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COST EFFECTIVENESS OF QUALITY MANAGEMENT SYSTEM IN A REINFORCED CONCRETE FRAME CONSTRUCTION COMPANY

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Abstract

The main purpose of this research is to determine cost effectiveness of implementing and maintaining quality management system using existing data from information filled in nonconformity report over a period of 4 years (2011 to 2014). The research uses a single case study research design to fulfill the objectives of the study. The data extracted from the annual account of the reinforced concrete frame construction company were analysed. The findings suggest that the company under study has implemented a quality management system within their organisation. The findings show that the cost of quality conformance increases from 2011 to 2014 except for 2013 which is lower than that of 2011 due reduced working months of the quality manager in that year. For the cost of quality non-conformance, the findings show that about 77% of the total value are not recovered by the company in 2012, while this is reduced to about 18% in 2014 due quality management system put in place by the company. It was also shown that the ratio of profit before tax (PBT) to turnover declined by 2.86% in 2012 and by 17.14% by 2013 while it declined by 10% in 2014 when compared to 2011. The study concluded that commitment of the company to quality management system has rubbed off the company of some revenues in the form of profit that would have accrued into the cover of the company. However, the implementation of the quality management system is paying off on its own right. The study recommended that one of the areas that researchers need to give proper attention is to conduct more studies on a number construction companies in order to create an industry norm.

Keywords: *cost; Construction Company; quality; United Kingdom*

1.0 Introduction

Construction companies like any other business organisation aim at implementing construction projects to the satisfaction of their customers in order to give value for the money invested, thereby making construction projects cost effective (Al-Momani, 2000; Chin *et al*.,2003). This is to uphold the stipulated industry standards and building specifications. Construction companies within the industry compete to meet the demands or the needs of their customers. It has been suggested that the ability of an organisation to produce quality services and products is one of the key factors to compete in the international market (Said *et al.*, 2006). Construction companies should adopt approved techniques to ensure that their products and services meet the expected standards and satisfy the needs of their customers. To achieve these objectives, there is the need for an effective quality management system in the construction company.

Quality management (QM) has been defined as the application of a quality management system (QMS) in managing a process to achieve maximum customer satisfaction at the lowest overall

cost to the Organisation while continuing to improve the process (American Society for Quality, 2013). The ASQ further defined QMS as a formalised system that documents the structure, responsibilities and procedures required to achieve effective quality management. This process aims at providing confidence to the management of an organisation that the intended quality of their products and services is being achieved. The primary focus of a QMS should not be on correction but on prevention, with emphasis on doing things right the first time; eliminating and at worst reducing waste and reworks to the barest minimum.

The quality of workmanship and products is covered by a quality management scheme such as the ISO 9000 series (Department for Communities and Local Government, 2010). The ISO 9000 is a set of standard developed by the International Organisation for Standardisation for creating quality management systems in various organisations in the world based in Geneva. These standards set down the elements companies need for organising and controlling operations to achieve high quality products and services. The introduction of ISO 9000 into the construction industry serves as a basic strategy for influencing competitiveness in the construction industry and is mandatory for companies wanting to compete in the European market (Tariq, 2002). QMS is a strategic tool for enhancing performance management and helping companies gain effectiveness by reducing non-conformances and wastes, and ensuring construction projects, products and services are delivered to schedule and at contract cost.

The research by Rosenfeld (2008) determined the optimal level of investment in quality by construction companies suggests that investing less than 2% in prevention and appraisal entail higher failure cost whereas investment of over 4% may not pay itself back. However, various researchers have attempted to quantify the cost of quality and have come up with varying figures. Ledbetter (1994) arrived at 11.2% of the project sum as the sum of the Cost of Quality and the Cost of Non-Quality at the design and construction phase. In a study on a heavy industry project to test quality performance management system (QPMS) by Willis and Willis (1996), the Total Quality Related Cost was 12% *i.e.* prevention and appraisal cost being 8.7% and failure cost 3.3%. Abdul-Rahman *et al.* (1996) also found the cost of non-conformity to be 5% to 6% of the project sum. In spite of all this figures, the overall view is that the cost of nonconformity/failure cost/cost of non-quality is a significant amount of the project sum. The rate of failures could be reduced by continuous investment in prevention leading to a reduction in appraisal cost (Campanalla, 1990). The cost benefit of implementing a QMS was found to be 15% of the total construction costs which could be gained by increasing prevention cost and by eliminating rework (BRE, 1982). The Cost of quality is required to be stated to ensure proper adequate measurement of the effectiveness of the quality system that is being adopted (Love and Sohal, 2003).

The main focus of this research is to determine the cost effectiveness of implementing and maintaining QMS in a RC frame construction company using existing data extracted from non-conformance reports over a period of 4 years (2011 to 2014). These information were examined alongside the data extracted from the company's financial records. The specific objectives of this paper are to:

1. evaluate the cost of implementing and maintaining a quality management system in a RC frame Construction Company, and
2. establish cost effectiveness of the quality management system in the RC frame Construction Company.

1.1 Review of Previous Literature Related to Costs of Quality in Construction

Quality managers and researchers have acknowledged that there are immense benefits attributable to the implementation of quality management system (QMS) by firms, especially in the construction industry. These benefits, according to Castelvecchi (2003) and Freiesleben (2005) includes increased productivity, improved morale, increased adaptability of the firms, and significant increase in firms' profit profiles. Dahlgaard *et al.* (1992) argues that knowing the cost of quality will

actually aid in measuring any improvement made in a QMS. This, invariably, will provide a kind of tool for measuring QMS of a firm by converting the problems associated with quality into cost.

The works of Juran in the 1950s give details relating to the concept of quality costs. This work was progressed by Feigenbaum (1951) by coming up with a Prevention, Appraisal, and Failure (PAF) model of quality costs. This offers a robust classification of cost of quality. Further to this, the work of Crosby (1979) redefined the cost of quality in terms of the cost attached to Conformance and Non-conformance to quality standard. In other words, Crosby (1979) sees the quality costs as something that can be estimated from the sum of the prices attached to Conformance and Non-conformance. These traditional classifications of quality costs are adopted by a superfluity of researchers in the area of quality costs in construction. Among these researchers are the works of Abdul-Rahman (1993), Low and Yeo (1998), Josephson *et al*. (2002), Song and Lee (2004), and Rosenfeld (2009). Interestingly, Song and Lee (2004) summarised the classification of quality costs and offered a kind of operational definitions of each term used in costs of quality as shown in Table 1.

