MODELLING OF TOTAL QUALITY MANAGEMENT FRAMEWORK IN CONSTRUCTION PROCESS

Mwidini Kassim Kiombile[1, a], Vitalis Agati Ndume[2, b]

[1]Tanzania Buildings Agency, P.O. Box 902, Dodoma, Tanzania
[2]Dar es Salaam Institute of Technology, P.O. Box 2958, Dar es Salaam, Tanzania
[a]mwidini.kiombile@tba.go.tz, [b]ndumev@gmail.com

ABSTRACT

The purpose of this study was to model the total quality management framework in construction process in Tanzania. The study analyses the critical success factors that contribute to the implementation of total quality management in the construction process. To achieve the objective, a survey was conducted where questionnaires were distributed to construction firms in Dar es Salaam. The data were analysed statistically using Average index (A.I). The assessment of Critical success factor was analysed by grouping a total of 23 subject items into 6 dimensions of subject items. The average index was applied to each factor and those factors with low average index (5.661) were described as strong disagreed while those factors with higher average index (7.563) were described as strong agreed. The findings indicate that the most tested critical success factors that contribute to the implementation of total quality management in construction process were supply chain management, process management, customer focus, and continuous improvement. Others were management and leadership as well as employee satisfaction. This study concludes that when the quality implementation is patchy and not uniformly functioning in the construction firms then in case of time constrained projects and events with diverse customer characters set, it will be difficult to meet the agreed customer requirement. Therefore, a mechanism should be developed to minimize the gap between the supply management and the customer focus. A proper method is required to incorporate the voice of customer in the design process. To achieve this goal, total quality management framework and modelling is required to attain maximum satisfaction of customer.

Key words: Total Quality Management, Quality, TQM, Construction Management, TQM model, Average Index

1.0 INTRODUCTION

Total quality management (TQM) describes a management approach to long-term success through customer satisfaction. TQM is a strategic approach to business improvement (Vicky et al., 2001). In TQM, efforts of all members of an organization participate in improving process, products, services and culture in which they work (Giri M. 2014). It is an integration of quality and management tools aimed at increasing the business and reducing loses due to wasteful practices. According to Pheng et al. (2004), much time, money and resource both human and materials are wasted each year due to inefficient or non existent quality management procedure.

Twaiss and Graham (2008), add that many analytical studies conducted in different countries show that, there is scarcity of information about the nature and stage of TQM implementation

in other regions of the world including South America, Africa and Middle East. It is argued that failure in the implementation of TQM is a result of the mismatch in an organizational culture (Cheng et al, 2011). It is also noted that for a success of TQM organizational participants should have a clear and common understanding and agreement on approach towards achieving the quality goals. The total quality management framework is built upon a set of core values and factors which are the foundation for integrating the key performance requirements within quality framework. The TQM is the cream of the crop (Inmon et al., 2019). Critical Success Factors (CSF) are the basic factors of TQM that are used in the design of total quality management framework. The construction firms should realize that a key area to ensure commercial success is a good quality product (Delgado, 2008). The design of the framework model includes the design requirements procedure, identification and facilities of measures from a data bank (Chang *et al*., 2008).

Many researchers developed various framework and model based on the nature of their research. Schofield (2010) produced the process focused operation requirements frameworks to synthesize program, sponsor and technical authority of construction requirements. A generic framework that focus on high level system engineering view point to ensure that all requirement process and interaction are understood simultaneously.

2.0 THE RESEARCH METHODOLOGY

The study area was in Dar es Salaam City of Mainland Tanzania in East Africa. The questionnaires was used as an instrument of collecting data by delivered hand in hand in hard copies to construction firms in the Dar es Salaam city. The data analysis process was governed by quantitative data which were analysed by using Statistical Package for the Social Science (SPSS). Determination of the critical success factors was the key foundation of this study. Each factor was analysed by computing the average index (A.I). The computational of an average index was adopted in a report by (Enshassi *et al*, 2007). The following formula was applied.

Average Index (A.I) =

$$\left(\left(1*n_1\right) + \left(2*n_2\right) + \left(3*n_3\right) + \left(4*n_4\right) + \left(5*n_5\right)+\ldots\ldots+k*n_k\right)/N \qquad (2.1)$$

Where N= Total number of Respondents,

n_1= Frequency of Strongly Disagree
n_2=Frequency of Disagree,
n_3=Frequency of Neither Agree nor Disagree
n_4=Frequency of Somehow Agree,
n_5=Frequency of Agree
n_k = Frequency of Strong agree
k= is an array number

A total of 23 factors were grouped into six (6) dimensions such as management and leadership, continuous improvement, customer focus, employee satisfaction/improvement, process management and supplier chain management. In order to validate the findings, the average index for each group was computed to identify CSF in each domain. The factors with a high average index (7.563) were described as 'Strong Agreed' and that with a low average index (5.661) were described as 'Strong Disagreed'.

