on continual improvement?
4. How do socio-demographic factors of rank/position, level of education and class of organization affect the extent of laboratory total quality management practice

Materials and Method

Research design

This is a cross-sectional study.

Population

Population of this study consisted of university, industrial, and medical laboratories in Port Harcourt, Nigeria between July and October, 2016.

Sample/Sampling Technique

Purposive sampling was used to sample six hundred (600) laboratory personnel.

Instrument

Researcher-developed, open and closed ended; self-administering questionnaire was used to collect data from the respondents for the socio-demographic variables (rank/position, level of education and class of organization) and items that measured the extent of laboratory quality implementation. The questionnaire was pre-tested using twenty (20) laboratory personnel who were not part of the research sample. The extent of quality practice was coded as: great extent (4), some extent (3), low extent (2) and no extent (1).

Procedure and Data Collection

The purpose of the study as well as other details concerning the research was explained to the respondents. The questionnaire was given to each participant with full instructions on how to answer the questions.

Validity of the Instrument

The content validity of the instrument was done by the researcher's supervisors together with seven (7) subject matter experts in laboratory quality management systems, their criticisms and recommendations were taken note of. The questionnaire was modified based on the recommendations made.

Reliability of the Instrument

The reliability of the instrument for this study and Cronbach alpha was 0.94.

Data Analysis

Microsoft Excel 2016 package and Statistical Package for Social Sciences (SPSS) version 22 were used for data analysis. Descriptive statistics of percentages and frequencies were used for the purpose of description. Mean and standard deviation were used to determine the extent of total quality management practice. The analysis of variance (ANOVA) was used to test the significant differences in quality assurance of results, supplies/inventory management and continual improvement at 0 .05 level of significance. Quartile method was used for the result synthesis: No Extent=<25%; Low Extent = 25-50%; Some Extent = 51-75%; Great Extent = >75%. Sqiures and others (2011) used quartile method in a similar study. The extent of total quality management practice was benchmarked at > 75% which corresponds to rate 4, which means that the optimum extent of laboratory quality management implementation was greater than 75 percent (great extent or 4). P <0.05 was considered as statistical significant. The results were standardized or scaled up to 100% for the purpose of description.

Results

Respondents' Characteristics

A total of 600 questionnaires were delivered to the laboratory personnel in the sampled population. Five hundred and sixteen (516) of these questionnaires were correctly filled in by the participants. This gave 86% response rate. Table 1 below shows that 137 (26.6%) of the respondents were Junior Analysts, 324 (62.8%) were Analysts, Safety Officers were 2 (0.4%), Laboratory Managers were 28 (5.4%) while Laboratory Directors were 25 (4.8%). There was no respondent for both Quality Officer and Technical Manager. Laboratory Analysts were the highest while Safety Officers were the least participants in the study. Respondents with tertiary education were 440 (85.3%) and secondary education was 76 (14.7%) while there was no respondent with primary education. This indicates that majority of the respondents had tertiary level of education. Personnel from private laboratories contributed to 169 (32.8%) whereas public laboratories contributed to 347 (67.2%) of the respondents. This shows that more respondents for this study were from public (government- owned laboratories).

Table1: Overall Social-demographic Data of Sample

Demographic variables	Number of respondents	Percent
Position/Rank		
Junior Analyst	137	26.6
Analyst	324	62.8
Quality Officer	0	0
Safety Officer	2	0.4
Technical Manager	0	0
Laboratory Manager	28	5.4

Director	25	4.8
Total	516	100.0
Highest Level of Education		
Primary	0	0
Secondary	76	14.7
Tertiary	440	85.3
Total	516	100.0
Class of Organization		
Private	169	32.8
Public	347	67.2
Total	516	100.0

Table 2: Extent of Quality Practice Based on Rank/Position of Workers (n=516)

	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Junior Analyst	137	56.9315	3.98184	.34019	49.69	68.95
Analyst	324	58.0298	3.59192	.19955	46.51	70.56
Quality Officer	0	0.0000	0.00000	0.0000	0.00	0.00
Safety Officer	2	61.3600	10.70560	7.5700	53.79	68.93
Technical Manager	0	0.0000	0.00000	0.0000	0.00	0.00
Laboratory Manager	28	75.8439	1.49362	.28227	73.19	78.62
Director	25	76.9876	1.29634	.25927	74.25	79.47
Total	516	59.6362	6.72124	.29589	46.51	79.47

Note: No Extent= <25%; Low Extent = 25-50%; Some Extent = 51-75%; Great Extent = >75%.

