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Quality Maintenance Effort Optimization in Software Industry

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***Abstract*—** This paper conceptualizes a very important Software Process metric Cost of Quality (COQ) in different aspects and provides ways to optimize its value through prior activity planning and implementing the tasks according to the pre-planned effort distribution. The solution is built based on the analogy between effort and real life cost expenditure. While the solution is direct, it deals with multiple pre-requisites like understanding the components of COQ, setting its limits which ensures both quality and budget. There are multiple important sub concepts coming out of it like Systematic Planning, Wastage Elimination, Prioritization of Tasks, and Modulated Effort leading to generation of regulated COQ value as Output. This article showcases the Pilot Results as experienced from few real life projects from one organization and simulated the real life scenario through step by step utilization of the proposed solution. The result shows that proposed solution is able to reduce variance by approx. 99% while achieving the sigma level improvement of approx. 3σ. The solution also ensures many potential benefits in many aspects like identifying gaps / quality vulnerabilities based on previous performances, prioritization of task, maintenance of balance between Cost & Quality, controlled utilization of available resources, waste identification, quantification & elimination.

***Keywords*—** Cost of Quality, Wastage Elimination, MUDA Wastes, Cost-Quality Balance, Cost Optimization, Quality Vulnerability, Quality Maintenance Effort

I. INTRODUCTION

Cost of Quality ([1]-[8])is the metric that indicates an organization the extent to which its resources are used for activities that prevent poor quality, that appraise the quality of the organization's products or services, and that result from internal and external failures.

The importance behind the study and understanding concepts of Cost-Quality relationship is being able to maintain the proper balance between these two factors having adequate knowledge of its components.

For example, one team has no idea on exactly what amount of effort to be spent on review activity of the deliverables and they do reviews without any pre-calculated/pre-estimated efforts. At the end of the delivery phase team suffers from band-width crisis due to over consumption of effort in reviews (or spending an extra amount of effort in reviews, compared to available capacity). This results good quality in deliverables but significant schedule slippage appears, resulting Customer dissatisfaction.

On the contrary, due to lack of planning team spends very little amount of effort in deliverable reviews and delivers before schedule as there are surplus effort which they saved by insufficient reviews. This results on time (or before time) delivery without ensuring expected quality on the deliverable resulting Customer dissatisfaction.

Hence, there must be proper balance in planning through which team is able to optimize between Quality & Cost, i.e. maintaining maximum Quality with expense of minimum Cost.

Cost of Quality metric is derived from the listed formula:

%COQ = 100 * (Preventive Effort + Appraisal Effort + Internal Failure Effort + External Failure Effort) [9]/Total Effort

Where,

Preventive effort gets generated from effort spent in preventive activities like Training & Development, Defect Prevention [10],[11], Prepare Standard & Guideline,

Appraisal effort gets generated from effort spent in appraisal activities like Project Review Meeting, Audits, Review, Testing and Final Inspection,

Internal failure effort gets generated from effort spent in resolution of defects which arise out of internal review/testing,

External failure effort gets generated from effort spent in resolution of defects which arise out of external testing like Quality Assurance Testing, User Acceptance Testing etc.

Every organization sets its own target of %COQ value for different project types depending upon its existing structure, quality standard, normal trend etc. It is a common practice of setting a target first and then fine-tuning it depending upon values generated on a regular basis by different types of projects.

Below are sample target values of COQ set by an organization and these values will be referred for showcasing the case study in next section:

1. Development Project: 15% - 17%
2. Maintenance Project: 10% - 11%
3. Production Support Project: 9% - 10%
4. Testing Project: 0% - 8%
5. Conversion Project: 6% - 24%
6. Package Implementation Project: 7% - 19%

These values are decided based on nature of project. For example, in Development project significant code changes are involved. Prior to starting new code writing defect prevention activities like required training, research works for finding existing standards etc. are required, which will contribute to Preventive bucket. Post code writing requirements are rigorous review and testing, final inspection activities which essentially lead to appraisal effort; similarly for Maintenance or Production Support project volume of code changes are minimal. Hence quality maintenance effort requirement is also less.

The article content is structure in listed way:

- Section II contains various conceptualizations derived from study on Cost of Quality metric. These concepts are utilized at background while forming the solution
- Section III details the proposed solution of "Activity Planner Tool" based on top of prior activity planning concepts. This section provides details of solution feature and usage guide through screenshots of five planning steps as captured in the excel based tool
- Section IV contains benefits of utilizing proposed solution
- Section V is the Case Study section which shows data from sample development and maintenance projects before and after implementing the proposed solution, statistical validation of the improved data. This section tries to prove the usefulness and capability of proposed solution through statistical results
- Section VI is the real life simulation of proposed activity planner solution depicted by an example. The scenarios in this example are all assumptions, based on real-life execution experiences of software projects
- Section VII & VIII list the concluding points and future scope improvements respectively.

