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Implementation of Quality Control Tools on Educational Project

Kunal Shitole
[1]PG Student, Department of Civil Engineering,
Trinity Academy of Engineering, Pune

***Abstract*—TQM is an acronym for total quality management. It is a method for management of whole project to achieve excellence in production. Basically, it is the integration of all functions and processes within an organization for achievement of continuous improvisation in the quality of goods and services. The goal is satisfaction of the customer. It is the application of quantitative methods and human resources to improve all processes within a firm with the end goal of satisfaction of customer's need. In educational building, quality needs to be exceptional. So it is quite necessary to implement TQM. For implementing TQM in educational building, quality control tools like checklists and histogram are quite helpful. In this project, the main objective is to implement the TQM concept in educational building using QC tools to determine the improvement of quality.**

Keywords—TQM, quality control tools.

I. 1. INTRODUCTION

TQM is one of the most popular modern management concepts. Total quality management (TQM) is a system focusing on customer satisfaction through a concept of "continuous improvement". The concept of quality has existed for many years, though it's meaning has changed and evolved over time. In the early twentieth century, quality management meant inspecting products to ensure that they met specifications. In 1940s, during World War II, quality became more statistical in nature. Statistical sampling techniques were used to evaluate quality, and quality control charts were used to monitor the production process. Quality began to be viewed as something that encompassed the entire organization, not only the production process. Since all functions were responsible for product quality and all shared the costs of poor quality, quality was seen as a concept that affected the entire organization.

Quality control is a narrow concept while TQM is a wide concept. Therefore, to implement

TQM, quality control concept should be focused as it is integral part of it. In our project, we have implemented TQM on education site using quality control tools like histogram and checklists.

Earlier on the construction site, only material quality aspects were taken into consideration for maintaining quality of construction. But with the development of TQM in recent years, human aspects and processes are also taken into account. Human errors cause a significant degradation in the quality of construction. Human aspects can be improved by educating and training personnel at all levels of organization.

Implementation, coordination, competitiveness of worker, skill level of workers, and level of sub-contractor are lagging on a construction site. Therefore, there is a need for implementation of TQM in educational project and this can be achieved by applying QC tools.

TQM appears to be consistent with a move towards human resource management, not only in emphasis on employee commitment rather than compliance, but it also identifies line managers as having a key responsibility for the management of people. Both TQM and HRM call for the involvement of top management and in this sense can be seen as requiring a more strategic approach to the management of resources.

Thus TQM needs to be implemented on educational site using quality control tools like histogram and checklists.

II. 2. LITERATURE REVIEW

A. Applying total quality management to the educational process:

In this paper Robert c. Winn and Robert s. Green, explains how total quality management can be applied to the educational process by considering student as a customer. If the student is identified as one of the customer, one must try to satisfy the customer but one must be very sure to know what the customer really wants. Educational process must try to satisfy student's long term needs, not simply short term desires. TQM can be powerful tool in the educational setting though it was developed with manufacturing in process in mind. The key elements to a successful implementation of TQM are: gain support of everyone in the chain of supervision, identifying customer, and focus on refining the process and use of Deming's 14 principles as a guide and checklist during implementation effort.

B. 2.2 The effect of total quality management on construction project performance (case study: construction firm in Yemen):

Nashwan Mohammed Noman Saeed and Awad Sad Hasan carried out the survey of 40 companies from construction sector (30% of sample size) and the data was collected. 29 questionnaires were returned. The response rate was 72.5%. These 40 construction firms were then classified into 3 classes. From the data collection, it was clear that the concept of TQM in most of the construction firms of Yemen was absent. Data analysis showed that top management does not lean most of the TQM concepts, low salary, incentives and training almost non-existent, poor standard of imported material. These results helped the author to identify that TQM process was necessary for improvement of construction project performance. In this study, the TQM framework was developed. This framework demonstrates the relationship between TQM and construction

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project performance through examining the effect of TQM constructs on elemental level of project performance.

III. METHODOLOGY

For doing this project following methodology was adopted:

i. Inspection of site.

ii. Collection of data from the site.

iii. Preparing histogram on data obtained from BOQ.

iv. Flowchart of the activities to be done for project was made.

v. Using histogram, costing of the important aspects of project were found.

vi. Checklists were prepared for implementing TQM for these important activities.

viii. Final results and conclusions were obtained from the histogram, flowchart and checklists.

In this way, TQM was implemented on educational site with the help of QC tools (checklist, cause and effect diagram and histogram).

IV. DATA COLLECTION

In this project, for implementing TQM on the site, qc tools such as histogram, checklist were used.