Data in the table above show a total mean of 59.64. This implies that based on rank/position; there was some extent of quality practice with less variability.

Table 4.7a also reveals that Junior Analyst had a mean and standard deviation of 56.93, while Analyst had a mean of 58.03. There were no respondents for Quality Officer and Technical Manager. Moreover, Safety Officer had a mean value of 61.36. Laboratory Manager had a mean value of 75.84 while Director had a mean value of 76.99. This implies that Laboratory Directors had great extent of laboratory quality practice together with Laboratory Managers (mean=75.84) while Safety Officer (mean=61.36), Analysts (mean=58.02) and finally Junior Analysts (mean=56.93) had some extent of practice. This implies that Laboratory Directors had higher extent of quality practice while Junior Analysts had the least extent of quality practice.

Table 3: There is a Significant Difference in the Extent of Quality Practice Based on Rank/Position of Workers Using a One-Way Analysis Of Variance (ANOVA) (n=516)

	Sum of Squares	df	Mean Square	F	Sig.(P-value)
Between Groups	16726.376	4	4181.594	326.788	<0.0001*
Within Groups	6538.774	511	12.796		
Total	23265.151	515			

Table 3 above shows a p-value of < 0.0001, therefore there is a significant difference thus p ≤ .05. This implies that rank/position affect the extent of quality practice. This further indicates that laboratory workers differ in the extent of quality practice based on rank/position of workers.

Table 4: Extent of Quality Practice Based on Workers' Level of Education (n=516)

	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Primary	0	0	0	0	0	0
Secondary	76	59.1907	6.22626	.71420	49.70	77.33
Tertiary	440	59.7132	6.80680	.32450	46.51	79.47
Total	516	59.6362	6.72124	.29589	46.51	79.47

Data in Table 4 above show a total mean value of 59.64 and a standard deviation of 6.72. This implies that the extent of quality practice based on workers' level of education was to some extent. There was no respondent that had primary education as the highest level of education. However, workers' with tertiary level of education had a mean value of 59.71 and a standard deviation of 6.81 while secondary level of education had a mean of 59.19 and a standard deviation of 6.23. This implies that the extent of quality practice was higher with personnel that have tertiary level of education compared to secondary level of education.

Table 5: There is no Significant Difference in the Extent of Quality Practice Based on Workers' Level of Education Using a One-Way Analysis Of Variance (ANOVA) (n=516)

	Sum of Squares	df	Mean Square	F	Sig.(P-value)
Between Groups	17.696	1	17.696	0.391	0.532
Within Groups	23247.455	514	45.229		
Total	23265.151	515			

Data in Table 5 above show that the calculated F-value was 0.391 and the corresponding P was 0.532, therefore P >0 .05. This implies that the laboratories are the same in the extent of quality practice based on level of education. This further implies that the differences in their means are likely due to chance variation.

Table 6: Extent of Quality Practice Based on Class of Organization (n=516)

	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Private	169	59.7994	7.26842	.55911	49.69	78.62
Public	347	59.5568	6.44744	.34612	46.51	79.47
Total	516	59.6362	6.72124	.29589	46.51	79.47

Table 6 shows a total mean of 59.64 and a standard deviation of 6.72.However, public organizations had a mean of 59.56 and a standard deviation of 6.45 while private organizations had a mean of 59.80 and a standard deviation of 7.27. This implies that the extent of quality practice was higher in private than public organization.

