

# Development of Quality Key Performance Indicators (KPI's) for Quality Management in Construction – A Review

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**Abstract**— For a successful construction project it needs to be well balanced within time, cost and quality factors. Within the construction management a measurement of performance in cost, time and quality point of view is very fundamental task. This is usually based on professional observations and checking's with use of metrics such as Key Performance Indicators (KPI's). Due to considerable changes in recent times, technology widening and high expectations of user need of key performance indicators in construction industry has increased to pace up with others. As construction industry is facing issues with maintaining quality, this type of study has become necessary. KPI's helps to more economical utilization of all resources and resulting into improvement in quality performance by user point of view. This project work is focused on implementing Key performance indicators within planning, scheduling stage as well as day to day quality performance checks. The quality breakdown structure is adopted as basic tool to consider various elements in construction quality for different work packages in construction project. Analytical Hierarchy Process (AHP) has been adopted to put them in relationship and to evaluate their relative weight in project and its sub processes.

**Key words:** Construction Quality, Key Performance Indicators (KPI'S), AHP

## I. INTRODUCTION

Maintaining quality is one of significant task for construction industry from past. Concept of quality assurance and quality control has been implemented in other economic sectors effectively. Being unique from other industries construction industry needs its own approach for quality control and assurance. Construction project management can play a significant role to maintain quality and for that it requires much more meaningful information than past. There are some factors which demands to focus over quality throughout project life cycle.

- Now a day's construction projects involve more sub process than past, improving project complexity simultaneously.
- Total duration of construction projects exceeds limits which have been quoted before.
- As new technology introduced in work cost and time requirement becoming more and more.

To overcome these issues project owners and working professionals needs to adapt new approach for quality assurance and control. The quality control and quality assurance has broad meaning as per various working sectors are concerned, which needs to be understand first.

## II. CONCEPTS OF QUALITY BY QUALITY MANAGEMENT GURU'S

Over the past few decades, Total Quality Management (TQM) gurus have been developed certain theories in the area of business quality improvement. For adapting new quality performance measurement understanding of quality control and assurance by these theories needs to go through. <sup>[1]</sup>

### A. W. Edwards Deming (1950)

W. Edwards Deming played an important roles and responsibilities on management at both the individual and company level, which he believed 94% of quality problems are management responsibility. He has pointed out fourteen point plans which is a complete philosophy of management that can be applied to any scale of organizations in the public, private or service sectors. The Deming's cycle is a universal improvement methodology where the whole idea is to constantly improve and thereby reduce the difference between the requirements of the customers and the performance of the process. As an explanation, the cycle is about learning and ongoing improvement, learning what works and what does not in a systematic way; and the cycle repeats; after one cycle is complete, another cycle is started.

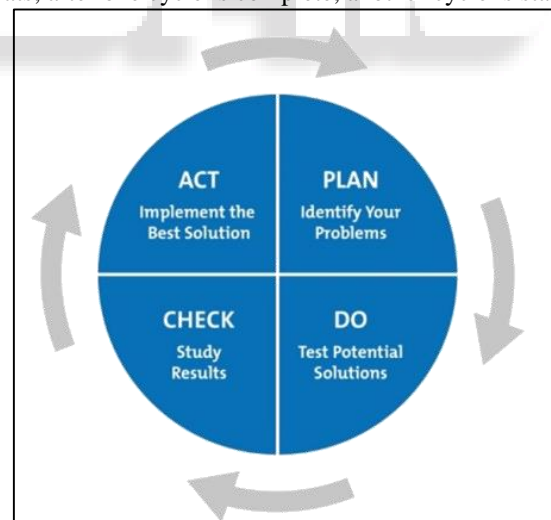


Fig. 1: PDCA cycle

### B. Dr. Joseph M. Juran (1988)

Dr. Joseph M. Juran developed the quality trilogy namely quality planning, quality control and quality improvement. A good quality management requires proper quality actions to be planned out, improved the quality and controlled using tools. The trilogy works by achieving the process control at one level of quality performance, then plans are made to improve the performance on a project based on project basis, using tools and techniques such as Pareto analysis. He not only concentrates on the end customer, but on other external

and internal customers. Each person along the chain, from product designer to final user, is a supplier and a customer. In addition, the person will be a process, carrying out some transformation.