Table 1: Summary of classification of quality cost (Adapted from Song and Lee, 2004)

Category		Contents
Conformance Quality	Prevention Cost	- Cost arising from prevention measures - Cost related to education, planning, etc.
	Appraisal Cost	- Cost related to performing check on products or services - Cost for conducting inspection, lab test, on-site test, etc.
Non-conformance Quality	Internal – Failure Cost	- Cost related to resolving problems prior to delivery of product to customer - Cost related to disposal, reproduction, stand-by, etc.
	External – Failure Cost	- Cost related to solving customer claims in connection with products or services - Cost related to maintaining quality assurance, exchange, refund, etc.

There are many previously established studies on costs of quality in construction and it is important to conduct a review of them in order to show the extent of the work done. This section, therefore, gives a summary of these studies. In the study conducted by the Building Research Establishment (1982) in relation to implementation of quality management system by firms, the study found out that there are immense cost benefits a construction company stands to gain for implementing the quality management system in the firms. Specifically, the study discovered that about 15% cost savings can be attained on total cost of construction should any rework eliminated on the project.

Interestingly, the research of Hansen (1985) on failure costs for building projects executed by turnkey procurement method calculates these failure costs through archival analysis of the project documentations and interview of key specialty staff of the projects studies. The results of the study show that two of the projects recorded a failure cost of 11% of production cost, while the remaining project recorded just about 5.5% failure cost. The study adduced the reason for this disparity may be due to the method of estimation, which may have underestimated the true level cost. Josephson and Hammarlund (1996) conducted quite a number of research in the quality, especially cost of quality since 1986 through 1996. For example, issues related to defects in building projects were conducted as reported in (Josephson, 1990; Josephson, 1994; Hammarlund, *et al*, 1990; Josephson and Hammarlund, 1996).

The study of Josephson *et al*. (2002) investigated the number of errors as well as cost rework costs recorded by seven projects handled by seven different construction firms. The finding of the study shows that the projects incurred costs of rework of up to 4.4% of the contract sum. In yet another study conducted by Aoieong *et al*. (2002), a process costs model was used to estimate and evaluate the costs of quality of construction projects. The approach measured the costs attributable to construction process. The approach was validated with the use of two case studies. The result indicates that for the two companies investigated, quality costs were captured for concreting process.

The research of Kazaz *et al*. (2005) proposed the methodology for modelling the optimal level of total quality based on Turkey mass-housing project data. The output of the study centres on determining the optimal total cost of quality. The result shows a huge optimal cost of quality of up to 16.76% of the total cost was recorded. Abdelsalam and Gad (2008) investigated the cost of quality in Dubai based on data collected from residential construction projects. The study shows that the costs of quality on those projects investigated represents about 1.3% of the total cost of the project, while the optimum cost of quality was estimated to be 1.34% of the total cost of quality. The study also investigated the failure costs as estimated this to be 0.7% of the project cost. The study of Simpeh *et al*. (2012) investigated a total of 78 construction companies using questionnaire survey. The result of the study indicated that a 2.93% of contract sum was the mean of direct costs of quality recorded by those companies. Additionally, 2.20% of the contract sum was recorded as the mean of indirect costs of rework expended by the companies.

2.0 Research Methodology

Undertaking a research task of scientific inquiry requires the researcher to formulate a sound methodology for conducting the research. Bryman (2003) identifies different research designs that can be implemented for any research endeavour. These designs include experimental, cross-sectional, longitudinal, case study, comparative, and level of analysis. This research adopts the single case study approach in order to gain an in depth understanding of the problem. The case study research is defined by Yin (2003) as an empirical inquiry that investigates a contemporary phenomenon in its real life context, especially when the boundaries between the phenomenon and context are not evident.
In this single case study research, data were collected through company archive records and documents. The data are related to details of cost of quality conformance and non-conformance. Also included are the corrective action required as well as the cost of corrective action in terms of the time and resources required for corrective action. Data related to the cost of implementing and maintaining QMS in form of cost of certification, cost of managing QMS, and cost of yearly audit were collected and analysed as cost of quality conformance. Also, details relating to the cost of quality non-conformance were collected and analysed accordingly. In addition to those data, details about the company's turnover and profit before tax (PBT) were collected for the years 2011 to 2014. All those data were analysed accordingly using trend analysis, bar and pie charts, multiple bar chart and ratio analysis.

2.1 Details about the Case Study Company

The company was established in the early 80s and it has since continued to succeed and excel within it areas of specialism which are groundworks and reinforced concrete frames. It has gained a reputation as one of the best contracting companies in London and the south east of England. The company currently has a turnover of over a £100 million per annum and has become one of the leading companies in its area of specialism. The company has a distinguished track record for outstanding quality, health and safety, delivering projects on time to its clients. It also offers its client with value engineering and programming advice. The Board of Directors of the company believe that Health and Safety, environmental and quality should have equal importance as all aspects of its business. Owing to this, over the years, it has invested heavily on each of these sectors.

The company has its own training centre which is used to deliver a range of courses developed by competent professionals within the firm and which of the courses are endorsed by institutes and professional bodies. The courses range from health and safety trainings, quality management training to IOSH accredited courses for health and safety "managing safety by IOSH and Managing Environmental Responsibilities within the Group" IOSH Accredited course. The company has been accredited by British Standard Institute and is endorsed to BS EN ISO 9001, BS EN ISO 14001 standards. The company has been able to deliver projects timely and maintain high standards by having a well-integrated and robust management system. The management system include the health and safety management system, quality management system and the environment management system. The company's management system is in accordance with the ISO 9001 and 14001 standards and follows the procedures and has a set policies which guides the managers and the work force on their various sites.

All procedures on site are continuously audited by internal auditors and health and safety advisors, environmental mangers, contract manager and the quality manager. Further audits for 3rd party accreditation are done by professional bodies or institutes such as BSI, CARES Achillies to keep the accreditations.