Table 7: There is no Significant Difference in the Extent of Quality Practice Based on Workers' Class of Organization Using a One-Way Analysis Of Variance (ANOVA) (n=516)

	Sum of Squares	df	Mean Square	F	Sig.(P-value)
Between Groups	6.691	1	6.691	0.148	0.701
Within Groups	23258.460	514	45.250		
Total	23265.151	515			

Table 7 above shows that the calculated F-value was 0.148 and the corresponding P-value was 0.701, therefore P>0.05. This implies that the laboratories do not differ in the extent of quality practice based on class of organization. This further implies that the differences in their means are likely due to chance.

Table 8: Extent of Quality Practice Based on Quality Assurance of Results (n=516)

Core Business Area	**Quality Assurance**			
	Min.	Max.	Mean±SD (%)	Extent of Practice
Medical	26.00	80.00	46.6200±13.12567	Low extent
University	20.00	78.00	39.6105±10.39311	Low extent
Industrial	30.00	70.00	46.0000±11.53776	Low extent
Total	20.00	80.00	44.0078±12.54738	Low extent

Table 8 above shows a total mean value of 44.01 and a standard deviation of 12.55. This implies that there is low extent of quality practice based on quality assurance of results.

Results in Table 8 further reveals that medical laboratories had a mean of 46.62 and a standard deviation of 13.13 while university laboratories had a mean of 39.61 with a standard deviation of 10.39 and also industrial laboratories had a mean of 46.00 and a standard deviation of 11.54. From the results above, all the laboratories had mean values within 25-50 %(low extent). This indicates that medical laboratories had a better quality assurance of results whereas university laboratories had the poorest quality assurance of results.

Table 9: There is a Significant Difference in the Extent of Quality Practice Based on Quality Assurance of Results Using a One-Way Analysis Of Variance (ANOVA) (n=516)

	Sum of Squares	df	Mean Square	F	Sig(P-value)
Between Groups	5824.110	2	2912.055	19.851	<0.0001
Within Groups	75255.859	513	146.698		
Total	81079.969	515			

Data in Table 4.28a show that the calculated F-value was 19.851 and the corresponding P-value was <0.0001, therefore P < 0.05. This implies that the laboratories have different extent of quality assurance of results.

Table 10: Extent of Quality Practice Based on Supplies/Inventory Management (n=516)

Core Business Area	Supplies/Inventory Management			
	Min.	Max.	Mean±SD (%)	Extent of Practice
Medical	40.00	80.00	64.2570±8.87481	Some extent
University	37.14	77.14	59.9099±7.29383	Some extent
Industrial	34.29	77.14	59.4508±11.19855	Some extent
Total	34.29	80.00	62.4142±8.72209	Some extent

Data in Table 10 above shows that the total extent of quality practice based on supplies/inventory management had a mean of 62.41.This implies that there is some extent of quality practice based on supplies/inventory management.

Results in the table above further reveal that medical laboratories had mean of 64.26 and a standard deviation of 8.87 while university laboratories had a mean of 59.91 and a standard deviation of 7.29 and industrial laboratories had a mean of 59.45 with a standard deviation of 11.20.This implies that medical laboratories had better supplies/inventory management while industrial laboratories had the poorest supplies/inventory management.

Table 11: There is a Significant Difference in the Extent of Quality Practice Based on Supplies/Inventory Management Using a One-Way Analysis Of Variance (ANOVA) (n=516)

	Sum of Squares	df	Mean Square	F	Sig. (P-value)
Between Groups	2438.684	2	1219.342	17.026	<0.0001
Within Groups	36739.880	513	71.618		
Total	39178.564	515			

Table 11 show that the calculated F-value was 17.026 and the corresponding P-value was <0.0001, therefore P <.05. This implies that the laboratories have different extents of supplies/inventory management. This also implies that the differences in their means are not likely due to chance.