Type of construction: Educational Site

Developer: Synergy Ski Infradevelopment. (SYNFRA)

Site name: Cipla's Outreach Chemistry Lab, IISER, Pashan, Pune.

Location: Indian Institute of Science, Education and Research, Pune

Architect & RCC consultant: C.R. Narayan Rao, Chennai.

By the inspection of site, several quality issues were observed. Therefore, with the help of QC tools these issues were solved thus TQM was implemented on the site. The following QC tools were used:

Fig. 1. Actual Site Image

A. *Histogram:*

A histogram is a bar graph that shows frequency data. Histogram provides the easiest way to evaluate the distribution of data.

B. *3.2 Flow Chart*

Flow charts are Graphical Representation clarifying how the process is working in the form of series of chains by showing all the steps of the process. It shows the start and end points of the process.

They are useful in identifying important areas for collection of data and generating assumptions about potential causes of problems.

C. *Checklist:*

Checklist consists of list of items and some indicators of how often each item on the list occurs.

Checklists are tools that make the data collection process easier by providing pre-written descriptions of events likely to occur.

V. DATA ANALYSIS

A. *Histogram*

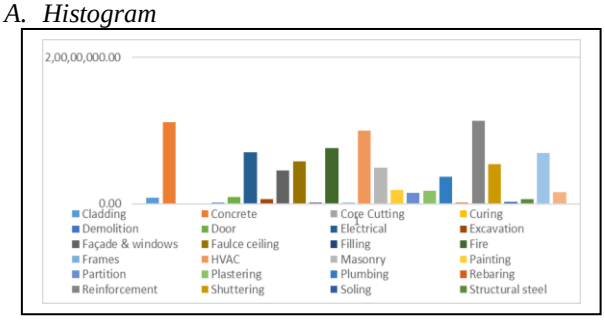

Fig. 2. Histogram obtained from BOQ

Maximum cost is of steel as per BOQ. Therefore, quality of steel & Wastage should be more focused than remaining activities, as small amount of Variation in Quality may cause large variation in cost as per BOQ.

After steel, maximum cost is of Concrete. Therefore, quality of Concrete should be focused.

Therefore, likewise different activities can be sorted out according to cost in decreasing order and their preference for maintaining quality is decided. E.g. Activity which has maximum cost is given first preference for maintaining its quality.

Therefore, by histogram, different priorities for checking qualities of various processes can be set to maintain quality of entire construct.

B. *Checklist*

Below are some sample checklists:

TABLE I. COLUMN REINFORCEMENT CHECKLIST

Activity	Yes	No	Remark
GFC Drawing Available?	☑		No Changes
Check For Centre To Centre Distance Between Two Columns (As Per Centre-line Plan)	☑		No Changes
Check For Rectangularity Of Column (Diagonally)	☑		No Changes
Check If One Stirrup Is Placed Inside Starter While Concreting?	☑		No Changes
Check For Diameter Of Stirrups As Per Drawing	☑		No Changes
Check For Spacing Of Stirrups As Per Drawing		☑	Spacing is More As per DWG specification- Rectification Required

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Check For Cutting Length Of Stirrups		☑	Cutting length of stirrups should be such that it can be perfectly Tied to the main reinforcement Maintaining its verticality
Check For Spacing As Per Drawing (Confining Zone And Non Confining Zone)		☑	
Check For Wastages (Reza Bars)	☑		No Changes
Check For Main Vertical Bars (Dia And Size Of Bars)	☑		No Changes
Cutting Length Of Bar As Per Drawing		☑	Alternate lap required
Check For Curtailment Of Bar (If Any)	☑		Main Reinforcement bars are curtailing From Second floor column onwards to Terrace Column
Check For Lap Length As Per Drawing		☑	Lap Length -50 X Dia of main bar
Checking For Plumb		☑	Verticality should be maintained so as to avoid its Rework & Repair
Check For Thickness Of Cover Block At Every Intervals		☑	Clear Cover should be maintained at all the edges

TABLE II. BEAM REINFORCEMENT CHECKLIST

Activity	Yes	No	Remark
GFC drawing available?	☑		No Changes
Check for main bars for dia and length		☑	For Plinth Beam 32 mm dia bars must Be Replaced By 25 mm bars as per Changes by Client
Check for extra bottom bars placed (dia & length)		☑	Short By 0.20 m Length- Rectification Required
Check for extra top bars placed (dia & size)		☑	Short By 0.180 m Length- Rectification Required
Extra bars provided at the junction of main beams and secondary beams		☑	Work In Progress
Check for dia of stirrups as per drawing	☑		No Changes
Check for spacing as per drawing (confining zone and non-confining zone)		☑	Spacing is More As per DWG specification- Rectification Required
Check for cutting length of stirrups		☑	Cutting length of stirrups should be such that it can be perfectly Tied to the main reinforcement Maintaining its verticality
Check for thickness of cover block at every intervals		☑	Clear cover should be maintained to avoid shuttering bulkage, Honeycombing effect & Reduce chances of direct contact of steel with outside Temperature

