Factors Affecting Quality of Reinforced Concrete Building Construction in Dar ES Salaam, Tanzania

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Abstract: **The complexity of the nature of construction makes it one of the most adverse business that has ever existed. Construction projects have often suffered from poor quality, large waste, poor productivity, time and cost overruns for a long time. Many new and innovative management systems such as Just in Time (JIT), Quality Function Deployment (QFD) and Total Quality Management (TQM) have been introduced in construction to meet these challenges. It is considered that in order for the innovative management systems to function in reinforced concrete (RC) building construction, root cause of the problems should first be addressed. Literatures have established various factors affecting quality in RC building construction process especially in the design and construction phases. Research was carried out to determine whether the factors are significant in the Tanzanian context and the order in which the factors affect quality of RC building construction in Tanzania.**

Keywords: **Factors, Quality, Reinforced concrete, Building, Construction industry.**

1. INTRODUCTION

Construction industry has always been an essential part of a nation's economic growth and a reflection of the social aspirations of its people. In many ways, the pace of the economic growth of any nation can be measured by the development of physical infrastructures such as buildings and roads (Takim & Akintoye, 2002). Its share to the total GNP is on average 10% in almost every country (Aspinwall & Delgado, 2008). The value added in construction has a multiplier effect by stimulating business in auxiliary and secondary industries (Baradyana, 2000). Construction industry has higher capacity to generate employment than the rest industrial sector ILO (2001). Despite of its importance, construction industry is blamed to have underperformed compared to other industries (Haseeb & Huang, 2013; Wanberg *et al*., 2013; Shofoluwe *et al.*, 2012). It is considered that full potential of the industry has not been realized (Ofori, 2012). It is well established that the project cost, time, and quality are core elements that contribute to project success as well as the main factors concerning the client (Wanberg *et al*., 2013; Rad & Khosrowshahi, 1998; Bowen *et al*., 1998). For the majority of projects, cost and time parameters are the main preoccupying factors (Delgado, 2006; Love *et al.,* 2005; Rwelamila & Hall, 1995 cited in Rad & Khosrowshahi, 1998). According to Rad and Khosrowshahi, 1998 project quality is often taken for granted and inadequate attention has not been given to this parameter. Quality is one of the important key performance indicators of a construction project (Khattak *et al*., 2015). Failure to attain required quality in construction considerable time and other resources are wasted (Round *et al.,* 1985). This paper aims to examine factors affecting quality of reinforced concrete buildings construction in Tanzania. The research takes a holistic approach to the study of building process by investigating factors affecting quality in the design and construction phases of building projects in Tanzania.

2. LITERATURE REVIEW

2.1 Definition of Quality:

Quality can be defined as conformance to requirement of a project (Crosby, 1979 cited in Suarez, 1992). Quality can also be defined as meeting the legal and functional requirement. According to Arditi and Gunaydin (1999) requirements may be simple or complex, or they may be stated in terms of the end result required or a detailed description of what is to be done. As it is argued by Arditi and Gunaydin (1999) law defines quality in terms of professional liability a legal liability that requires professionals to know their profession and practice it responsibly. On the other hand quality can be defined from the function view point, by how the project conforms to its requirements (Lema, 1996). Using this definition a quality project can be described by terms such as ease in understanding drawings, level of conflict in drawings and specifications, economics of construction, ease of operation and ease of maintenance (Delgado, 2006; Arditi & Gunaydin, 1999). In the construction industry Arditi and Gunaydin (1999) defined quality as meeting the requirement of the designer, contractor, regulatory authorities as well as the owner. In addition there is a difference between product quality and process quality. According to Nagasaku and Oda 1965 cited in Arditi and Gunaydin (1999) product quality is the quality of the elements directly related to the physical product itself while process quality is the quality of the process that causes the product to be either acceptable or not

2.2 Factors Affecting Quality of RC Building Construction in Tanzania:

The aim and objective of the building sector is to provide buildings of the required quality for the whole community (Ayodeji, 2011). Establishment of the project requirements for quality begins at the inception (Arditi & Gunaydin, 1999). Project requirements are the key factors that define quality in the process of construction (Delgado, 2006). The process of construction can be broken down into three main phases (Delgado, 2006; Baradyana, 2000; Arditi & Gunaydin, 1999) namely (1) the planning and design phase (2) the construction phase, and (3) the maintenance and operation phase. Factors that affect quality in design and construction phases of of the construction process have been identified through literature review and are discussed in the following sections.