Table 12: Extent of Quality Practice Based on Continual Improvement (n=516)

Core Business Area	Continual Improvement			
	Min.	Max.	Mean±SD (%)	Extent of Practice
Medical	41.82	80.00	63.3755±7.7070	Some extent
University	43.64	80.00	60.8421±7.3477	Some extent
Industrial	47.27	80.00	61.9573±9.1106	Some extent
Total	41.82	80.00	62.3712±7.7322	Some extent

Data in Table 12 show a total mean of 62. and a standard deviation of 7.73.This implies that there was some extent of continual improvement with less variation.

The table further shows that medical laboratories had a mean of 63.38 and a standard deviation of 7.71 while university laboratories had a mean of 60.84 and a standard deviation of 7.35 and finally industrial laboratories had a mean of 61.96 and a standard deviation of 7.73.This indicated that all the laboratories had some extent of quality practice because all the

mean values fell within 51-75 percent. This also implies that medical laboratories had the highest extent of continual improvement while university laboratories had the lowest extent of continual improvement.

Table 13: There is a Significant Difference in the Extent of Quality Practice Based on Continual Improvement Using a One-Way Analysis Of Variance (ANOVA) (n=516)

	Sum of Squares	Df	Mean Square	F	Sig. (P-value)
Between Groups	751.264	2	375.632	6.415	0.002
Within Groups	30038.678	513	58.555		
Total	30789.942	515			

Data in Table 13 above show that the calculated F-value was 6.415 and the corresponding p-value was 0.002, therefore P <.05. This implies that the laboratories have different extents of quality practice based on continual improvement.

Table 14: Extent of Quality Practice among Selected Laboratories in Port Harcourt Metropolis Using ANOVA (n=516)

Core Business Area	Total Extent of Quality Practice			
	Min.	Max.	Mean±SD (%)	Extent of Practice
Medical	46.51	79.47	60.0171±7.1396	Some extent
University	49.70	77.77	59.1151±5.7959	Some extent
Industrial	49.96	75.69	59.0508±7.9273	Some extent
Total	46.51	79.47	59.6362±6.7212	Some extent

Results in Table 14 above reveal a total mean value of 59.64 and a standard deviation of 6.72. This indicates that there is some extent of quality practice.

Data above further show that show that medical laboratories had a mean of 60.02 with a standard deviation of 7.14 while university laboratories had a mean of 59.12 with a standard deviation of 5.80 and industrial laboratories had a mean of 59.05 with a standard deviation of 7.93. This indicated that medical laboratories had the highest extent of quality practice in Port Harcourt metropolis while industrial laboratories had the least extent of quality practice. This also implies that university laboratories had less variation whereas industrial laboratories.

Table 15: There is no Significant Difference in the Extent of Quality Practice Among Selected Laboratories in Port Harcourt Metropolis Using a One-Way Analysis Of Variance (ANOVA) (n=516)

	Sum of Squares	Df	Mean Square	F	Sig. (P-value)
Between Groups	104.032	2	52.016	1.152	0.317
Within Groups	23161.119	513	45.148		
Total	23265.151	515			

Table 16 above show that the calculated F-value was 1.152 and the corresponding P-value was .317, therefore P >.05. This implies that there is no difference in the extent of quality practice, that is to say that there extent of quality practice was the same across the

selected laboratories. This further implies that the differences in their means are likely due to chance.

Discussion

The findings of this study are as discussed here below according to the stated objectives: This study found that there was some extent (below 75%) of total quality management (TQM) practice based on rank/position of the personnel, with mean± standard deviation of 59.6362 ± 6.72124; and p=<0.0001. Laboratory Directors had the highest extent (mean = 76.9876±1.29634) while Junior Analysts had the least extent (mean=56.9315 ±3.98184). This is consistent with the findings of Blumen and others (2010) who reported that laboratory supervisors know more about the quality assurance procedures in the laboratory, while inexperienced laboratorians with 0 to 10 years of experience were most likely not to know. Moreover, this study is in agreement with the findings of Blumen and others (2010); who found a significant difference between knowledge of quality assurance and years of experience, furthermore Taamneh (2001) and Al-humedhi (2000) also found a significant difference in the extent of TQM implementation. However, this study is in disagreement with the findings of Al-Shdaifat (2015) and Al-Lozi (2003 who found no relationship between the extent of TQM and years of experience.