TABLE III. SLAB REINFORCEMENT CHECKLIST

Activity	Yes	No	Remark
GFC drawing available?	☑		No Changes
Any changes in drawing as per client	☑		No Changes
Check shuttering levels, for thickness of slab depth (if any)	☑		Depth of slab may vary if levels not maintained.
Check for one way slab	☑		No Changes
Check if number of main bars provided as per drawing	☑		No of bars should be-(Span / Spacing + 1)
Check spacing of main bars	☑		Rectification needed as spacing varies
Check for bent ups (crank bars) provided as per drawings	☑		Crank bars must be provided as per specified in the DWG(L/4)
Check for alternate bent up		☑	Rectification needed
Check for distribution bar dia and numbers as per drawing	☑		Distribution bars are Provided shorter length than as specified in the Drawing
Check for extra top bars at end as per drawing		☑	Length of extra top bar must be equal to the Bent-up portion of slab
Check for chair bars for maintaining the thickness of the slab (dia and numbers)		☑	For maintaining the clear cover & Proper spacing between Bottom bar & Crank bar Chairs play vital Role
Check for two way slab	☑		No changes
Check for main bar provided as per drawing (both ways)	☑		Provided
Check for bent ups (crank bars) provided as per drawings	☑		Provided
Check for alternate bent up	☑		Provided

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Check for chair bars for maintaining the thickness of the slab (dia and numbers)	☑		Provide chairs at spacing of per meter length
Check for extra top bars at end as per drawing	☑		Length of Extra top bars must be Equal to (S

TABLE IV. COLUMN SHUTTERING CHECKLIST

Activity	Yes	No	Remark
GFC drawing available?	☑		No changes
Check for size as per drawings		☑	If shuttering not done as per size provided rework/chipping may be required
Check center to center distance between two adjacent columns		☑	
Check in to in distance between two adjacent columns		☑	To avoid offsets which may lead to rework while finishing
Check plumb of reinforced steel, vertical bars		☑	Vertical bars if not in plumb may lead to honey-combing
Check for proper shuttering to columns		☑	Shuttering supports if not properly placed may lead to bulkage
Check For Water Tightness Of Shuttering Ply-board		☑	Water tightness of ply-board is essential to avoid wastage of cement slurry
Check age of wooden planks		☑	Wooden planks with large amount of holes & damages shall not be used to shuttering work
Shuttering oil laid properly	☑		Shuttering oil is essential for maintaining the finishing edges of shuttering ply-board
Check for height of shuttering till beam bottom		☑	If shuttering height is small than beam bottom sufficient packing must be done so as to avoid wastage of concrete & avoid bulkage.

TABLE V. BEAM SHUTTERING CHECKLIST

Activity	Yes	No	Remark
GFC drawing available?	☑		No changes
Check for size of beam as per drawings		☑	Width of beam shall be checked so as to identify for any type of bends in shuttering work.
Check bottom level of beam at every interval		☑	Beam bottom level should be maintained so as to avoid bulkage in shuttering work
Check age of shuttering plywood		☑	Wooden planks With large amount of holes & Damages Shall not be used to shuttering work
Check for water tightness for shuttering joints		☑	Water tightness of ply-board is essential To avoid wastage of cement slurry
Check for bottom and side shuttering supports	☑		To Avoid bulkage in shuttering
Shuttering oil laid properly		☑	Shuttering oil is essential For Maintaining the Finishing edges of shuttering ply-board
Check For Joints Of Shuttering Plaits And Ply-board	☑		So that There may not be Any Shuttering gaps & To avoid concrete wastage

TABLE VI. SLAB SHUTTERING CHECKLIST

Activity	Yes	No	Remark
GFC drawing available	☑		No Changes
Check level of slab at each interval as per GFC drawing		☑	Slab level shall be maintained as per the GFC drawing provided
Check depth of slab		☑	Slab thickness should be same so as to avoid any undulations which may have to be repaired
Check for thickness of shuttering plate	☑		Shuttering plates must be of Equal thickness & without bends and breakages
Check for unequal shuttering plate?		☑	If shuttering plate sizes vary joints cannot be matched properly
Shuttering plate joints fixed by silicon or any other sealant		☑	If joints no sealed properly may lead to concrete wastage on a large scale
Check for shuttering plate rested properly over putti and properly tied?		☑	If shuttering plate not rested properly over wooden patti chances of slippage may occur
Shuttering oil laid properly	☑		Shuttering oil is essential For Maintaining the Finishing edges of slab bottom surface finish