2.2.1 Construction Supervision:

Construction supervision is important to achieve good quality of the constructed building structure. NCC (2017) and Rubaratuka (2013) reported that some supervising consultants do not provide adequate supervision and as a result some contractors do not adhere to design specifications as well as good construction practices. The audit conducted by NAO (2014) cited in NCC (2017) observed that 19 of the 51 projects audited showed poor quality which was attributed to poor supervision by consultants. Also PPRA (2012) cited in NCC (2017) conducted value for money audits of 137 construction project carried out by Local Government Authority (LGAs) in Tanzania financial year 2011/12 and provided further evidence of poor performance on the part project supervision by consultants.

2.2.2 Code of Design and Practice:

The popular British Standards that are commonly used in the building industry in Tanzania need to be updated for local use in Tanzania (Makenya & Nguluma, 2007). According to Makenya and Nguluma (2007) the standards should include basic factors such as climatic conditions giving examples of materials like earth bricks and cement-sand mixture which have thermal conductivity (k) of 0.14 W/mK and 0.53 W/mK respectively which are considerably low. In the absence of a national code of practice, the design and construction of most of reinforced concrete structures are carried out using foreign codes namely British Standards (BS) which in most cases are not directly applicable to local conditions (Rubaratuka, 2013). According to Rubaratuka (2013) some of partial safety factors for material and loading for BS are not directly applicable locally therefore applying them in Tanzania in some cases, may not be appropriate and may affect quality and durability of a building structure.

2.2.3 Lack of Adequate Construction Technology:

Lack of construction technology has been considered as a factor affecting quality of RC building construction. According to Rubaratuka (2013) investigation carried in Dar es Salaam revealed that poor workmanship and hence poor quality in RC building construction is partly a result of lack of adequate skilled labourers qualified and committed technical staff and lack of proper tools and equipments to undertake construction works.

2.2.4 Lack of Coordination among Construction Key Stakeholders:

Coordination of key stakeholders is considered to affect quality of RC building construction. Jha (2005) cited in Hai *et al*. (2012) concluded that coordination between construction project participants is the most significant factor, saying that lack of coordination may also cause duplicity of work. According to NCC (2017) professional bodies i.e. CRB, AQRB and ERB are primarily concerned with the availability of professionals at the projects sites and their involvement in the projects in Tanzania. There is no coordination among three professional bodies in Tanzania (i.e. CRB, AQRB and ERB) as their inspectors visit project sites separately and as a result, there has been overlap of functions and activities between them (NCC, 2017). The professional bodies (i.e. CRB, AQRB and ERB) and other authorities (i.e. NCC and Municipal councils) are involved in building construction processes but none acti as a central body that collects, stores and analyse information about project particulars and team of professionals involved, capacity of professional personnel in terms of education, experience, quality of work, working drawings, plants and equipment available at the site for the benefit of the construction industry (NCC, 2017).

2.2.5 Quality of Concrete:

Concrete quality is reported as one of the causes of building collapse (Rubaratuka, 2008, 2013). A study carried by Figueroa (2014) in East Africa, showed that low cement content was the most frequent cause of RC building failure in East Africa. According to Figueroa (2014) concrete is one of the most abundant construction materials in East Africa, and cement accounts for close to 70% of the cost of the materials in concrete. Theft, errors and fraud related to cement is not easier to detect and it is easy to get market of cement in the construction site vicinity. Therefore low cement content detected in the concrete (Figueroa, 2014) was linked to theft. On the other hand steel is the structurally dominant component in reinforced concrete (Figueroa, 2014) but theft, errors and fraud related to reinforcement steel bars are easier to detect and it is not easy to get market of the same in the construction site vicinity.

2.2.6 Inadequate of Quality Construction Materials:

Inadequate of quality construction materials is reported in various forms. NCC (2017) reported that the mushrooming of brickyards that make and sell substandard bricks is just one aspect of the mess in the construction sector that industry sources blame on lack of building code and effective regulator (Rubaratuka, 2008, 2013). When a brick is finally out, some parameters should be clear: the sand-cement ratio, quality of water and sand, type of cement used, and the kind of compression applied in making the brick. As claimed by NCC (2017) it is not known who does the checks to ensure that the bricks have been sufficiently cured before they are put up for sale. Tanzania construction industry is seen as becoming a dump ground for poor quality products (NCC, 2017). Contractors Registration Board (CRB) called for concerted efforts by all stakeholders towards raising the quality of construction materials to guarantee the safety of buildings and other structures. The then CRB Registrar, Eng. Boniface Muhegi, the then Registrar of the Engineers Registration Board (CRB) was quoted telling the 'Daily News' newspaper in Dar es Salaam cited in NCC (2017) that it was high time key stakeholders in the construction sector - contractors and their clients - work together towards identifying genuine materials before deciding on the purchase. Again Eng. Mlote was quoted in the Citizen newspaper cited in NCC (2017) that "*shops are full of iron bars made of scrap in backyard factories. They use these iron bars to erect high-rise buildings, but they are not useful. It is all over the country*". According to NCC (2017) the consequences of using sub-standard bricks or other poor quality building materials is that home owners and the government are forced to pay twice or thrice the amount of a project completed using substandard materials.