3.0 RESULTS AND DISCUSSION

3.1. Results

Regularly, there may be several possible causes associated with the problem of total quality management in construction management. Likewise, there may be several factors necessary for the solution of the same. To be successful, understanding and identifying critical success factors of TQM in construction is necessary. Many studies proposed complex statistical solutions, however no study proposed solution using analysis of average index.

In this study main factors were categorised into 6 major groups. For each category, there were sub categories as presented in Table 1. The main category includes supplier chain management (A.I= 7.563) which was ranked 1, Process management (A.I=6.625) which was ranked 2, employee satisfaction and empowerment (6.354) was ranked 3, customer focussed (A.I=6.177) was ranked 4, continues improvement (A.I=6.177) which was ranked 5 and lastly management and leadership (A.I=5.661) was ranked 6.

The results further indicate that in the domain of supplier chain management 'thoroughly examining the supplied materials before their uses had an A.I of 7.609 followed by the process of maintaining consistence suppliers having A.I of 7.516. The analysis of sub domain of process management indicates that receiving and reviewing drawings and specifications prior to constructions has higher A.I (7.156) followed by clarity of work processes and methods A.I (5.406). The analysis of customer focused indicate that construction company giving full attention to client needs had a higher score (A.I =6.922).It was followed by a need of giving feedback to client (A.I =6.016). The need to create mechanism for construction company to measure client satisfaction had a lower score (A.I =6.125).

Management and leadership are also pillars in TQM in constructions. According to Maxwell leadership ability is the lid that determines a person's level of effectiveness. The lower an individual's ability to lead, the lower the lid on his potential. This idea is troubling for some people because it means that no matter how much you desire to be a 10 on the scale of leadership, there is a cap to your abilities based on a number of factors. Some of these factors are your people's skills, planning abilities, vision, dedication to success and your past results (John, 2013). There are dozens of traits of leadership which are beyond this article to discuss. The analysis of leadership and management indicate that management with clear vision of TQM in the firm (A.I=6.242) has higher priority followed by management which support new technologies (A.I=6.125). Other sub factors include management which are willing to empower employee to have adequate knowledge (A.I =5.500), followed by management which are committed to ensure success of quality policy and Finally management which is creating TQ awareness scored A.I of 5.391. All in all it is concluded in the book by John (2013) that "True leadership cannot be awarded, appointed, or assigned. It comes only from influence, and that cannot be mandated. Leader and manager in a firm are encouraged to develop philosophy of leadership" and create an environment in which an organization continuously improves its ability (Inmon et al., 2019).

The gradual refinement of existing products and services and significant redesign of products and services are enabled by continuous innovation of the employee in construction management. The analysis of domain of continuous improvement of the process and supplied material indicate that construction company evaluating their performance and taking measures to improve had a higher scored of 6.469 compared to the processes of encouraging innovation to employee which had score of 6.078.

With the current world of competition the construction industries must strive not only for customer satisfaction but also for customer delight one step ahead of customer satisfaction. We argue that the foremost question to be asked by client in project management is "when to complete the project and second question will be how much quality it has, and finally how safe it is". Completing project on time becomes priority to clients followed by quality and finally safety. The good answer of all three questions makes client happy. To achieve client satisfaction, employees must first be satisfied. The analysis of employee satisfaction and empowerment indicate that company encouraging teamwork scored higher (A.I = 6.609) followed by employees being encouraged to attend professional training for skills improvement (A.I=6.609). Good communication among employees and good organization job description ranked third (A.I=5.781) and fourth (A.I=5.750) respectively. Other factors that contribute to satisfaction domain includes social relation (A.I=5.563), having suggestion and recommendation box (A.I=5.438).