II. CONCEPTUALIZATIONS

A. Potential Causes for High Variance in COQ Values – Fishbone RCA

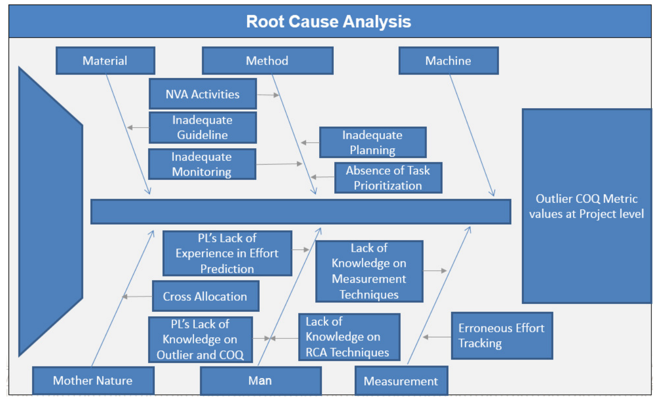

Figure 1 : Fishbone Analysis of High Variance in COQ Values

As denoted in the Fishbone diagram, potential causes are:

1. Method or Process

a. More tendency of having Non-Value Adding activities due to no planning. Refer to section Wast-age Elimination

b. Lack of Monitoring of Quality Maintenance Activities by Project Leader (PL).

i.e. PL is not monitoring whether consumed effort is as per plan and logged effort is in sync with con-sumed effort

c. Absence of Activity Planning in team, ideal time for activity planning being first week of every month by PL. Refer to section Activity Planning – Backbone of Quality

d. Absence of Task Prioritization. Refer to section Prioritization of Tasks

e. Cross Allocation of Team Members in wrong Work Order Numbers due to project's Budget con-straints – this leads to data redundancy in system

2. Material

a. Lack of guideline in terms of standards, maintenance techniques etc. Refer to section Solution Formation

3. Measurement or Inspection

a. Lack of Knowledge in Measurement Techniques, COQ generation formula, relationship among Preventive, Appraisal and Rework efforts

b. Erroneously reporting Time Consumption on executed activities due to improper effort logging by team

4. Man or People

a. PL's with no experience in Time / Effort Prediction, which affects Activity Planning by PL
b. PL's limited knowledge in Cost of Quality aspects
c. Standard RCA Knowledge and regular RCA practices are missing, due to which PL is not able to troubleshoot the outlier incident

B. Activity Planning – Backbone of Quality ([12], [13], [14],[17])

Planning is one of the most important time management and project management techniques. For individuals involved in multiple simultaneous activities on a regular basis with strict timeline, activity planning is most important in order to ensure following:

1. Activity planning helps in formulating feasible plan of action in achieving the target
2. Planning helps teams to be prepared for obstacles, which may lead to non-value adding wastage if not mitigated on time
3. Planning helps in utilizing experiences from historical instances which is the essence of prevention
4. Team can prioritize activities through prior planning, given the existing strength and expected quality parameters

Metric Cost of Quality depends upon mainly three types of activities – Preventive, Appraisal and Rework. If Rework activities are categorized as Rework due to Internal Failure & Rework due to External Failure, below relationship holds true:

Appraisal Activity (AA) is directly proportional to Internal Failure (IF) [AA ∝ IF] -------------------------------- EQ1

This is because more effort in internal review and testing means more chances of capturing internal de-fects

Appraisal Activity (AA) is inversely proportional to External Failure (EF) [AA ∝ 〖EF〗^(-1)] ------------- EQ2

This is because more effort in internal review and testing means less chances of external defects

Preventive Activity (PA) is inversely proportional to Internal Failure (IF) [PA ∝ 〖IF〗^(-1)] -----------------EQ3

This is because defect prevention activities ensure avoidance of defect injection, hence less chances of errors

Preventive Activity (PA) is inversely proportional to External Failure (IF) [PA ∝ 〖EF〗^(-1)] ---------------EQ4

This is because defect prevention activities ensure avoidance of defect injection, hence less chances of errors

From Customer Satisfaction perspective, reducing External Failure is the target for any project. Appraisal Activities are important as that ensures reduction in External Failure. However, simultaneously Appraisal activities increase internal defect capturing which includes certain amount of cost for fixing those failures Rework due to resolution of defects / failures can be avoided if defects are prevented from being injected in the code. From last four equations it is evident that Preventive activities must be paid higher attention, as that may reduce overall cost consumption in Appraisal and Rework buckets. This type of activity distribution is not possible for any team without having prior activity planning.

C. Wastage Elimination ([15], [16])

While continuing with previously drafted equations among activity types, Cost of Quality Maintenance Activities can also be categorized among two components – Cost of Value Adding Activity (VA) and Cost of Non-Value Adding Activity (NVA).
This can be rewritten as:
Cost(C) = VA + NVA -- EQ5

Again, Quality (Q) is also directly proportional to Cost (C) [Q ∝ C] --EQ6
This is because, more cost spent on quality maintenance activities will ensure more improved quality

However, practically Cost cannot be unlimited, rather it should target a maximum value as set by the Organization. Hence Quality needs to be attained with sufficient cost according to available capacity, but within budget. Hence there appears an upper limit on Cost part which are denoted by C_max. Hence, EQ5 can be rewritten as:

C = VA + NVA, C <= 〖C〗_max --EQ5-1

Again Quality factor (Q) gets derived based on only Value Adding part of the activities. So, keeping cost within budget Quality can be improved by reducing Non-Value Adding activities and increasing Value Adding part, and this continues until Non-Value Adding part is totally eliminated, which is an ideal scenario and may not always be achievable in real life. Hence to keep in sync with real life situations our aim is to optimize cost of quality, by maximizing VA and minimizing NVA activities.

Now Value Adding and Non-Value Adding activities can further be decomposed into elementary level tasks. Value Adding activity for Quality maintenance include mainly listed ten tasks which are covered in Preventive, Appraisal and Rework bucket.