2.2.7 Involvement of Quacks and Incompetent Professionals:

Involvement of quacks and incompetent professionals in building construction process affects quality of final building product. As noted by Nkori (2017) following factors related to involvement of quack and incompetent professional affects quality of building construction: (1) abuse of business names, where unfaithful contractors collude with developers to contravene the contractor's registration Act, (2) construction sites without registered contractors and it has been difficult for CRB taking legal action because of lack or misrepresentation of defaulters' information. According to Agwu (2014) building clients mostly individuals, have a penchant for cutting corners by not employing qualified contractors and consultants in the building construction as they want to spend minimum (not optimum) amount of money on the construction. Other indication of involvement of quacks and incompetent professionals is noted in a study by

Nkori (2017) which showed that 14.8% of building project studied did not register their project, 4.2% did not erect sign board, while 3.4% used non registered contractors.

3. METHODOLOGY

Factors affecting quality of building construction were identified through literature. In literature review past researches from both developed and developing countries had been studied. Key construction players (i.e. consultants and contractors) were requested to indicate impact of the factors affecting quality of reinforced concrete (RC) building construction in Tanzania by a research schedule. The consultants and contractors were to respond by indicating numbers in a five (5) points Lickert scale, where 1 indicated very low impact while 5 indicated very high impact. Unit of analysis for this study is buildings, therefore RC buildings which were under construction in Dar es Salaam central business district (CBD) were surveyed where consultants and contractors involved in the construction of these buildings were requested to respond to the research schedules. On one hand, Dar es Salaam CBD was purposive selected because all reported incidences of building collapse occurred in Dar es Salaam CBD. On the other hand RC buildings under construction were randomly selected.

3.1 Reliability Test:

This study conducted internal consistency test to test reliability of its interview schedule used for primary data survey/collection. Cronbach's alpha (α) test was used to test internal consistency of the interview schedule for reliability and level of random error. A Cronbach's alpha (α) test was conducted using Statistical Package for Social Sciences (SPSS) software. Minimum acceptable value of alpha is 0.5 to 0.6 (Ogwueleka, 2011 cited in Inuwa 2014; Tavakol *et al*. 2011). Table 1 shows the SPSS results of the Cronbach's alpha (α) test.

Table 1: Cronbach's Alpha (α) for the factors affecting quality of RC buildings

Measurement	No of Item	Cronbach's Alpha (α)	Reliability status
Factors affecting quality of RC building construction	11	0.74	Good

Source: Author (2017)

3.2 Data Analysis:

This research used the non-parametric chi-square goodness of fit test to test its hypothesis (McNabb, 2009; Kothari, 2004). This is a predictive test used to determine whether there is difference between observed and expected frequencies of the sample distribution. SPSS software was used to compute mean values and p-value for the goodness of fit test. Formula for computing chi-square (χ^2) is given (McNabb, 2009; Kothari, 2004) as:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Where:

χ^2 = Chi-square,

O_i = Observed frequency, and

E_i = Expected frequency.