3.0 Data Analysis and Discussion of Results

Based on the objectives of the study, data were analysed and discussed in the following Sections.

4.0 Costs of Implementing and Maintaining a Quality Management System

Data collected from the company's archival records relating to the cost of quality conformance and the cost of quality non-conformance were analysed in order to generate the total cost of implementing and maintaining the quality management system, which in essence is the cost of quality. Details about these analyses are discussed in Sections 4.1.1 and 4.1.2.

4.1 Analysis of cost of quality conformance

Table 2 gives the costs as relate to the quality conformance of the company. This consists of three different cost items, which are: cost of quality related testing, direct cost of quality related activities, and the cost of third party certification.

Table 2: Cost of quality conformance

	2011	2012	2013	2014
Cost of quality related testing				
a. Cube tank	£ 1,604.35	£ 1,637.10	£ 1,670.51	£ 1,704.61
b. Training by ESG for cube making	£ 730.00	£ 1,110.00	£ 740.00	£ 1,875.00
c. Cost of cube moulds	£ 4,560.00	£ 4,560.00	£ 4,560.00	£ 4,560.00
d. otb START system	£ -	£ -	£ 10,694.00	£ 33,050.00
e. On site calibration of survey equipment	£ 3,086.55	£ 3,249.00	£ 3,420.00	£ 3,600.00
Sub-Total 1	**£ 9,980.90**	**£ 10,556.10**	**£ 21,084.51**	**£ 44,789.61**
Direct cost of quality related activities				
Cost of Quality manager	£ 50,000.00	£ 55,000.00	£ 10,000.00	£ 65,000.00
Cost of project manager's time (30%)	£ 231,491.25	£ 243,675.00	£ 256,500.00	£ 270,000.00

Sub-Total 2	**£ 281,491.25**	**£ 298,675.00**	**£ 266,500.00**	**£ 335,000.00**
Cost of 3rd party certification				
BSI Annual Management Fee	£ 620.00	£ 620.00	£ 620.00	£ 620.00
BSI audits	£ 2,424.00	£ 2,424.00	£ 2,424.00	£ 2,424.00
Sub-Total 3	**£ 3,044.00**	**£ 3,044.00**	**£ 3,044.00**	**£ 3,044.00**
Grand Total Cost	**£ 294,516.15**	**£ 312,275.10**	**£ 290,628.51**	**£ 382,833.61**

4.1.1 Cost of quality related testing

The analysis was carried out from the year 2011 to 2014 based on the available data. Cost of quality related testing includes the cost of cube tank, cost of training for cube making, cost of cube moulds, *otb* start system, and on-site calibration of surveying equipment. These are summed up together in order to get the total cost of quality related to testing. Details of these costs are shown in Table 2. Also, Figure 1 reveals the trend of this cost over time. It shows that the cost of quality related testing grows over time as this increases on a yearly basis.

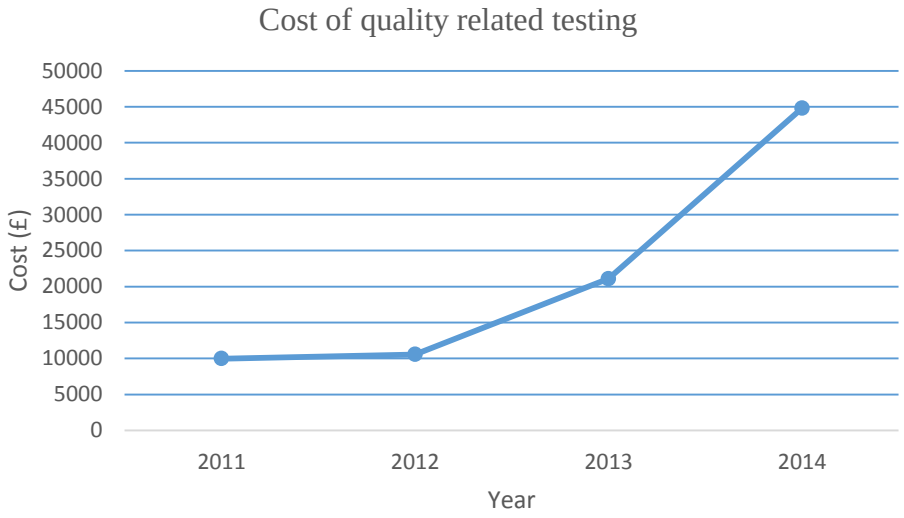

Figure 1: Cost of quality related testing

4.1.2 Direct cost of quality related activities

It is equally important to show the trend of direct cost of quality related activities. This is calculated based on the cost attributed to quality manager as well as part of the cost of project manager's time. 30% of the cost of project manager's time was taken as the time dedicated to maintaining quality standard of the project on site. This calculation is shown in Table 2. Additionally, the trend of this cost for the four years under review is shown in Figure 2. The trend reveals that this cost grows from 2011 to 2014 except for 2013, which shows a bit of decline in the figure witnessed in 2011. This result is attributed to the fact the quality manager was hired for just only two months in 2013, therefore there is a decline in the cost attributed to the cost of quality manager for that year. One interesting finding from this analysis is that direct cost of quality related activities accounted for about 95% of the total cost of quality conformance in 2011 and 2012, while this is about 91% in 2013 and 87% in 2014. The implication of this is that the direct cost of quality related activities get the lion share of the total cost of quality conformance for the company. Special attention is therefore needed to be accorded this cost.