VA = Training & Development (TD) + Defect Prevention (DP) + Prepare Standard & Guideline (PSG) + Review (Rev) + Testing (Test) + Project Management Review (PMR) + Audits (Audit) + Final Inspection (FI) +Internal Failure (IF) + External Failure (EF) ---EQ7

Non-Value Adding activities are seven types of wastes / Muda's known as TIMWOOD [7] in Lean methodology:
NVA = Transport + Inventory + Motion + Waiting + Over Processing + Over Production + Defects
---EQ8

Where

Transport is - Unnecessary transport and handling of goods

Inventory is - Inventories awaiting further processing or consumption

Motion is - Unnecessary motion of employees

Waiting is - Waiting for an upstream process to deliver, or for a machine to finish processing, or for a supporting function to be completed, or for an interrupted worker to get back to work

Over Processing is - Unnecessary over-processing (for example, relying on inspections rather than designing the process to eliminate problems)

Over Production is - Overproduction of things not demanded by actual customers

Defect is – Failure to meet the expectation

Purpose of this activity planning concept is identifying potential existence of NVA wastes from historical data, which are causing most cost, without improving quality. Once identified team will be able to minimize them by taking proper solution steps and will be able to put more effort in VA activities, which will in turn help in improving the quality

D. Capacity vs Standardization

Capacity denotes maximum possible containment level and Standardization denotes minimum expectation level to be met. In terms of cost, Capacity is synonymous to Maximum allocated Budget (Upper Limit), Standardization is synonymous to Minimum Budget requirement (Lower Limit) for ensuring that expected standard is achieved.

For Quality Maintenance activities there are Organization wide lower and upper targets which are decided based on the maturity of Organizational processes at some point of time. On a regular interval this type of targets may move forward to denote current process maturity and an effort is made to sync up all the ex-isting projects to move up to that standard.

Optimization is required to ensure that existing process is able to meet the minimum quality requirements for which lower limit needs to be adhered, while upper limit denotes cost of quality must not exceed the available budget.

For example, in one Organization COQ limits are set as 15% and 17% for Development projects during the year 2013-2016, by an external Auditing agency. So all development projects made an explicit effort to maintain expected quality standard with Cost limits. However, at that point of time containment of Agile Development projects were minimal. With inclusion of more Agile Development projects supported by the Organization it was noticed that due to Agile methodology, same level of quality maintenance was possible with less cost as the process deals with short cycle time with minimum chances of failure. So while the Organization is re-audited by the same external agency, this target of 15%-17% need to be segregated among Agile and Non-Agile processes based on improved process maturity at Organization level.

However, the optimization between Capacity and Standard is a continuous practice to be executed by each and every elementary unit of the Organization

E. Prioritization of Tasks

Prioritization is an essential skill of a team to make very best use of efforts for each and every team member. As a principle, it means doing 'first things first;' as a process, it means evaluating a group of items and ranking them in their order of importance or urgency.

As depicted in equations EQ5-1 and EQ6, Quality is directly proportional to Value-Adding Activity Cost and Cost of maintaining quality is limited to an upper limit C_max. That essentially indicates team has to prioritize all open value-adding activities according to urgency and requirement of executing project, as team will not have sufficient Cost bandwidth to execute all the activities in one month. Naturally less prioritized items need to be moved to next month and to be taken care during month beginning activity planning by Project Leader.

This prioritization concept is explained in detail through the Real Life Simulation Example on Section 10.

F. Effort Modulation & Regulated Output

Project level Effort Modulation shows its effect in the metric value output. This is an analogy to Control System concept of "Transient State and Steady State Response" ([17], [18], [19]) where these four steps occur and system moves through two states Transient State and Steady Sate:

1. No modulation of input - Output oscillates to great extent
2. Input modulation starts and at preliminary stage – Output oscillation reduced, with negligible visibility of the change
3. Input modulation stabilizes and at intermediate stage – Output oscillation reduced, which is prominent
4. Input modulation process is at matured and stable stage – Output oscillation eliminated

First three steps are contained in Transient state where the Steady State is reached at step 4 when no oscillation exist.
The same concept can be utilized here to show that with more matured practice of Activity Planning and Feedback Analysis in place, COQ metric value seizes the oscillation which is a notation of reduction in variation.
Through implementation of Activity Planner tool (explained in next section "Solution Formation") by all the project teams, they are able to modulate their effort distribution and to regulate the COQ value.

Below figure shows how COQ regulation is actually done. Before piloting the tool (Pre-pilot phase) the COQ value is truly random and can take any value.

As we move towards right through Time coordinate, we can see gradual reduction of the oscillation in COQ metric value as project teams are able to modulate their effort distribution as per the priorities of the tasks & set of project requirements. The well-planned effort distribution led to COQ value within standard limits, with reduced variance in place.
In steady state phase the COQ stays in very close proximity region of the expected COQ target with almost negligible variance Thus the output is regulated.

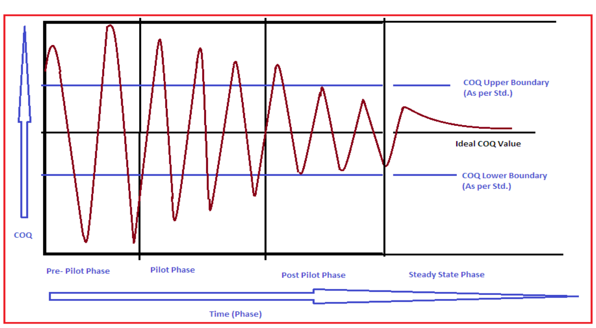

Figure 2 : Transient Response Feature Diagram

III. Solution Formation

Based on the challenges identified in Fishbone RCA, the below solution has been proposed. Here the idea is instead of considering Cost of Quality metric as the eventual outcome of activities, proactively planning tasks in such a way that Cost of Quality standards are met automatically. This is much similar to standard Prediction Models working today.