This study found that there was some extent, below 75% (mean = 59.64± 6.72) of TQM practice based on level of education with p=0.532. However, tertiary level of education had the highest extent of TQM practice (mean =59.71±6.81) while secondary level had mean = 59.19 ±6.81 and none of the participants had below secondary level of education. This is in line with the finding of Al-Shdaifat (2015) who revealed that workers' level of education as a socio-demographic variable of total quality management implementation was below 60 % and thus no relationship was found between the extent of implementation of TQM and level of education. Al-Shdaifat further maintained that there was no significant difference in total quality management implementation based on workers' level of education. However, this present study is in disagreement with Al-humedhi (2000) and Taamneh (2001) who found a significant difference

Furthermore, the present study found that there was some extent, below 75% (mean = 59.64± 6.72) of TQM practice based on workers' class of organization with p=.0.701. Private laboratories had a higher extent of TQM practice than public or government owned laboratories. This finding is in consonance with the reports of Al-Shdaifat (2015) who indicated that workers' class of organization as a socio-demographic variable of total quality management implementation was below 60 %. According to Al-Shdaifat in his study, the private sectors implemented more of the principles of TQM when compared with public sectors. Al-Shdaifat further asserted that there was no significant difference in total quality management implementation based on workers' class of organization and was supported by Al-Neyadi (1999) in Al-Shdaifat (2015).

This study found that there was low extent, less than 50% (mean = 44±12.55) of TQM practice based on quality assurance of results with p<0.0001. Medical laboratories had the highest extent of TQM practice followed by industrial while university has the least extent of TQM practice. This is in line with the findings of Manickam and Ankanagari (2015) who stated in their study that process control and internal/external quality assessment scored 43 percent, which according to the present study was low extent of TQM practice. This was supported by Addis and others (2013) who declared that there was lack of consistency in the quality of laboratory work.

The findings of this study showed that there was some extent (mean = 62.41±8.72) of TQM practice based on supply/inventory management. This is in consonance with Fraga

(2012) who in his study stated that materials and reagents management scored 20 percent. This is supported by Manickam and Ankanagari (2015) who in their study stated that purchasing and inventory scored 30 percent.

The results of this study showed that there was some extent (mean = 62.37±7.73) of TQM practice based on continual improvement with p = 0.002. This is in agreement with Al-Shdaifat (2015) who found that continuous improvement was the least (41.6±23.3) implemented TQM principle in his study with p<0.0001 and supported by Taamneh (2001). However, this is inconsistent with the study of Garcia and others (2002) who found in their study that continuous improvement was the highest implemented principle.

This study found that there was some extent (59.63±6.72) of TQM practice which was below the optimum extent of TQM for the study. This implies that there was a poor TQM practice. This is in agreement with the studies of Al-Shdaifat (2015) who asserted that the extent of TQM implementation was poor and supported by Lee, Khong, Ghista and Mohammad (2006) who found that TQM implementation was very low. However, this is inconsistent with the studies conducted by Taamneh (2001); and Al-Lozi (2003).

The limitations of this study include the sample size together with the research design which was a cross-sectional and descriptive

Conclusion

The present study concluded that there was below 75% extent of TQM which was an indication of poor practice in Port Harcourt Rivers State. There was a significant difference in the extent of TQM based on quality assurance of results, supplies/inventory management and continual improvement. Furthermore, there was a significant difference based on rank/position but there was no significant difference based on level of education and class of organization. The researcher recommends trainings on TQM and supply chain management, the use of plan-do-check-act cycle for continual improvement, quality assurance of results using proficiency testing and other quality assurance tools.

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