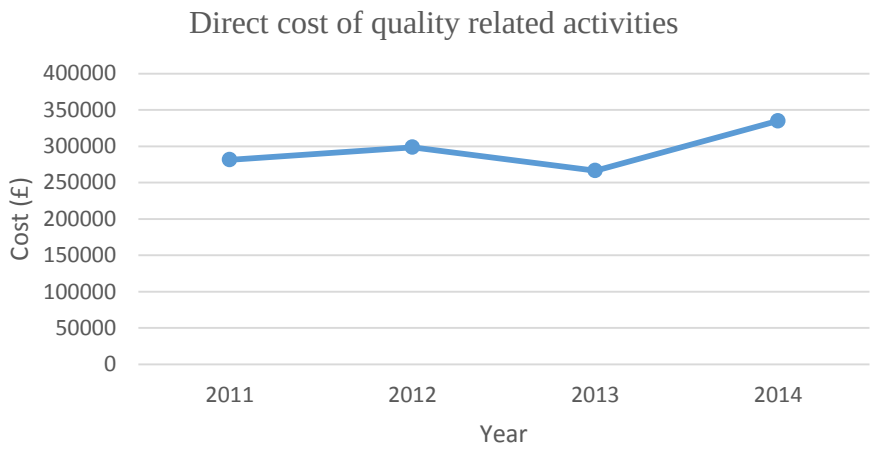

Figure 2: Direct cost of quality related activities

4.1.3 Cost of third party certification

The third component of cost of quality conformance is the cost related to third party certification. This cost, as shown in Table 2, has two items. That is, the cost as relates to the BSI annual management fee and BSI audits. For the four years under review, this cost is constant for all the years as can be seen in Figure 3. This therefore implies that there is no change in the cost of third party certification for the company.

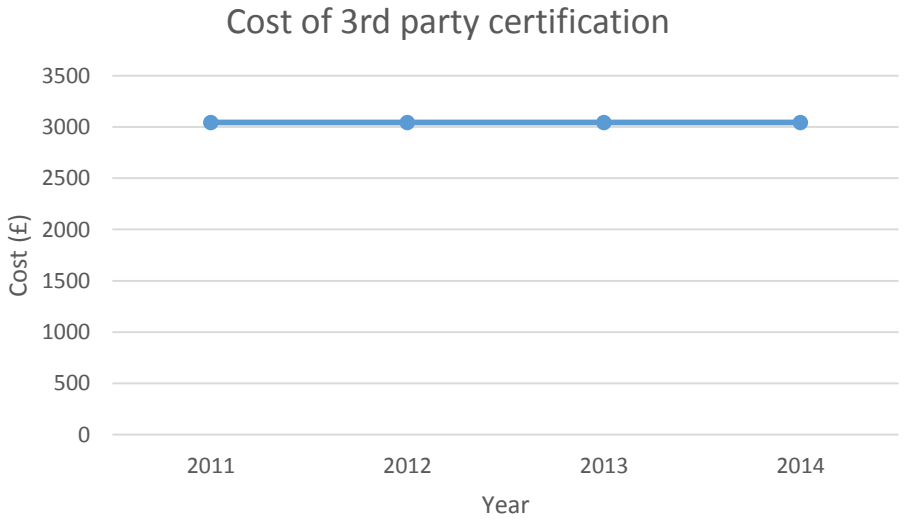

Figure 3: Cost of third party certification

4.1.4 Total cost of quality conformance

Figure 4 shows the trend of total cost of quality conformance and tabulated in Table 2. This is the summation of the three components, which are cost of quality related testing, direct cost of quality related activities, and costs associated with third party certification. Expectedly, the trend follows the pattern exhibited by the direct cost of quality related activities since it carries the largest junk of costs as discussed above under the direct cost of quality related activities. The trend shows that the cost of quality conformance increases from 2011 to 2014 except for 2013 which is lower than that of 2011. As previously explained, this was due to the fact that the quality manager of the company worked for only two months in 2013.

Figure 4: Cost of quality conformance

4.1.5 Analysis of the cost of quality non-conformance

In this Section, analysis of the cost of quality non-conformance is conducted to show the trend in this cost over four years of between 2011 and 2014. Further analysis is performed to reveal the things that are contributing to those quality non-conformance cost.

Figure 5 shows the trend in the cost of quality non-conformance from 2011 to 2014. From the graph, it is noticed that the cost of quality non-performance for 2012 jumped by about 97% when compared to 2011, the one of 2013 increased to about 113%, while that of 2014 is about 171%. This is nearly double when compared with that of 2011. The question then remains that what is responsible for this growth in the cost of quality non-conformance, even when more resources (in terms of cost of quality conformance) are committed to quality by the firm?

Figure 5: Cost of quality non-conformance

To find an answer to the question raised above, it is necessary to carry out a year by year analysis of the cost of quality non-conformance. Based on the available data, the in-depth analysis is done for the years 2014 and 2012 only. Table 3 shows the cost of quality non-conformance for 2014. For the year under consideration, 24 projects were analysed.

The costs related to non-conformance are divided into recoverable and non-recoverable costs. As the name suggests, recoverable costs are the value of non-conformance costs that are recovered back by the company based on provisions in the contract clauses. Interestingly, it can be deduced from Table 3 that only about 18.14% of the total value of non-conformance are not recovered by the company. However, it is unclear from the data supplied whether or not the time dimension as a result of rework from non-conformance is factored in the costs.

Table 3: Non-conformance analysis for 2014

Project No.	No. of NCR's	Value	Recoverable	Non-recoverable
1281	4	£ 91,051.00	£ 90,551.00	£ 500.00
1289	6	£ 2,160.00	£ 2,160.00	£ -
1294	15	£ 6,578.00	£ 3,136.00	£ 3,442.00
1296	43	£ 59,362.12	£ 58,512.12	£ 850.00
1297	13	£ 3,970.00	£ 150.00	£ 3,820.00
1298	3	£ 3,170.00	£ 3,170.00	£ -
1301	4	£ 5,500.00	£ 3,000.00	£ 2,500.00
1303	4	£ 2,173.20	£ 2,173.20	£ -
1304	8	£ 960.00	£ 360.00	£ 600.00
1307	6	£ 1,159.00	£ 1,059.00	£ 100.00
1311	11	£ 5,987.00	£ 4,026.00	£ 1,961.00
1314	21	£ 5,046.00	£ 4,544.00	£ 502.00
1317	9	£ 11,219.25	£ 604.17	£ 10,615.08
1318	10	£ 45,500.00	£ 45,500.00	£ -
1319	0			
1322	8	£ 12,731.72	£ 9,581.72	£ 3,150.00
1324	26	£ 6,356.35	£ 756.35	£ 5,600.00
1325	4	£ 680.00	£ 180.00	£ 500.00
1326	8	£ 3,798.07	£ -	£ 3,798.07
1327	0			
1328	7	£ 900.61	£ 855.11	£ 45.50
1329	7	£ 13,060.00	£ -	£ 13,060.00
1334	1	£ -	£ -	£ -
1335	1	£ -	£ -	£ -
		£ 281,362.32	**£ 230,318.67**	**£ 51,043.65**

A probe into the areas attributable to those costs reveals that non-conformance related issues in setting-out is the highest with more than 50 cases in all the projects handled by the company in the year 2014 as shown in Figure 6. This is followed by concrete in terms of service and cube failures. Other suppliers too in terms of service and quality contributed to these costs as they appear in more

than 20 cases of the company's projects in 2014. Additionally, workmanship, reinforcement, client in terms of drawings information, and other in-house issues contributed to the value of quality non-conformance costs for the year under review as shown in Figure 6.