A. Introducing Activity Planner Concept

To build a sustainable solution which takes care of quality maintenance cost for a project, an analogy is drawn between effort consumption and real life money expenditure. The concept is explained below:

In real life scenario, quite often we are involved in buying multiple items together. For every item we have certain quality expectations in mind. Simultaneously we need to keep the budget constraints in focus as well. Hence every time while buying certain items simultaneously we keep focus in two things – standard quality and capacity in terms of budget. Normally we plan for it before searching for the intended item. Most of the time we end up within normal budget and sometimes we cross the budget also although that is minimal. Hence proper budget setting and planning can ensure optimal money expenditure for individuals.

Similarly, effort consumption can also be considered - as effort is nothing but soft cost (cost which is de-rived indirectly from effort calculation with per hour billing rate). This is because in any industry effort can be converted to cost whenever per hour billing rate or per hour salary amount is known for an employee. Quality Maintenance Cost is derived only from efforts in different categories and its budget is set at organization level. Hence it can also be optimized with regular activity planning practice in place.

We propose the solution by introducing monthly activity planning concept and planning tool at project level, as that is a standard granular level in which activities can be judged. This project level planning de-pends upon no. of team members actively working in the team, no. of working days in current month and COQ budget at organization level in terms of lower and upper bound.

B. Features of Activity Planner Tool

This section provides important features of our proposed solution "Activity Planner Tool" which can be used at the beginning of every month by project leaders for pre-planning team's quality maintenance activities by prioritizing tasks in order to maintain the Cost budget while ensuring minimum Quality expectations. The tool was built on simple formula based excel, containing five planning steps. The whole solution is depicted as screenshots from that excel showcasing step by step planning.

The activity planner concept is a bottom up approach which starts with setting cost at first level. Cost set-ting is based upon project type wise Organizational budget, no. of team members and no. of working days in current month. Cost setting needs to be performed at granular level of implementation as follows:

Cost of Quality value setting

- Preventive effort value setting:
  - i. Training and Development effort
    - a. Prioritization of Trainings – Training Plan
  - ii. Defect Prevention effort
    - a. Prioritization of previously identified preventive actions – DPCA Report
  - iii. Prepare Std & Guideline effort
    - a. Planning for regular revision of coding standards and guidelines

- Appraisal effort value setting:
  - i. Project Management Review effort
  - ii. Audit effort
  - iii. Review effort
  - iv. Testing effort
  - v. Final Inspection effort

- Rework cost setting
  - i. Non-Maintenance project Rework (upper limit 5% of total effort)
  - ii. Maintenance project Rework (upper limit 2% of total effort)

Throughout the month one team needs to follow the activity planner as designed by Project Leader at the beginning of the month and organize relevant activities according to that. Sometimes Quality Maintenance cost may overrun the planned budget. Team will be responsible to find out proper causes for that and take care of those causes while planning next month activities. This way activity planner tool may act as an experience based prediction model where team predicts quality vulnerabilities from its existing nature and plan to eliminate those in advance.

Activity planner concept is built on formula based excel, where PL needs to execute 5 steps as listed be-low:

- Step1- Selection of Project Type (Development/Maintenance/Support/Testing/Conversion/ Package Implementation)

--Tool will provide COQ Upper Limit, Lower Limit and Rework Upper Limit

- Step2- Setting planned COQ value within limit (coqVal)

- Step3- Setting COQ Component Values within Rework Limit

--PL sets Preventive (prevVal), Appraisal budgets (apprVal) from within planned COQ value.

--Tool ensures that Rework (reworkVal) bucket does not cross its specified limit

- Step4- Providing Data for Effort Calculation

--PL provides information on No. of Associates (ResCount) in Team and No. of working days in current month (DayCount)

--Tool calculates Total Effort (in PH) as { ResCount * DayCount * 9} (assuming 9 PH per day)

--Tool calculates COQ Effort (in PH) as {Total Effort * coqVal}

--Tool calculates Preventive Effort (in PH) as {Total Effort * prevVal}

--Tool calculates Appraisal Effort (in PH) as {Total Effort * apprVal}

--Tool calculates Rework Effort (in PH) as {Total Effort * reworkVal}

--Tool calculates Non-COQ Effort (in PH) as {Total Effort – COQ Effort}

- Step5- Consuming Planned Efforts in Tasks

--Tool calculated Preventive Effort needs to be consumed by

1. Training & Development
2. Defect Prevention
3. Prepare Std & Guideline

--Tool calculated Appraisal Effort needs to be consumed by

1. Project Management Review
2. Audits
3. Review
4. Testing
5. Final Inspection

These 5 steps cumulatively ensures Quality Maintenance activities spent in an optimized way.