Table 1: Critical success factors that contribute to the implementation of TQM

No.	Critical Success Factor	1	2	3	4	5	Average Index	Rank
A	**SUPPLIER CHAIN MANAGEMENT**						**7.563**	**1**
1	Supplied materials are examined thoroughly before being used.	3	2	10	45	54	7.609	1
2	Company maintains regular suppliers to ensure consistency.	5	9	7	48	49	7.516	2
B	**PROCESS MANAGEMENT**						**6.625**	**2**
3	Drawings and specifications are reviewed prior to constructions	5	17	11	44	42	7.456	1
4	There is clarity of work processes and methods	3	2	17	37	28	7. 406	2
5	Check sheets are available to monitor the adherence of scheduled processes	8	14	17	39	45	7.313	3
C	**CUSTOMER FOCUS**						**6.354**	**3**
6	Company gives full attention to client needs	5	12	16	39	42	6.922	1
7	Company gives feedback forms to clients after delivery of products	11	4	16	42	30	6.316	2
8	Company has mechanism to measure client satisfaction	14	9	5	45	33	6.125	3
D	**CONTINUOUS IMPROVEMENT**						**6.177**	**4**
9	Company evaluates performance and take measures to improve it	12	3	13	43	37	6.469	1
10	Company encourages employees to be creative and innovative in improving processes	14	5	15	40	32	6.078	2

11	Company has an improvement perception not just maintaining the traditional work methods	10	7	15	31	38	5.984	3
E	**MANAGEMENT AND LEADERSHIP**						**5.703**	**5**
12	Management has a clear vision for implementing quality goals	11	5	21	37	31	6.247	1
13	Management is supportive of technology advancement to improve quality	2	15	17	36	33	6.125	2
14	Management empowers all employees to have adequate knowledge in quality procedures	4	9	13	34	31	5.500	3
15	Management is committed to ensuring the success of the quality policy	5	14	22	35	22	5.453	4
16	Management creates quality awareness among employees	1	13	9	39	27	5.391	5
F	**EMPLOYEE SATISFACTION AND EMPOWERMENT**						**5.661**	**6**
17	The company encourages teamwork rather than individual work	17	3	9	32	49	6.609	1
18	Self-improvement is encouraged to improve skills and performance	9	13	8	41	35	6.219	2
19	Good communication is encouraged to eliminate fear/withdrawal	6	9	11	37	33	5.781	3
20	Employees enjoy job descriptions and working environment	7	3	11	22	34	5.750	4
21	Social relations are encouraged in the company	12	14	3	33	35	5.563	5
22	Company encourages suggestions from employees	8	15	21	23	31	5.438	6
23	Questionnaires and complaint forms are available to collect employee satisfaction information	6	12	5	33	32	5.266	7

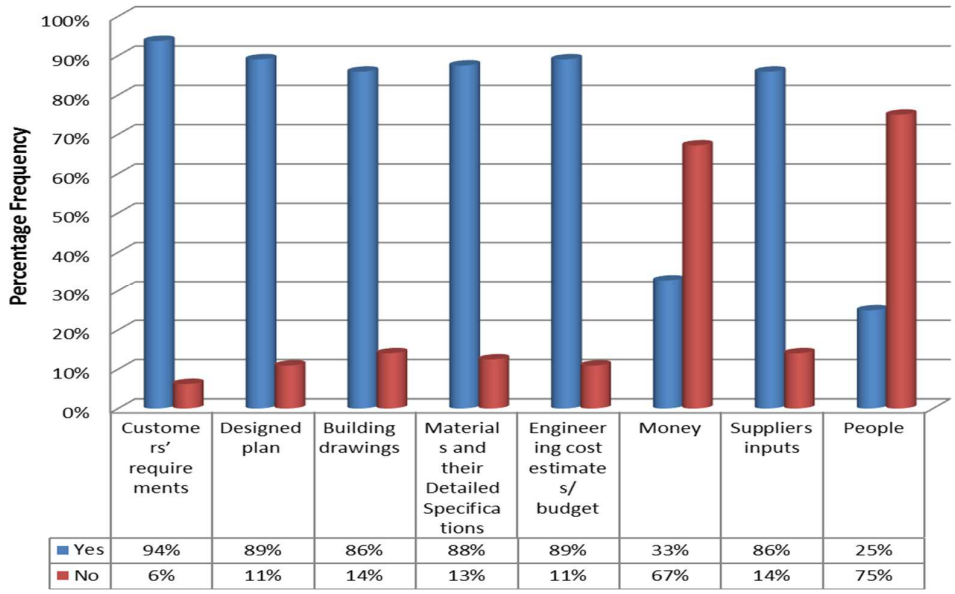


Figure 1: The Inputs of TQM Framework

Regarding the inputs that produce outputs of a TQM framework, a total of eight (8) inputs were identified and ranking in percentage value as presented in Figure 1. Customer's requirements had the highest score with 94%, followed by designed plan and engineering cost estimates each with 89%. Materials and their detailed specifications were fourth with 88%. The building drawings and supplier's inputs had 86% each. Others were people's money which ranked the seventh with 33%. The last position (8th) was Money which scored 25%.