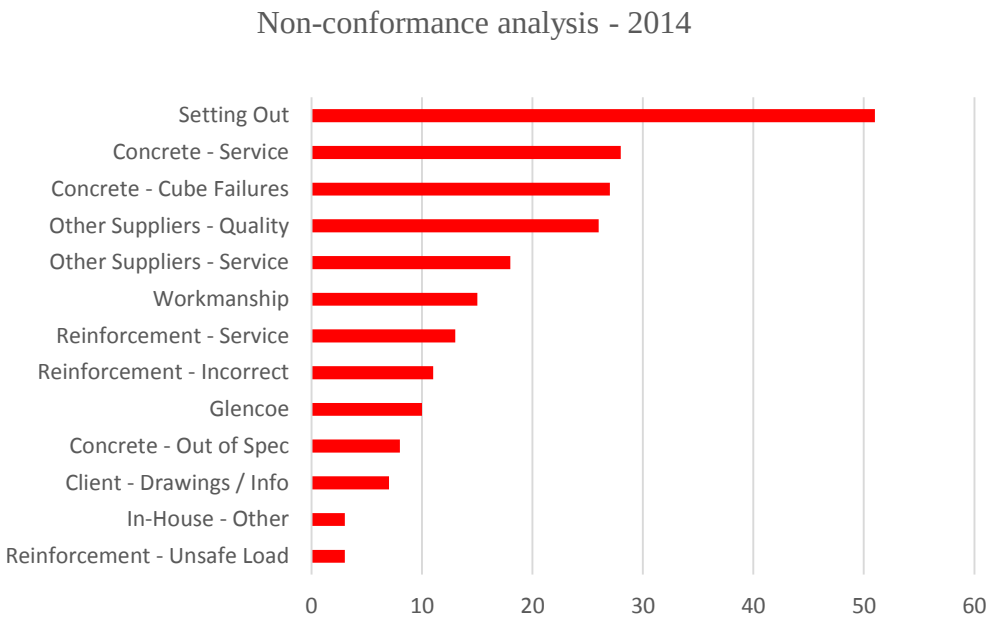

Figure 6: Quality non-conformance analysis

Furthermore, Figure 7 shows whether the quality non-conformance is based on issues from the company's side (in-house) or the supplier to the company. The analysis indicates that 69% of quality non-conformance are due to non-conformance issues from the suppliers why the remaining 31% are in-house issues. This by implication means that the company needs to pay more attention to quality issues of the suppliers.

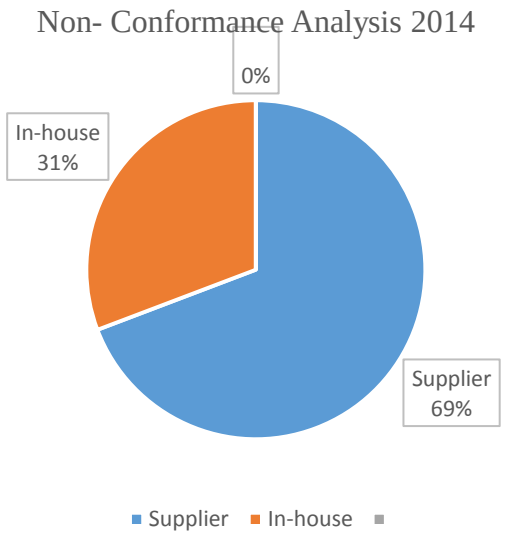

Figure 7: Quality non-conformance analysis based on parties responsible

Table 4 also gives the breakdown of the values of quality non-conformance costs for the year 2012. It is interesting to note that 21 different projects account the quality non-conformance in the year under review. Further, it can be deduced from Table 3 that about 77% of the total value of non-

conformance are not recovered by the company. This value is extremely high when compared to about 18% in the year 2014. This also suggests that some measures were put in place by the company to change the course of trajectory of this increase. Based on this result, it is however necessary to investigate the cause of high percentage of non-recoverable cost witnessed in the year 2012.

Table 4: Non-Conformance Analysis for 2012

Job Nr	Value	Recoverable	Non recoverable
1120	£ 32,650.00	£ 1,200.00	£ 31,450.00
1173	£ 1,250.00	£ -	£ 1,250.00
1179	£ 3,561.00	£ 1,890.00	£ 1,671.00
1196	£ 17,231.82	£ -	£ 17,231.82
1201	£ 240.00	£ -	£ 240.00
1214	£ 26,425.00	£ -	£ 26,425.00
1218	£ 4,297.50	£ -	£ 4,297.50
1219	£ 46,735.75	£ 22,455.75	£ 24,280.00
1221	£ 900.00	£ -	£ 900.00
1227	£ 1,489.50	£ 1,489.50	£ -
1228	£ 9,090.48	£ -	£ 9,090.48
1229	£ 4,650.00	£ 4,100.00	£ 550.00
1230	£ 20,660.00	£ 30.00	£ 20,630.00
1232	£ 3,674.30	£ 1,242.30	£ 2,432.00
1235	£ 900.00	£ -	£ 900.00
1249	£ 4,295.00	£ 3,329.00	£ 966.00
1252	£ 12,345.95	£ 8,500.95	£ 3,845.00
1254	£ 2,225.00	£ 1,325.00	£ 900.00
1255	£ 1,379.00	£ -	£ 1,379.00
1265	£ 4,096.00	£ 2,096.00	£ 2,000.00
1266	£ 6,336.18	£ -	£ 6,336.18
Total	**£ 204,432.48**	**£ 47,658.50**	**£ 156,773.98**

To trace the reason behind the high percentage of non-recoverable costs by the company, Figure 8 shed more light to this. The analysis in Figure 8 shows that quality non-conformance level related to "workmanship" issues occurred in near 200 different cases in 2012, which is more than 50% of all the cases of quality non-conformance in the year 2012. Others that contributed to the quality non-conformance include concrete placing, cube/slump test results, concrete finishes as so on. What is appalling by this result is that Figure 8 fails to give the areas of workmanship that contributed to this high non-recoverable costs by the company.