IV. Benefits

1. Activity Planner tool helps identifying gaps / quality vulnerabilities based on previous performances of team

2. Planning activities ensures systematic execution of quality maintenance effort, less chance of abrupt activities

3. Prior evaluation of COQ ensure maintenance of minimum standard (lower limit of COQ value) and maximum budget (upper limit of COQ value)

4. When component wise effort availability is known, team tends to prioritize activities to fit in availa-ble budget

5. Systematic planning eases troubleshooting errors and causal analysis for outliers

6. Controlled utilization of available resources are ensured

7. Minimum variance in Cost of Quality value, on a long term basis

8. Provides scope of Non-Value adding effort (Waste) identification at project level – helps making sys-tems leaner

9. Helps fresher / new joiners in the team to understand the entire COQ planning things in a user friendly manner as this COQ planner tool is operated in very simple way

V. Case Study and Statistical Analysis of Results

The case study section showcases results of a Proof of Concept (POC) exercise which is conducted on three sample development and three sample maintenance type of projects in one Organization, and it helps in proving the proposed solution through statistical validation of improved results.

- Selected project details are provided in section 5.1. Introduction: Proof of Concept
- Cost of Quality data for selected projects before implementation of activity planner solution is shown in section 5.2. Situation before Implementation of Solution
- Cost of Quality data for selected projects after implementation of activity planner solution is shown is section 5.3. Improvement after Implementation of Solution
- Sections 5.4 through 5.9 provide statistical measurements using different techniques on before improvement and after improvement data of selected projects and comparison between the two cases.

A. Introduction – Proof of Concept

Activity Planner tool is piloted on few selected projects from one organization. Collected results have shown positive responses retrieved in COQ metric values, pertaining to prior planning concept. The selected projects have below characteristics:

Selected Development Projects:
DevProjectA - Team Size - 26, Complex Project with Multiple Applications
DevProjectB - Team Size - 72, Waterfall Methodology
DevProjectC - Team Size - 6, Agile Methodology

Selected Maintenance Projects:
MaintProjectA - Team Size - 8, Agile Methodology
MaintProjectB - Team Size - 16, Waterfall Methodology
MaintProjectC - Team Size - 63, Complex Project with Multiple Applications

B. *Situation before Implementation of Solution*

Before implementation of Activity Planner concept, selected piloted projects showcased below COQ values over a period of six months.

Table 1 : Development Project COQ Values Before Improvement

PROJECT NAME	Apr'15 COQ	May'15 COQ	Jun'15 COQ	Jul'15 COQ	Aug'15 COQ	Sep'15 COQ
DevProjectA	0	0.36	0	0.22	0	0.34
DevProjectB	21.42	65.36	11.05	39.98	17.12	17.2
DevProjectC	0	0	0.6	0	2.83	1.15

Table 2 : Maintenance Project COQ Values before Improvement

PROJECT NAME	Apr'15 COQ	May'15 COQ	Jun'15 COQ	Jul'15 COQ	Aug'15 COQ	Sep'15 COQ
MaintProjectA	0.29	1.8	1.4	1.06	11.55	9.8
MaintProjectB	4.44	5.69	0.19	0.06	0.14	5.05
MaintProjectC	5.68	5.94	9.02	4.53	4.42	1.18

C. *Improvement After Implementation of Solution*

After implementation of Activity Planner concept same projects showcased below results over five months duration:

Table 3: Development & Maintenance Project COQ Values After Improvement

PROJECT NAME	Oct'15 COQ	Nov'15 COQ	Dec'15 COQ	Jan'16 COQ	Feb'16 COQ
DevProjectA	15.95	14.91	15.03	15.01	16.8
DevProjectB	15.98	21.64	14.38	19.26	15.34
DevProjectC	16	16.02	14.44	15.01	14.98

PROJECT NAME	Oct'15 COQ	Nov'15 COQ	Dec'15 COQ	Jan'16 COQ	Feb'16 COQ
MaintProjectA	10.07	10.54	10.97	10.08	10.17
MaintProjectB	10.5	10.48	10.53	10.51	10.52
MaintProjectC	10.5	10.28	10.6	10.55	10.29

D. Trend in COQ Values

Below are the comparative charts before and after implementation of activity planner, for all six piloted projects:

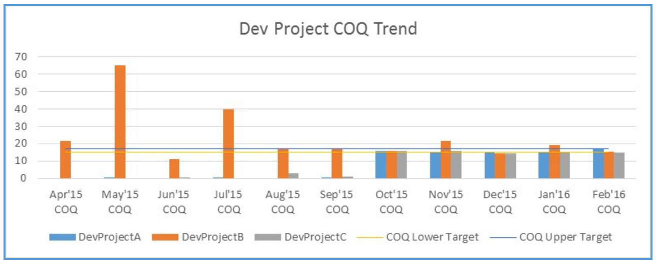

Figure 3 : COQ Monthly Trend for Development Projects

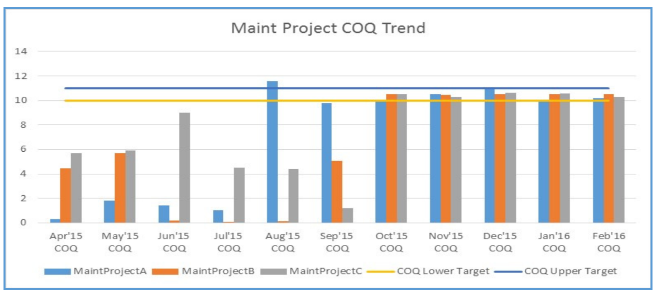

Figure 4 : COQ Monthly Trend for Maintenance Projects

E. Variance Trend

Below are the Variance trend charts for all six piloted projects (three Development Projects, three Maintenance Projects as piloted) before and after improvement. Here, the variance represents the average value of the variances for three projects in any particular month.