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Fix the gap where shuttering plate cannot be laid	☑		If joints no sealed properly may lead to concrete wastage on a large scale

TABLE VII. CHECKLIST FOR MASONRY

Activity	Yes	No	Remark
Pre Check			
GFC Drawing Available?	☑		No changes
Check if Cleaning the entire floor done?		☑	Cleaning of entire floor is necessary so as to maintain the level of Brick bond
Check size of bricks as per the approved size	☑		Bricks if found of irregular shape may create undulations
Check if bricks wetted properly?		☑	Bricks if not wetted properly absorb water from the adjacent mortar Leading to shrinkage cracks on a large scale
Check if farma available?	☑		Available
Check right angle available?		☑	Right angle if not available while masonry work Corner edges right angle cannot be achieved
Check if hacking being done at joints of masonry and RCC?		☑	Hacking is necessary so as to maintain binding between Masonry & RCC work
Check if line out being done by rich mortar?	☑		Yes
Process check			
Check if all opening placed as per the architectural drawing provided?	☑		Yes
Check if thickness of joints at every interval as per drawing received?	☑		Joint thickness of mortar should be maintained between every two layers so as to avoid shrinkage cracks
Check if plumb line and level as per drawing?	☑		To maintain verticality of masonry wall
Check if concrete band thickness as per drawing? (if provided)	☑		As per the height specified in the Drawing
Check For Sill Level Of windows as per drawing Specified?	☑		Sill level of outer Window Is 0.95 m above Floor Finish level & 1.20 m for Windows in Corridor portion
Check if Proper mortar provided at the topmost layer of masonry below Beam bottom?		☑	So as to avoid development of cracks

TABLE VIII. CHECKLIST FOR INTERNAL PLASTERING

Activity	Yes	No	Remark
Check if GFC drawing available?	☑		No Changes
Check if Cleaning of entire floor is complete?	☑		No Changes
Check if Hacking of concrete surface is done properly?		☑	Hacking is necessary so as to maintain the Bond between Plaster & Concrete surface.
Check if right angle available at working location?	☑		Right angle if not available while masonry work Corner edges right angle cannot be achieved
Check if chiseling/ cutting done if any bulging found?	☑		So as to maintain plaster thickness
Check if all concealed works complete/proper openings proved as per drawing?		☑	To avoid Rework & Re-Plaster.
Check if chicken mesh properly fixed on masonry and RCC joints?	☑		For maintaining the Bond between masonry & RCC joints.
Mortar Ratio?	☑		1:4
Check if any leakages found?	☑		Leakages should be repaired on urgent basis so as to avoid seepage of water inside plastered surface
Check for plumb?	☑		Verticality of plaster must be maintained
Check if size of doors and windows openings as per drawing?	☑		Door and window openings must be provided as per DWG Specified
Recheck if internal dimensions as per drawing? (measure dimensions diagonally)	☑		No Changes

VI. 6. RESULTS AND CONCLUSIONS

A. *Histogram*

From histogram, following conclusions were drawn:

Maximum cost is of steel as per BOQ. Therefore, quality of steel & Wastage should be more focused than remaining activities, as small amount of Variation in Quantity may cause large variation in amount as per BOQ.

After steel, maximum cost is of Concrete. Therefore, quality of Concrete should be focused.

Therefore, likewise different activities can be sorted out according to cost in decreasing order and their preference for maintaining quality is decided likewise. E.g. Activity which

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has maximum cost is given first preference for maintaining its quality.

Therefore, by histogram, different priorities for checking qualities of various processes can be set to maintain quality of entire construct.

After referring histogram, Activity wise Flow charts are prepared so as to track all the interlinked activities.

Thus with the help of histogram, TQM was implemented on this educational site.

B. Flow Chart

From Flow Chart, following conclusions were drawn:

Flow charts are Graphical Representation clarifying how the process is working in the form of series of chains by showing all the steps of the process. It shows the start and end points of the process. They are useful in identifying important areas for collection of data and generating assumptions about potential causes of problems.

C. Checklist

From checklist of various activities, various quality issues are determined.

As these issues can be identified and rectified in real-time on the site using checklist it helps in improving quality of the entire construct.

Thus checklist helped in maintaining TQM on the educational site.

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