Concerning the outputs of TQM framework, a total of five outputs items were identified and analysed. The result is presented in Figure 2. The results show that the quality product/buildings ranked the highest with 92% while form drawing score lower with 50%.

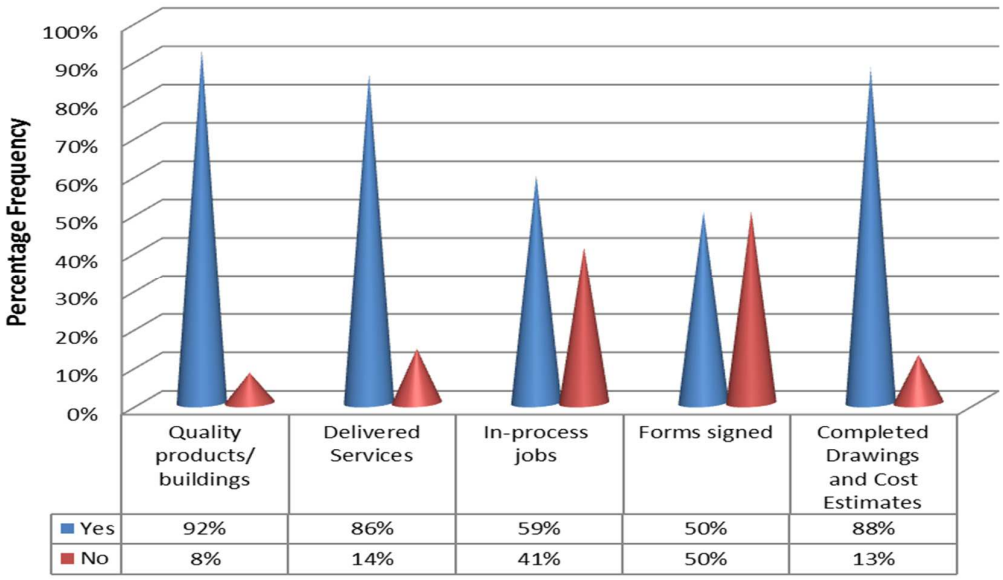


Figure 2: The outputs of TQM Fra**me**work

3.2. Discussion

From Table 1, the first most identified factor that contributes to the implementation of TQM is the supplier chain management with the highest average index of 7.563. The results show that the elements of supplier chain management are the most contributing elements towards achieving process management. The supplied materials should be examined thoroughly before being used. This is done to verify whether materials meet the required specifications and quantity as specified by the professional designer(s). This finding is supported by Hietschold et al (2014), Delgado (2008) and Kalpande et al., (2012) who encouraged the practitioners to use such a result of TQM as one of the CSFs. For quality control and quality assurance the construction firms should maintain the regular supplier to ensure consistency. Supplier chain management is also helpful for future records.

In construction firms, supplier chain management acts as a bridge between the clients, consultants and constructors or contractors. In Tanzania for example, the scope of work to be awarded a constructor is to supply, install, test and commission the project i.e. the contractors are also a suppliers. In practice, the constructor is not allowed to use his/her supplied materials before they are approved by the consultant who is a representative of the Client. Consultant as a professional designer has a technical reliability in the construction process in Tanzania.

Likewise the second most identified factor was process management with the average index of 6.625. Within the process management, the careful review of drawings and specifications prior to construction is believed to lead to the success in TQM in the construction process. The statements under process management such as drawings, check sheets and clarity of work process play a significant role in enhancing the quality of construction works. It is noted that process management is one of the main factors needed to ensure the quality of the product (Oakland, 2013).

Nevertheless the customer focus was ranked third with an average index of 6.354. As a matter of fact it should have ranked the first because in the construction process the first thing to be considered is the customer requirements. For ISO 9000 certified organizations the customer focus on satisfaction received the highest rating (Tari, 210). It is affirmed by Oakland (2013) that giving attention to meeting customer needs is paramount in customer loyalty. From the finding, we can conclude that the construction firms in Tanzania should include the supplier chain management in the total quality management framework. In the framework the supplied materials should meet the detailed specifications provided by the professional designers. Another factor to be included in the TQM framework is the process management. The process management will have the function of counter-checking and reviewing the drawings, materials and their detailed specifications, engineering cost estimates/budget before they are used for the construction process.