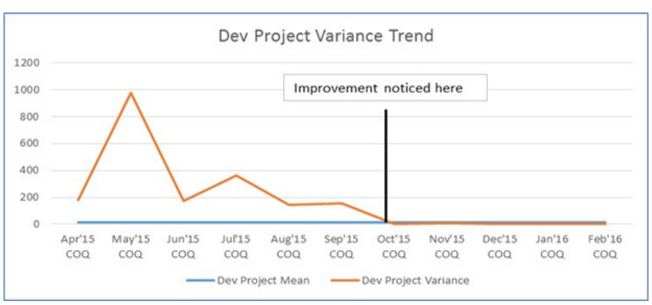

Figure 5 : COQ Variance Trend for Development Projects (Dev Project Mean = 16.00)

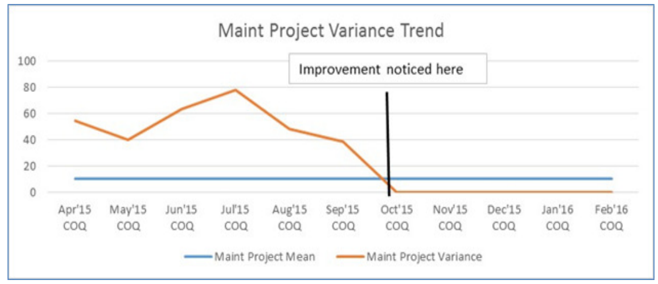

Figure 6 : COQ Variance Trend for Maintenance Projects (Maint Project Mean = 10.50)

F. Control Chart – Xbar-S

Below are the XBar-S charts for piloted projects, before and after improvement

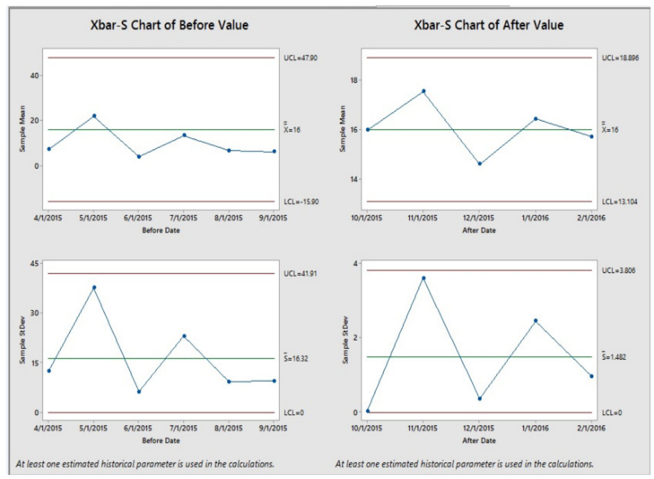

Figure 7 : XBar-S Charts Before and After Improvement - Development Project

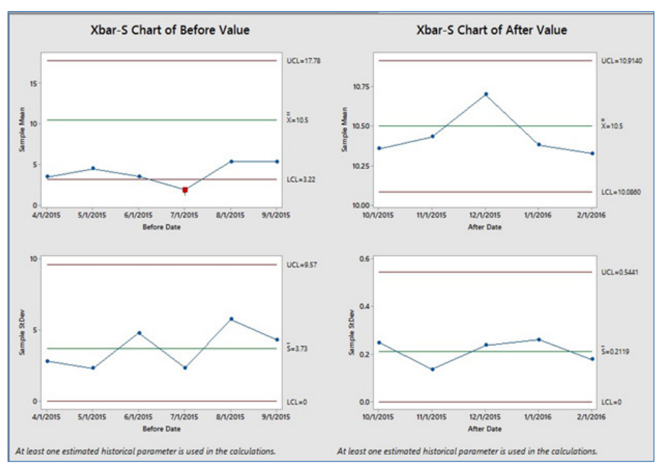

Figure 8 : XBar-S Charts Before and After Improvement - Maintenance Project

G. ANOVA – Equal Variance Analysis

Below is the output of ANOVA Equal Variance analysis for the piloted results, before and after improvement