4. STUDY RESULTS AND DISCUSSION

4.1 Results of the Analysis:

Results of the responses from contractors and consultants on factors affecting quality of RC building construction in Tanzania are shown Figure 1. The results show that there is no significance difference of opinion between contractors and consultant on the factors affecting quality in RC building construction.
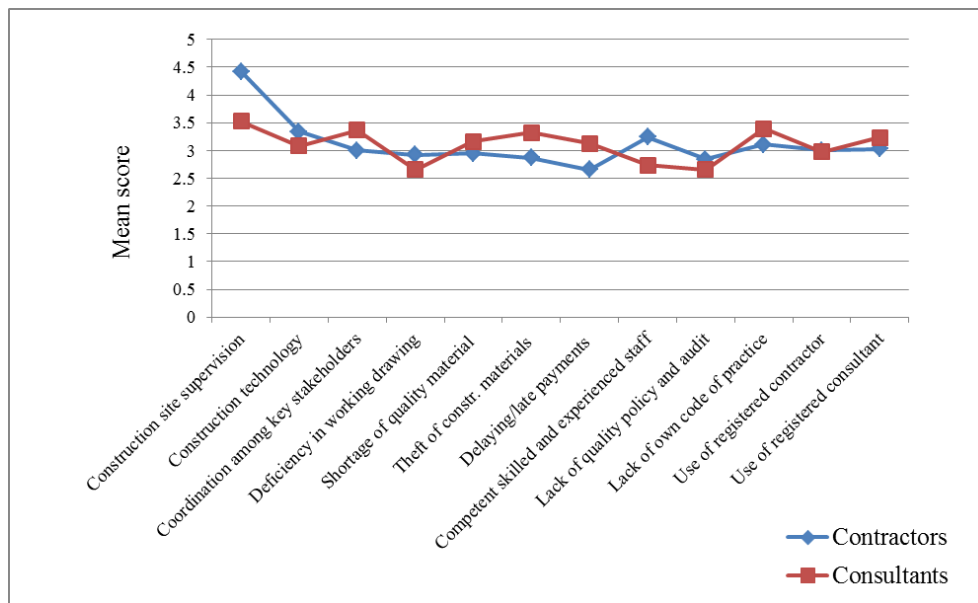
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Figure 1: Factors Affecting Quality of RC Buildings Construction

Source: Author (2017)

Table 2 depicts results of groups' (contractors and consultants) assessment on factors affecting quality of RC Buildings Construction and Table 3 depicts results of combined groups' (contractors and consultants) assessment on factors affecting quality in RC building construction in Tanzania.

Table 2: Groups' assessment on factors affecting quality in RC building construction

Challenges to achieve required quality	Contractors			Consultants		
	Mean	SD	Rank	Mean	SD	Rank
Lack construction supervision	4.42	.500	1	3.53	.687	1
Lack of construction technology	3.34	.481	2	3.08	.587	8
Lack of coordination of key stakeholders	3.00	.403	6	3.37	.633	2
Deficiency in design	2.92	.487	8	2.66	.534	11
Lack of quality constr. materials	2.95	.517	7	3.16	.495	6
Theft of construction material	2.87	.578	9	3.32	.471	4
Delaying/Late payment	2.66	.481	11	3.13	.578	7
Inadequate skilled & experienced staff	3.24	.431	3	2.74	.601	10
Lack of quality policy	2.86	.547	10	2.66	.481	11
Lack of design code of practice	3.11	.649	4	3.39	.495	3
Use of unregistered contractors	3.00	.592	6	2.98	.592	9
Use of unregistered consultants	3.03	.592	5	3.23	.592	5

Source: Author (2017)

Table 3: Combined Groups' Assessment on Factors Affecting Quality in RC Buildings Construction

Challenges to achieve required quality	Mean	SD	Rank
Construction supervision	3.975	0.594	1
Lack of own code of practice	3.250	0.572	2
Inadequate construction technology	3.210	0.534	3
Lack of coordination of key stakeholders	3.185	0.518	4
Theft of construction materials at site	3.095	0.525	5

Challenges to achieve required quality	Mean	SD	Rank
Shortage of quality materials	3.055	0.506	6
Use of registered consultants	3.030	0.592	7
Use of registered contractors	3.030	0.592	7
Inadequate skilled & experienced staff	2.960	0.453	8
Delaying/late payments by clients	2.895	0.530	9
Deficiency in working drawings	2.790	0.511	10
Lack of quality policy and audit	2.750	0.514	11

Source: Author (2017)

4.2 Hypotheses Testing Results:

This study tested null hypothesis. The null and corresponding alternative hypotheses are as shown below.

Ho: Factors affecting quality of RC building construction in Tanzania are not significant.

Ha: Factors affecting quality of RC building construction in Tanzania are significant.

Decision rule: Null hypothesis will be rejected if the computed p-value is less than 0.05 confidence level for the test (McNabb, 2009; Kothari (2004). Results from the SPSS hypothesis testing gave computed p-value of 0.000 which is less than 0.05 confidence level. Hence null hypothesis was rejected implying that factors affecting quality of RC buildings in Tanzania are significant.