In addition, the customer focus is very important in the TQM framework because in the flow of construction process the customer needs or requirement is the first element to be considered. The inputs and output should be included in the TQM framework as connector. The inputs with high range such as customer requirements, materials and their detailed specifications, building drawings, designed plans, engineering cost estimates/budget and supplier's inputs should be used as the inputs in the TQM. Likewise the output with high range such as quality product/ building, complete drawings and cost estimates and delivered services should be used as the outputs of the TQM process.

4.0 THE DEVELOPMENT OF TQM FRAMEWORK

The approach to develop TQM framework for construction was based on the critical success factors that contribute to the implementation of Total quality management as shown in Table 1. From the analysis the most three CSFs were selected and included in the TQM framework as shown in Table 2.

Table 2: Selected CSFs for TQM framework

Critical Success Factors	Average Index(A.I)
1. Supplier Chain Management	7.563
2. Process Management	6.625
3. Customer Focus	6.354
4. Continuous Improvement	6.177
5. Management/ Leadership	5.703
6. Employee Satisfaction/ Empowerment	5.661

4.1. Conceptual TQM Framework

The set of basic factors which form the building blocks of the proposed TQM framework in accordance with this study are supplier chain management, process management and customer focus. In this TQM framework, process management is at the centre of the supply chain management and customer focus.