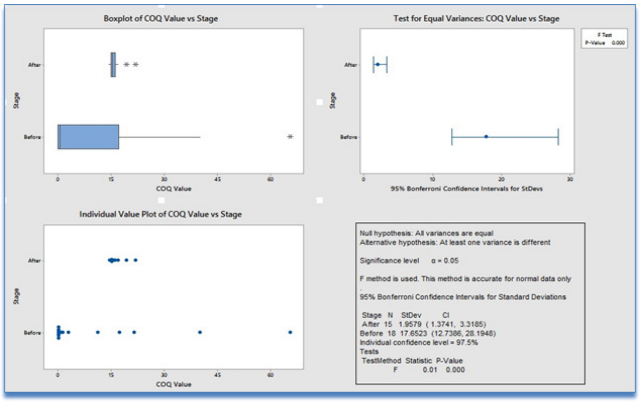

Figure 9 : ANOVA Equal Variance Analysis for Development Project

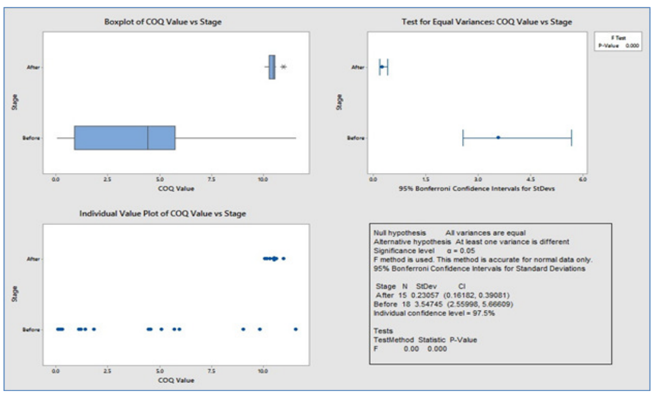

Figure 10 : ANOVA Equal Variance Analysis for Maintenance Project

H. Old and New Process – Sigma Level Improvement

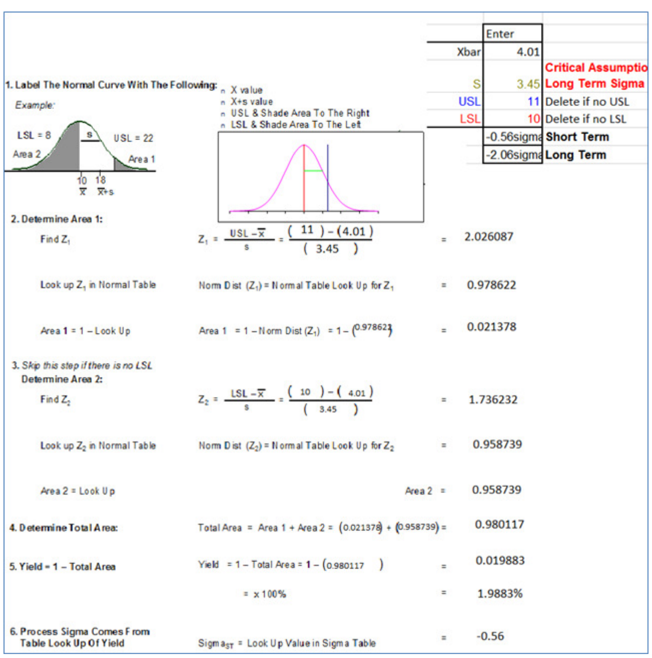

Figure 11 : Sigma Calculation on Before Improvement Data

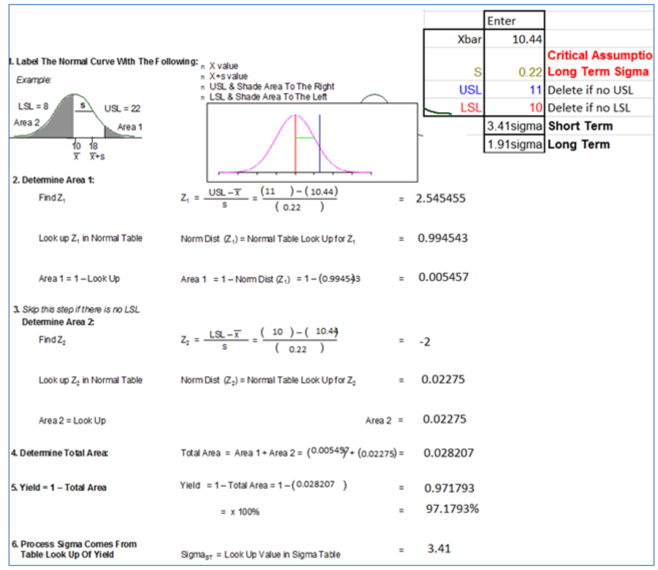

Figure 12 : Sigma Calculation on After Improvement Data

I. Old and New Process – Capability Analysis Summary

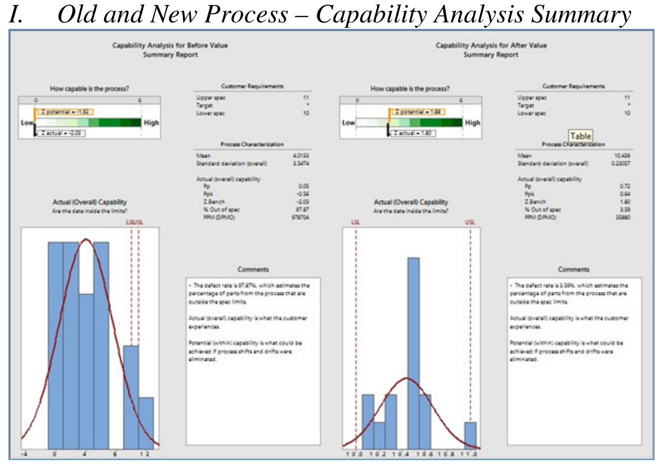

Figure 13 : Capability Analysis Report for Proposed Process

VI. REAL LIFE SIMULATION EXAMPLE

Here we are trying to provide a real life example of optimizing quality maintenance cost, using our pro-posed approach:

Raw Data for project:

A. Project Name – MyQualityMaintProject

B. This project consists of one PL and five team members (TM1, TM2, TM3, TM4, TM5)

C. Project Type – Maintenance

D. Activity list:

   i. Support
   ii. Small Enhancements
   iii. Quality Maintenance

1. Training & Development
2. Defect Prevention
3. Prepare Std & Guideline
4. Project Management Review
5. Audits
6. Review
7. Testing
8. Final Inspection
9. Rework