4.3 Discussion of the Results:

Table 3 shows that construction supervision is the highest factor affecting quality in RC buildings construction, with mean of 3.975 leaning to 4.0. Lack of own code of practice was ranked second with mean of 3.250, lack of construction technology was ranked third with mean of 3.210, lack of coordination of key stakeholders is ranked fourth with mean of 3.185, theft of construction materials at construction site was ranked fifth with mean of 3.095, shortage of quality materials was ranked sixth with mean of 3.055, use of registered consultants, and use of registered contractor were both ranked seventh with mean of 3.030. The second ranked factor up to seventh ranked factors are all above mean of 3.0 but leaning more to 3.0 implying that they are all moderately affecting quality of RC buildings construction in Tanzania. Other factors affecting quality of RC building construction in Tanzania according to results in Table 3 is: inadequate skilled & experienced staff, ranked eighth with mean of 2.960; delaying/late payments was ranked ninth with mean of 2.895; deficiency in building design as appearing in working drawings is ranked the tenth with mean of 2.790; and lack of quality policy and audit was ranked eleventh with mean of 2.750. From the eighth ranked factor to eleventh factors all are below mean of 3.0 but leaning to 3.0 implying that, they are also moderately in affecting quality of RC building construction.

These results are confirmed by the results of the hypothesis. Null hypothesis of was rejected and accepting alternative hypothesis that "**Factors affecting quality of RC buildings in Tanzania are significant**". Moreover, these results agree with a study by Hollway (2000) cited in NCC (2017) that consultants in Tanzania lacked both knowledge and experience. The study by NCC (2017) also support this study by the findings that, lack of properly trained, qualified and competent project managers have resulted poor quality of construction projects in Tanzania. The study by NCC (2017) advanced that registered consultants in Tanzania whether local or foreign do not always perform their duties as required. Furthermore, results of this study objective are in conformance to the study by Rubaratuka (2013) that, design deficiencies, poor construction technology and inadequate construction supervision are challenges of the quality of RC buildings in Dar es Salaam, Tanzania.

As per views of the author, the above factors can be divided into three groups i.e. factors requiring intervention at national level, factors that require attention of an organization and factors that requires attention of building owners. Factors involving lack of code of design and practice for design of RC structures, lack of proper construction technology of construction teams, lack of coordination among key stakeholders of construction industry, shortage of quality construction materials in the market, inadequate skilled and experienced staff in construction industry, delay or late payments by clients and lack of quality policy and audit in construction industry falls under factors that requires attention at national level. Factors that require attention at organization level is facilitation of supervision during building construction and theft control of construction materials at construction site. Where factors such as use of registered consultants and registered

contractors is within the capacity of clients. For the purpose of reducing construction costs individual building construction owners (clients) agrees with unfaithful consultants and contractors to use consultants or contractors names in the construction sign board for certain payment.

5.   CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion:

Quality of RC buildings in Tanzania is affected by a number of factors (i.e. inadequate s*upervision, lack of code of practice, inadequate construction technology, lack of coordination among key stakeholders, use of unregistered contractors/ consultants, deficiency in working drawings, inadequate skilled and experienced staff*). Some of the factors may result failure and finally building collapse. There is a great potential for quality improvement in the construction industry. In today's competitive world, the term quality and its concepts are very important for the construction industry. There are not much resources to waste, failures and reworks are not acceptable. As in the manufacturing industries, the construction industry should focus on process quality. TQM and its principles do apply to the construction, TQM philosophy of prevention is vital in RC building construction.

5.2 Recommendations:

This study indicates that future strategies and potential developments should base on the following findings. Clients, consultants, contractors and construction regulatory authorities should consider the following points in developing their quality management systems.

i)   Construction project should be considered as a process where all phases of building construction must conform to their quality requirement.

ii) Clients must use registered consultants and contractors in their requirement for building construction. Also the clients should promptly pay their consultant and contractors after they have raised their certificate for payment within the specified contractual time to avoid unnecessary complaints, constructions works stoppages and disputes.

iii) Consultants should make drawing with all necessary derails as required for build ability. Drawings and specifications provided must be clear, concise and uniform. Moreover, the consultants should carry out proper supervision during construction phase when a building construction is under their supervision.

iv) Contractors should control any kind of theft of construction materials stored at construction site

v)   The Tanzanian government through the appropriate regulatory body and training institutions should make sure that the following are implemented within shortest time possible:

a) Own code of design and practice for RC buildings construction is developed

b) Do away with presence of poor quality construction materials in the market and make available good supply of quality construction materials in the market.

c) Quality management as well as construction technology training and education should be conducted to all building construction practitioners. Also, modalities should be sought to provide on the job training to all building construction practitioners.

d) National Construction Council should coordinate all the construction regulatory authorities for better carrying out their duties in construction industry.

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