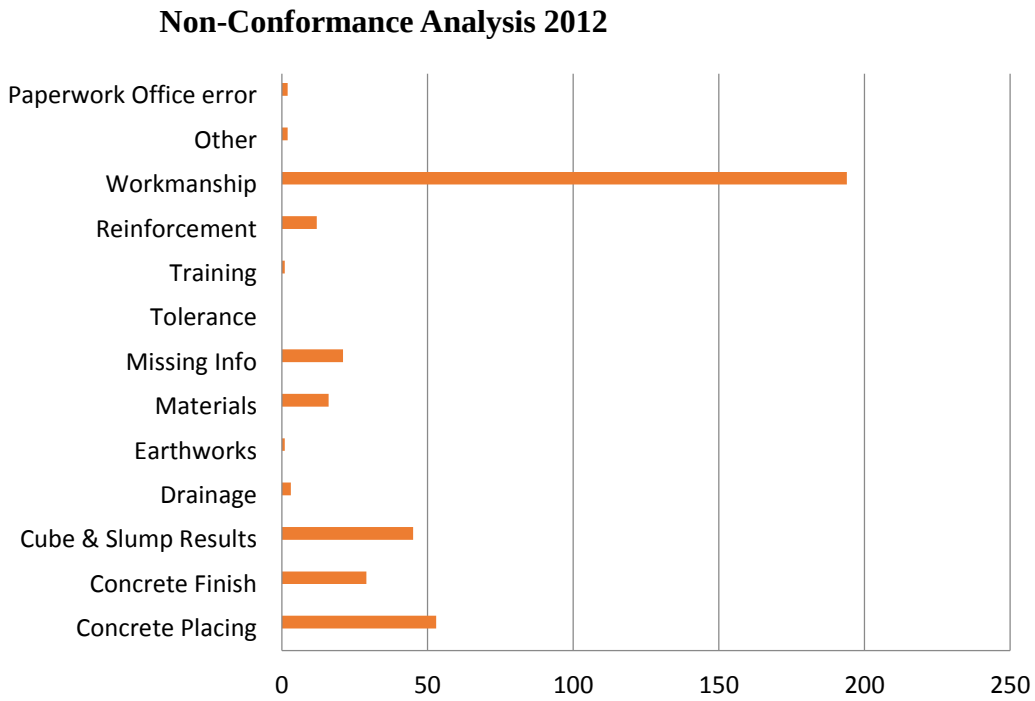

Figure 8: Quality non-conformance analysis for the year 2012

Following on from the fore, a further investigation into the quality non-conformance as relates to workmanship issues is shown in Figure 9. The workmanship analysis in the figure suggests that workmanship issues from PT gang, groundworks subcontractors, concrete gang, carpenter error, management error, engineering error, and steel fixer error are the causes of the high percentage of the non-recoverable costs witnessed in 2012. Of these causes, carpenter error is the most reported issue with about 60 cases, this is followed by engineering error (about 57 cases), concrete gang (about 35 cases) and so on. It is believed that the management of the company actually did something on this trend as the number drastically reduced in 2014 as shown in the analysis performed for 2014.

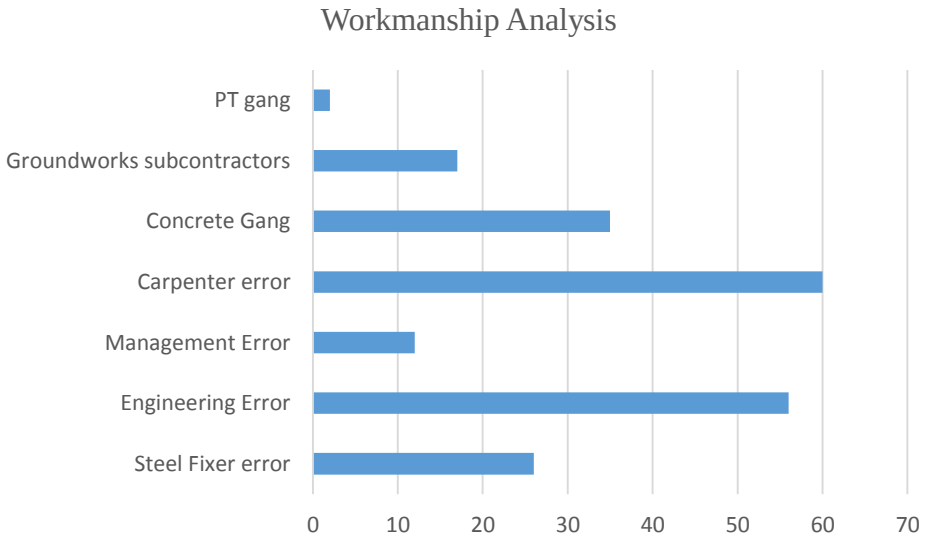

Figure 9: Workmanship analysis

4.2 Cost effectiveness of the quality management system in the RC frame Construction Company

The section of data analysis and discussion show the cost effectiveness of the quality management system in the company under study. This is demonstrated by studying the trend of the ratio of profit before tax (PBT) to turnover of the company, and the percentage of total cost of quality (TCQ) to turnover over the years. It should be noted that TCQ is separated into cost of quality conformance (CQC) and cost of quality non-conformance (CQNC) as shown in the analysis performed in Section 4.1.

Table 5 reveals the performance of the company in terms of profitability and the amount expended on quality management system for a period of four years under study. Ratios were computed in order to demonstrate whether or not the implementation of QMS has paid off for the company. The ratios that were computed are ratio of PBT to turnover, percentage of CQC to turnover, percentage of CQNC to turnover, and percentage of TCQ to turnover (Table 5, Figures 10 and 11).