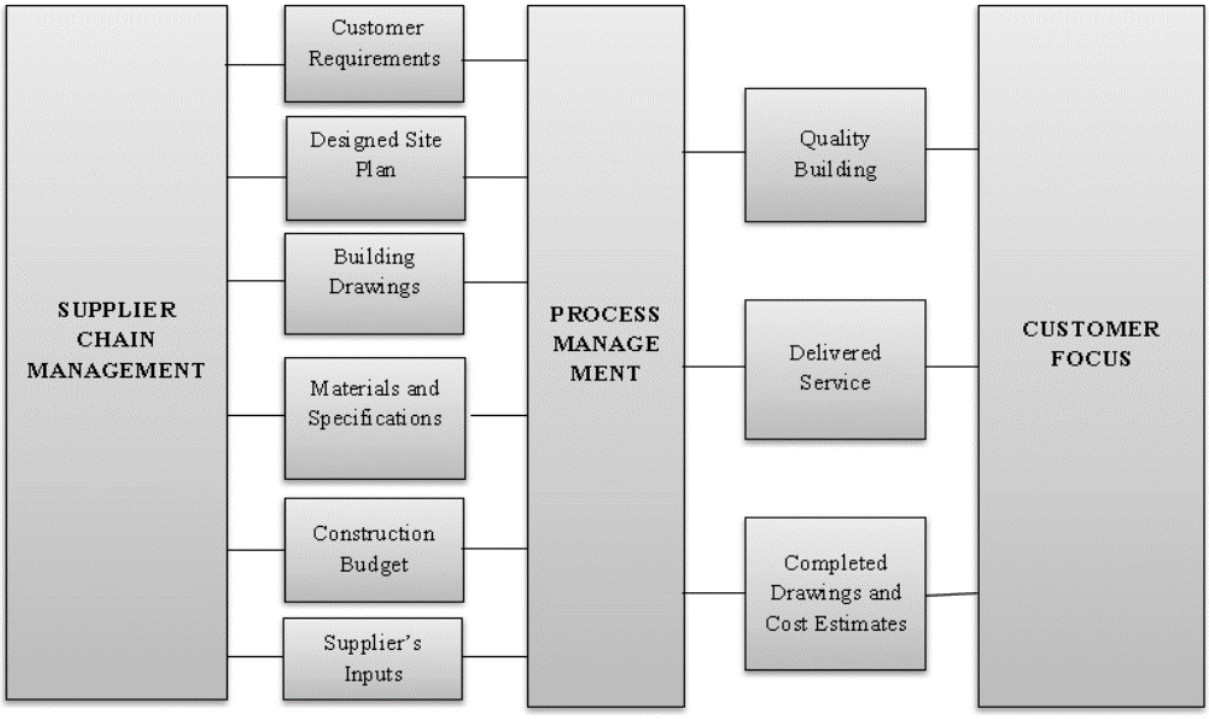


Figure 3: Total Quality Management Framework

4.2. Mathematical Model for TQM Framework

This model was developed with assumption that implementers of TQM require to know how much effort each factor would contribute to the process of construction. Since each factor is a process the unit of measure may not be necessary unless the actual work is known in advance. Based on Figure 3 the model depends on the Supplier Chain Management, Process Management and Customer Focus. Other parameter include Continuous Improvement, Leadership, as well as Employee Satisfaction. The interest is to find out how much effort implementers can put on each item to produce quality building, delivered service as well as cost estimate. The inputs are the independent variables of the outputs which represent the customer focus. It was noted that customer focus was the dependent variable of the inputs in which their outputs such as quality product, delivered and completed drawings and cost estimates were treated as the functions that depended on the inputs. Below is the formulation of the mathematical model of TQM framework: -

$$f(x) = a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6 + E \quad (4.1)$$

$$g(x) = b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + E \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.2)$$

$$h(x) = c_1x_1 + c_2x_2 + c_3x_3 + c_4x_4 + c_5x_5 + c_6x_6 + E \quad (4.3)$$

Where: -

$x_1 =$ *customer's requirements*,

$x_2 =$ *Designed site plan*,

$x_3 =$ *Building drawings*,

$x_4 =$ *Materials and their specifications*,

$x_5 =$ *Construction estimates / budget*,

$x_6 =$ *Supplier's input*,

$a_1, a_2 \ldots a_6, b_1, b_2, .. b_6$ *and* $c_1, c_2 \ldots\ldots c_6$ are the coefficients of the equation f(x), g(x) and h(x) respectively.

$E =$ *errors*

$f(x)$ *represents the output of quality product / building*,

$g(x)$ *represents the output of Delivered Service, and*

$h(x)$ *represents the output of Completed Drawings and cost estimate / budget*.

From the Figure 3 above, the process management can process the inputs variables to produce the quality output of quality product only or delivered service or completed drawings and cost estimates/ budget or quality building and delivered service or quality product/ building and complete drawings and cost estimate or quality product, delivered service and completed drawings and cost estimates.

Those outputs are the customer focus (customer satisfaction), let us assume the function that produce the outputs (quality product, delivered service and completed drawings and cost estimate) be P(x).

Hence,

$$P(x) = f(x) + g(x) + h(x) \quad (4.4)$$

The function that produce quality building and delivered service be Q(x). Hence,

$$Q(x) = f(x) + g(x) \quad (4.5)$$

The function that produced the quality building and completed drawings and cost estimate be R(x), hence

$$R(x) = f(x) + h(x) \quad (4.6)$$

The function that produced the output of delivered service and completed drawings and cost estimate be S(x), hence

$$S(x) = g(x) + h(x) \quad (4.7)$$

Now let us find P(x).

$$P(x) = \big(Q(x)+R(x)+S(x)\big)-\big(f(x)+g(x)+h(x)\big)$$

$$P(x)=\big[(a_1+b_1)x_1+(a_2+b_2)x_2+\ldots+(a_6+b_6)x_6\big]+\big[(a_1+c_1)x_1+(a_2+c_2)x_2+..+(a_6+c_6)x_6\big]+$$

$$\big[(b_1+c_1)x_1+\{b_2+c_2)x_2+\ldots+(b_6+c_6)x_6\big]-\big[(a_1+b_1+c_1)x_1+(a_2+b_2+c_2)x_2+...+(a_6+b_6+c_6)x_6\big]$$

$$=\big[(a_1+b_1+a_1+c_1+b_1+c_1)x_1+(a_2+b_2+a_2+c_2+b_2+c_2)x_2+....+(a_6+b_6+a_6+c_6+b_6+c_6)x_6\big]-$$

$$\big[(a_1+b_1+c_1)x_1+(a_2+b_2+c_2)x_2+\ldots+(a_6+b_6+c_6)x_6\big].$$

After some manipulation, it becomes

$$P(x)=[(a_1+b_1+c1)x_1+(a_2+b_2+c_2)x_2+(a_3+b_3+c_3)x_3+(a_4+b_4+c_4)x_4+(a_5+b_5+c_5)x_5+$$

$$(a_6+b_6+c_6)x_6.$$

Where $(a_1+b_1+c_1)$, $(a_2+b_2+c_2)\ldots$ $(a_6+b_6+c_6)$ are the coefficients of the function P(x) and

$P(x)$ is the function of TQM framework.