E. Allowed band for COQ is 10% - 11% in current organization

F. Project Start Date – Jan'16

G. Here is the necessary competency list for this project, in descending order of priority

Domain	Training Name	Team Members to be Trained	Estimated Time (Hours)
Technical	Core Java	TM1, TM2, TM3	10
	PL/SQL	TM3, TM4, TM5	10
Process	Security Training	TM1, TM2, TM3, TM4, TM5	1
	Integrated Quality Management Systems	TM1, TM2, TM3, TM4, TM5	5
	Defect Prevention Awareness	TM1, TM2, TM3, TM4, TM5	1
	Performance Improvement Basics	TM1, TM2, TM3, TM4, TM5	2
Aspirational	Dot Net	TM3	15
	SalesForce.com	TM2, TM4	25
	DBA Certification	TM1, TM5	35

Figure 14 : Competencyc List

Now the PL needs to create the activity planner and team has to follow it in listed ways:

<u>For the month of Jan'16 – Planned on 1st Jan'16</u>

Step1 – PL select project type Maintenance in Activity Planner Tool:

He finds COQ limit 10% - 11%, with Rework Target 2%, as per organizational standard

Step1 - Select Project Type As in EQP			
Select Project Type	COQ Lower Limit	COQ Upper Limit	Rework Target
Maintenance	10%	11%	2%

Figure 15 : Step1 - Proposed "Activity Planner" Solution

Step2 – PL sets his expectation of 10.5% COQ at month end (based upon experience)

Step2 - Set COQ Value within Limit	
Set your COQ Budget (Please consider setting any value within applicable range)	10.5%

Figure 16 : Step2 - Proposed "Activity Planner" Solution

Step3 – PL sets individual COQ components like this:

Step3 - Set COQ Component Values within Rework Limit	
Set Preventive Budget	6.0%
Set Appraisal Budget	3.0%
Rework Budget	1.5%
Total COQ	10.5%

Note: If the cell is RED, there is data mismatch between planned and calculated COQ. Please revise the distribution

Figure 17 : Step3 - Proposed "Activity Planner" Solution

Step4 – PL provides effort calculation data:
No. of Associates – 5 Team Members & 1 PL – Total 6; 21 working days for Jan'16; Organizational rule of 9 hours per working day

Step4 - Provide data for Effort Calculation		
Planned (Fill at Beginning of the Month)		Actuals (Fill at End of the Month)
No of Associates in team	6	
No. of Working Days in Current Month	21	
Total Effort in PH	1134	
COQ Effort in PH	119.1	0
Preventive Effort in PH (for current month)	68.0	0
Appraisal Effort in PH (for current month)	34.0	0
Rework Effort in PH (for current month)	17.0	0
Non-COQ Effort in PH	1014.93	0

Figure 18 : Step4 - Proposed "Activity Planner" Solution

So, PL can see 119.1 PH is available for 9 quality maintenance activities; 1014.93 PH is available for Support and Enhancement activities, total effort being 1134 PH.

Step5 – PL plans to consume efforts in most elementary level tasks like this:

Preventive Bucket		Assigned To - Project Role
Effort Required for Defect Prevention Analysis (PH)	30	TM1 - DP Prime
Effort Required for Preparing Standards, Guidelines, Manuals, Checklists etc. (PH)	10	TM3 - Standards Maintenance SPOC
Effort Required for Training (PH)	28	TM2 - Core Java (10 PH) TM4 - PL/SQL(10 PH) PL, TM1, TM2, TM3, TM4, TM5 - Security Training(6 PH) PL, TM1 - Defect Prevention Awareness(2 PH)
To be Consumed	0.0	
Appraisal Bucket		**Assigned To - Project Role**
Effort Required for PMR (PH)	10	PL
Effort Required for Audit(PH)	5	PL
Effort Required for FI (PH)	2	PL
Effort Required for Internal Review(PH)	10	TM2, TM4 - Internal Reviewes
Effort Required for Internal Testing(PH)	7	TM5 - Internal Test Associate
To be Consumed	0.0	

Figure 19 : Step 5 - Proposed "Activity Planner" Solution

Now PL assess actual effort consumption on 31st Jan'16 and he finds following information:

- As on 31st Jan'16 COQ value is 12%, because team spent 136.08 PH in quality maintenance activities, which is approx. 17 PH extra from planned
- PL checks team member wise effort spent report and find that TM3 attended Dot Net course for 15 hours and PI Basics Course for 2 hours – these two courses were not planned by PL for Jan'16
- PL discusses this with TM3 and finds that TM3 lost the planning information from his mail, due to over quota error
- PL decides to put activity planner on central display board, instead of sending mails
- PL follows the new strategy Feb'16 onward and able to optimize the COQ value

In this situation PL handles Waiting and Over processing wastes, by avoiding mails and making the planner available all time

VII. Conclusion

A. Summary

Below are the summarized points for the whole work delivered:

1. Concept building on Activity Planning, Task Prioritization, MUDA Wastes Elimination, Capability and Standards, Transient Quality output through controlled Efforts and associating all these concepts to Cost of Quality generation
2. Proposed solution of prior activity planning by simple excel based planning tool
3. Case study to showcase the statistical validation result of implementation of the solution on sample projects
4. Example of ideal usage of the solution

B. Limitations

This article does not provide provision for historical instances, which can be used for prediction

VIII. Future scope of improvement

Future scope of improvement includes:

1. Activity Scheduler ensuring Minimum Waiting Time – While Activity Planner solution works for the whole team, created by Project Leader at month beginning, at individual level also one should be able to prioritize activities on a daily basis while ensuring minimum waiting time for all stakeholders
2. Consolidation of Training Plan & Delivery Plans along with Activity Planner – This way Activity Planner can be treated as a consolidated planning tool
3. Merging Defect Prediction Model along with Activity Planner

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