Table 5: Quality management system performance

Year	Ratio of PBT to Turnover	% of CQC to Turnover	% of CQNC to Turnover	% of TCQ to Turnover
2014	0.063	0.349	0.257	0.606
2013	0.058	0.347	0.264	0.611
2012	0.068	0.359	0.235	0.594
2011	0.070	0.323	0.114	0.437

As shown in Table 5 and Figure 10, from 2011 to 2013, the ratio of company's PBT to turnover tends to decline and only marginally picked up in 2014. If 2011 is assumed to be the base year for the year-to-year comparison, the ratio declined by 2.86% in 2012 and by 17.14% by 2013 while it declined by 10% in 2014 when compared to 2011. This shows that the profitability capability of the company is on downward trend. The question to ask remains that could this be attributed to the implementation of the quality management system by the company?

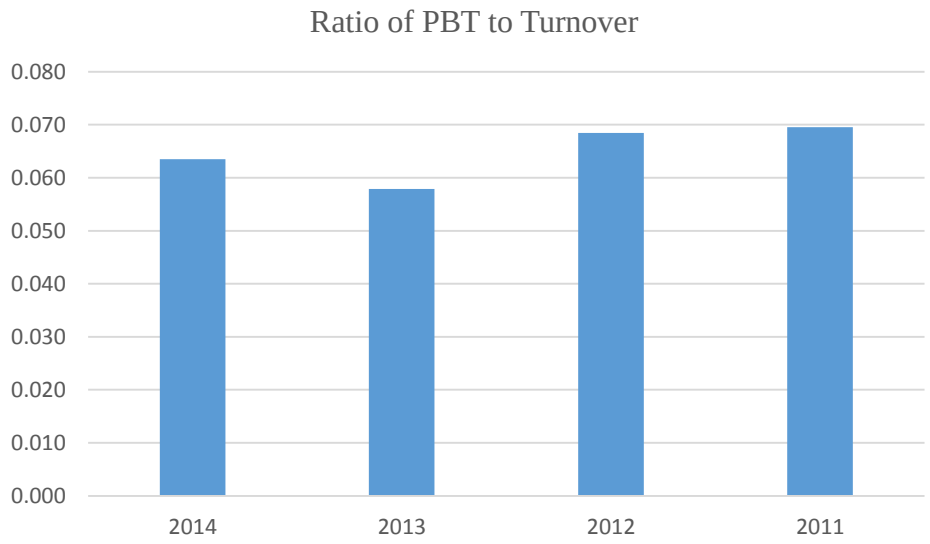

Figure 10: Ratio of PBT to turnover

To answer the question raised above, it is necessary to further investigate the trend of the percentage of cost of quality conformance to turnover, the percentage of cost of quality non-conformance to turnover, and the percentage of total cost of quality to turnover as shown in Table 5 and Figure 11. For the percentage of CQC to turnover, this is 0.323% in 2011, 0.359% in 2012, 0.347% in 2013 and 0.349% in 2014. One thing is worthy of note in the trend witnessed, there has been an increase in this cost beyond what was witnessed in the year 2011 reaching the peak so far in 2012. This same trend is witnessed for the percentage of CQNC to turnover. All the years witnessed an upward increase in this ratio compared to 2011. Although, this is not by the same margin witnessed under CQC. Apparently, for the two cases, more resources were committed to QMS of the company. The trend of percentage of CQNC to turnover seems to be the moderating factor influencing the upward trend witnessed in the percentage of TCQ to turnover.

The result as shown in Table 5 indicates that the percentage of total cost of quality to turnover committed to QMS of the company goes up by about 36% in 2012, about 40% in 2013, and about 39% in 2014 when compared to 2011. As earlier analysed, the ratio of PBT to turnover declined by 2.86% in 2012 and by 17.14% by 2013 while it declined by 10% in 2014 when compared to 2011. From this information, one may conclude that commitment of the company to QMS has rubbed off the company of some revenues in the form of profit that would have accrued into the cover of the company. It is, however, necessary to ask whether or not the evidence provided here is sufficient enough to come into this conclusion? One profound exposition into this is that about 77% of the total value of quality non-conformance are not recovered by the company in 2012. However, this value is down to about 18% in the year 2014. This shows that the implementation of QMS is paying off on its own right.

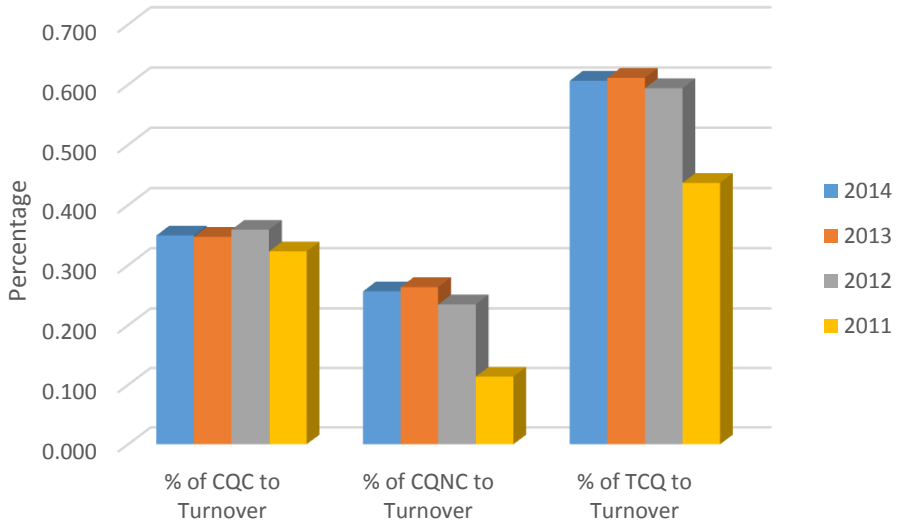

Figure 11: Figure showing the quality management system performance

5.0 Conclusions

This research has explored the quality management system in a reinforced concrete frame construction company. The study made an exposition into how a construction company has been able to meet the demand and needs of their customers by putting in a place a robust quality management system. And also, demonstrate whether or not the implementation and maintenance of quality management system is cost effective. The conclusions from the research can be summarized as follows:

- High cost of management of the quality management system is one of the side effects of implementing and maintaining a quality management system.

- The profitability capability of the company is on the downward trend.
- The implementation of the quality management system is paying off on its own right.