$$TQM=[(a_1+b_1+c_1)x_1+(a_2+b_2+c_2)x_2+(a_3+b_3+c_3)+(a_4+b_4+c_4)x_4+(a_5+b_5+c_5)x_5+$$

$$(a_6+b_6+c_6)x_6] \quad (4.8)$$

Let us assume that: -

$$p_1 = (a_1+b_1+c_1),\ p_2 = (a_2+b_2+c_2),\ p_3 = (a_3+b_3+c_3),\ p_4 = (a_4+b_4+c_4),$$

$$p_5 = (a_5+b_5+c_5)\ and\ p_6 = (a_6+b_6+c_6)$$

Therefore, the equation (4.8) became as follows

$$TQM = p_1x_1 + p_2x_2 + p_3x_3 + p_4x_4 + p_5x_5 + p_6x_6 \quad (4.9)$$

The values of the confidents Pi's in the mathematical model 4.9 are assumed to be proportional to the importance weight (% of those who said YES) as seen in Table 2. In that table, the selected variable was obtained from the large number of the respondents who agreed on as the inputs of TQM Framework. Thus, the coefficient of the model is as follows:-

$$p_1 = 18\% = 0.18,$$

$$p_2 = 17\% = 0.17,$$

$$p_3 = 16\% = 0.16,$$

$$p_4 = 16\% = 0.16,$$

$$p_5 = 17\% = 0.17,$$

$$p_6 = 16\% = 0.16.$$

From the equation (4.9) above, the coefficient p_1 to p_6 were substituted into equation (4.10)

$$TQM = 0.18x_1 + 0.17x_2 + 0.16x_3 + 0.16x_4 + 0.17x_5 + 0.16x_6 \quad (4.10)$$

Where xi $\varepsilon[\ 0,\ 10]$ such that:-

If $0 < xi < 4$, the results has poor quality
If $4 < xi < 7$, the results has good quality
If $7 < xi < 10$, the results has excellent quality
Therefore the mathematical model equation for TQM Framework was:-

$$TQM = 0.18x1 + 0.17x_2 + 0.16x_3 + 0.16x_4 + 0.17x_5 + 0.16x_6$$

4.3. The Components of TQM Framework

The following are the components of TQM framework described in detail:

i. Supply chain Management

The timely supply of the right quantity inputs that meet the right specifications determines the final quality of buildings as a product. It is better to maintain long-term supplier relationship for loyalty and trust. In addition, project managers, consultants and contractors are the suppliers of the construction process. Project manager can supply project management services on behalf of the client to ensure that the consultant and contractor deliver the quality and valuable building. Consultant can supply consulting services of the project including the designs and drawings of site plan; and the preparation of the construction budget (Engineering cost estimates). The contractor can supply the materials to be used in the construction process. To improve the supplier's performance, commitment and involvement of top management of the Supplying Company and construction should be increased.

ii. Process Management

According to triple role concept within each activity, there are three Actors: Supplier, Processor and Customer. For an efficient Process Management within the TQM framework, the customer should be satisfied before the next activity starts. The customer of the preceding activity becomes the supplier of the successful activity. For instance in the reinforced concrete activity, the carpenter who casts the formwork become the supplier of the steel bender, handling the reinforcement phase. Respondents rated Process Management as one of the CSFs due to its responsibility in quality control and quality assurance to ensure that employees adhere to the procedures and Standard Operating Practices (SOPs).

iii. Customer Focus

The purpose of the TQM framework is to produce goods and services consistently for a satisfied customer. To achieve this, we would have to know the needs of the customer and then adopt an appropriate framework and environment to achieve the desired needs at the possible cost. The expected results to the customers satisfaction were the quality building, delivered services and a complete set of site plans drawings together with the construction cost.

5.0 CONCLUSION

This paper contributed in the field of TQM by exploring critical success factors in Dar es Salaam. The key contribution is a development of total quality management framework in construction process in Tanzania. It can be concluded that TQM consists of organization-wide efforts to install and make permanent a climate in which an organization continuously improves its ability to deliver high-quality products and services to customers.

From the proposed framework it is concluded that, TQM framework as a systematic approach can manage the data/information of quality buildings from the start of construction to the finishing stages. The construction stage normally follows after the initial stages of collecting the requirements from the client and design the architectural plan for the building. The designing of the building provides the design professionals an opportunity to draw the building site plan. After the building site plan, there is a need to prepare the engineering cost estimates based on the provided detailed specifications of those materials and the completed drawings that should be used in the construction process. Those inputs should be reviewed and processed in the Process Management in order to achieve the quality product as goals of Customer Focus. We therefore conclude that, the flow of construction process above should be done by implementing the TQM framework.

This research was undertaken to delve in the issues concerned with total quality management in construction process; and to analyse ways to effectively control technological processes involved in the development of TQM framework for the client. The increasing competition in the field of products and services has resulted in development of TQM framework. The framework is aimed at developing quality buildings that meet the customer needs. With intense competition and the focus on the quality of the products and services, more revenue (profitability) generating processes are being linked to an organized structure that an organization cannot afford to ignore to keep a leading position in the market. Customer is never interested in complex development details of quality. What customer needs is quality products and services as an end user (beneficiary).

Currently, people have been working with writing mature and filing system to keep records of the building construction as effective procedures for the requirements gathering. Experience shows that a requirement gathering is relatively simple where customer characteristics are similar. The diverse the customer characteristics are the more difficult it will be to collect the requirements which will ultimately affect the quality of the product or services delivered and make it even more difficult to come up with a TQM framework that is fit for the purpose of achieving the quality.

If the quality implementation is patchy and not uniformly functional in all sections and departments of the construction firms, in case of time constrained projects and events with diverse customer character set, it will be difficult to set the agreed customer requirements. Therefore, a mechanism should be developed to minimize the gap between the supplier (professional designers, contractors and other service provider) and the customer (clients).

A proper method is required to incorporate the voice of customer in the design process. To achieve this goal TQM framework can be used during the design quality to satisfy customer requirements; translate customer demands into design target; and major quality assurance throughout the production stage or/and process at all levels.

REFERENCES

Chang, W. J., Liao, S. H., Tay, C., & Wu, C. C. (2008, December). Mapping TQM-innovation relationship on learning organization: A strategic management perspective. In 2008 IEEE International Conference on Industrial Engineering and Engineering Management (pp. 1620-1624). IEEE.

Cheng, Y. J.M. Kamara (2011), A framework for using mobile computing for Information management on construction sites, Autom. Construction, doi: 10.1016/j.autcon.2011.01.002.

Delgado, D.J. (2008), Improvement tools in the UK construction Industry, Construction Management and Economics, 23(9).

Enshassi et al. (2007), Factors Affecting Labour Productivity In Building Projects in the Gaza Strip, Journal of Civil Engineering and Management, Vol. XIII, No. 4.

Giri M. (2014), Total Quality Management (TQM) Implementation in Construction Firm, Politecnico Di Milano

Hietschold, N., Reinhardt, R., & Gurtner, S. (2014), measuring critical success factors of TQM implementation successfully, International Journal of Production Research, 52(21), pp. 6254–6272.

Inmon W.H., Mary Levins, (2019) Introduction to Data Vault Methodology. Where Does TQM (Total Quality Management) Fit in to All of This? Available at https://www.sciencedirect.com/topics/computer-science/total-quality-management

John C. Maxwell (1998) 21 Irrefutable Law of Leadership Revised & Updated 10th Anniversary Edition, Published by Thomas Nelson.

Kalpande, S. D., Gupta, R. C., & Dandekar, M. D. (2010). A SWOT analysis of small and medium scale enterprises implementing total quality management. International Journal of Business, Management and Social Sciences, 1(1), 59-64.

Oakland, J. S. (2013), Quality Management Third Edition, Elsevier Butterworth-Heinemann Publications.

Pheng L. S., and Teo J. A., (2004), The Implementation of Total Quality Management in Construction Firms Journal of Management in Engineering © ASCE.

Schofield D.M. (2010), A Framework and Methodology for Enhancing Operational Requirements Development, Massachusetts Institute of Technology

Tari´, J. J. (2010), Components of successful Total Quality management, The TQM Magazine, Vol. 17 No. 2.

Tang, S. L. and Lau, A. W. T., (2009), A survey on the advancement of QA (Quality assurance) to total quality management for construction contractors in Hong Kong, International Journal of Quality & Reliability Management, pp. 410-425.

Twaiss and Graham (2008), Current Issues and Challenges for TQM Implementations in the Information and Communications Technology Sector.

Vicky Manthou, Maro Vlachopoulou, (2001) Agile Manufacturing: The 21st Century Competitive Strategy, 2001 available at https://www.sciencedirect.com/book/9780080435671/agile-manufacturing-the-21st-century-competitive-strategy