The main limitation of this study is that the outcome of this research may not be generalised because the findings of the study is based on only one company. Also, the amount of data collected that are related to company's balance sheet limits the extent of data analysis performed for objective four of the study. Furthermore, the study is limited in the sense that the extent of data collected from the company, is for only four years. This shows that the company has not practised QMS for many years. This may likely limit the generalisation of the results.

While this research sheds insight into the quality management system of a reinforced concrete frame company, one of the areas that researchers need to give attention, is the conduct of more research studies on quality management systems in construction companies. This should be done in order to create an industry norm and make the findings more general. It is also recommended that further studies should be conducted in this research enclave by extending the number of years of data collected. This should be in excess of ten years in order to properly study the trend of quality management system by the companies and demonstrate whether or not the implementation of the quality management system is cost effective.

References

Abdul-Rahman, H. (1993). Capturing the cost of quality failures in civil engineering. International Journal of Quality and Reliability Management. 10, 3, 20-32.

Abdul-Rahman, H., Thompson, P.A. and Whyte, I.L., (1996). Capturing the cost of non-conformance on construction sites: An application of the quality cost matrix. International Journal of Quality & Reliability Management. 13, 1, 48-60.

Al-Momani, A.H., (2000) Examining service quality within construction processes, *Technovation*, 20, 11, 643-651.

Aoieong, R. T., Tang, S. L. and Ahmed, S. M., (2002). A Process Approach in Measuring Quality Costs of Construction Projects: Model Development. *Journal of construction Management and Economics*. 20, 2, 179-192.

American Society for Quality (2013). Quality Glossary. http://asq.org/glossary/q.html [Accessed 5 May 2013]

Building Research Establishment (BRE), (1982). Quality in Traditional Housing. An Investigation into Faults and their Avoidance. London: HMSO. 1.

Bryman, A., (2003). *Business research methods*. Oxford University Press, Oxford.

Building Research Establishment (BRE), (1982). Quality in Traditional Housing. An Investigation into Faults and their Avoidance. London: HMSO. 1.

Campanella, J. (1990). *Principles of quality cost*, 2nd edn, ASQC, Milwaaukee.

Chin, S. Kim, K. and Kim Y.S. (2003). A process-based quality management information system, Automation in Construction, 13, 2, 241-259.

Castelvecchi, J.P.E., (2003). Business and Management: Improving Profits by Reducing Rework. *ASHRAE Journal*. 45, 11, 62-64.

Crosby, P. B., (1979). *Quality is free: The art of making quality certain*. London: McGraw-Hill.

Dahlgaard, J.J., Kristensen, K. and Kanji, G.K., (1992). Quality costs and total quality management. Total Quality Management. 3, 3, 211-221.

Department for Communities and Local Government, (2010). The Building Regulations 2010: Materials and Workmanship 7. http://www.planningportal.gov.uk/uploads/br/BR_PDF_AD_R7_2013.pdf

Freiesleben, J., (2005). The opportunity costs of poor quality. The Quality Assurance Journal. 9, 1, 3-10.

Feigenbaum, A. V., (1951). *Quality Control: Principles, Practice and Administration.* New York: McGraw-Hill.

Hansen, R., (1985). Kvalitetssikring og kvalitetskostnader, Hovedoppgave, Institute for anleggsdrift, Norges Tekniske Hogskole, Trondheim, Norway.

Hammarlund, Y., Jacobsson, S., and Josephson, P.E. (1990). Quality failure costs in building construction. Proc., CIB W55/W65 Joint Symposium, International Council for Building Research Studies and Documentation, Sydney, Australia, 77-89.

Josephson, P. E. (1990). Quality in building construction—A discussion on costs of internal quality failures. Report 25, Department of Building Economics and Construction Management, Chalmers University of Technology, Gothenburg, Sweden.

Josephson, P. E. (1994). Causes of defects in building: a study of causes and consequences of defects, and impediments of learning in building projects. Report 40, Department of Building Economics and Management, Chalmers University of Technology, Gothenburg, Sweden.

Josephson, P. E. and Hammarlund, Y. (1996). The costs of defects in construction. The organisation and management of construction: Shaping theory and practice, D. D. Langford and A. Retik, eds. 2, 519-528.

Josephson, P. E., Larsson, B. and Li, H. (2002). Illustrative benchmarking rework and rework costs in Swedish construction industry. *Journal of Management in Engineering*. 18, 2, 7683.

Kazaz, A., Birgonul, M.T. and Ulubeyli, S., (2005). Cost-based analysis of quality in developing countries: A case study of building projects. *Building and Environment*. 40, 10, 1356-1365.

Ledbetter, W.B., (1994) Quality performance on successful projects. *Journal of construction engineering and management*, 120, 1 , 34-46.

Love, P.E.D. and Sohal, A. S., (2003). Capturing rework costs in projects. Managerial Auditing Journal. 18, 4, 329-339.

Low, S. P. and Yeo, K. C., (1998). A construction quality costs quantifying system for the building industry. *International Journal of Quality and Reliability Management*. 15, 3, 329 - 349.

Rosenfeld, Y. (2008). Cost of quality version cost of non-quality in construction: the crucial balance.

Said, I., Abidin, N. Z., & Shafiei, M. W. M. (2006). Management responsibility and business performance between ISO 9000 and non-ISO 9000 certified contractors in Malaysia. http://www.fab.utm.my/download/ConferenceSemiar/ICCI2006S1PP10.pdf [Accessed 11 January 2008]

Simpeh, E.K., Ndihokubwayo, R., and Love, P.E.D., (2012). Evaluating the direct and indirect costs of rework. Association of South African Quantity Surveyors. Durban. Jun. Available at: http://works.bepress.com/ruben_ndihokubwayo/24. [Accessed June, 2015].

Tariq, A. N. (2002). Organisational context and its impact on level of quality management in small and medium scale enterprises of Pakistan. PhD dissertation, Universiti Putra Malyasia, Malaysia.

Willis, T.H. and Willis. W.D., 1996. A quality performance management system for industrial construction engineering projects. *International Journal of Quality & Reliability Management.* 13(9), 38-48.

Yin, R.K. (2003). *Case Study Research*. London: Sage