Fig. 2: Quality trilogy

C. Philip B. Crosby (1979)

Philip B. Crosby is well known in Quality Gurus for the concepts of "Quality is Free" and "Zero Defects". His quality improvement process is based on four absolutes of quality which are:

- 1) Quality is conformance to requirements
- 2) The system of quality is prevention
- 3) The performance standard is zero defects.
- 4) The measurement of quality is the price of non-Conformance

D. Dr. Kaoru Ishikawa (1979)

Dr Kaoru Ishikawa has made many contributions to the development of quality and his total quality viewpoint, companywide quality control, his emphasis on the human side of quality, the Ishikawa diagram and the assembly and use of the "seven basic tools of quality" are the most noteworthy. The "seven basic tools of quality"

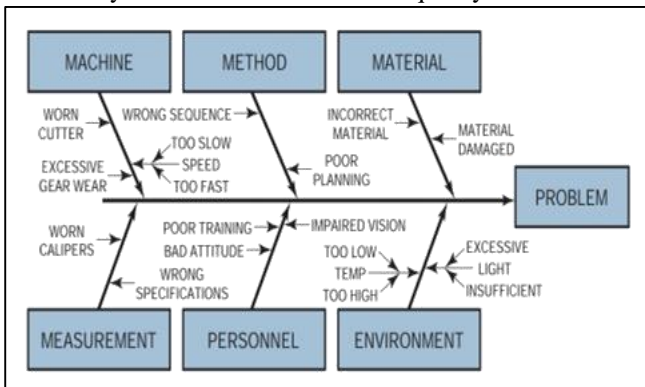


Fig. 3: Fishbone diagram

E. Armand V. Feigenbaum (1961)

Armand V. Feigenbaum was the originator of "total quality control" or often referred to as total quality. He has defined total quality as "An effective system for integrating quality development, quality maintenance and quality improvement efforts of the various groups within an organization, so as to enable production and service at the most economical levels that allow full customer satisfaction".

III. KEY PERFORMANCE INDICATORS (KPI'S)

The performance measurement is one of well-known issues for construction industry from very long time. To measure performance of working project in particular point view such as for quality, time, cost etc. there are some set of values known as metrics and performance indicators. Metrics in project management are measurement of project performance. These indicators are evaluated against the current work performance. Performance indicators are measures of project impacts, outputs and inputs that are monitored during project implementation, which assess work toward project objectives. They are also used later to evaluate a project's success indicators organize information to find out relationships between input, outputs and help to identify problems along the way towards project objectives.

Reference [2] divides these project performance metrics into "normal metrics" and "key performance indicators (KPI'S)." Key performance indicators are those critical metrics which defines exact and concise way to evaluate current project status and even can be used to forecast future project performance.

Reference [3] defines three categories of metrics:

- 1) Results Indicators (RIs), give information about what has been accomplished;
- 2) Performance Indicators (PIs), give information about what must be done to increase or meet performance requirements;
- 3) Key Performance Indicators (KPIs), the critical performance indicators that can drastically increase performance or accomplishment of the objectives.

Reference [4] explains a research study that aims at ranking key quality factors based on the European Foundation for Quality Management (EFQM) framework in the Indian construction industry.

Reference [5] explains performance indicators regarding the construction projects in India and also emphasizes the point of value management as one of the most important performance indicator in construction project.

In Project performance Management Practice there are several metrics, but only few of them can be used as KPIs. In construction project management there are some measures of building products and processes quality that are mandatory by law and needs to be verified mandatorily and some other ones that are requested by owner/customer through contract documents and specifications. Traditionally the performance of construction projects is measured by means of three basic performance indicators: cost, time and quality. Recent research employed additional performance indicators to better evaluate construction projects. In particular the Minister of Construction of the United Kingdom ref [6] identified six KPIs: cost, time, quality, health and safety, business performance and change orders. Instead, updated research [7], added to time, cost, quality, and safety KPIs, the following KPIs: environment impact, client and project team satisfaction, and technology transfer.

The aim of this paper is to define quality related key performance indicators for construction for quality control and assurance purpose. The main task of research is to define a method to assess construction project quality performance through as of date. This quality evaluation based on key

performance indicators is to find out current status of work, which can be improved within project duration. So that it could not be considered as quality certification.

Generalized methods are available for monitoring and evaluation of construction activities. But it could not identify indicators which will affect accurately on quality of construction project. Instead of assessing every piece of information collected, more focused and simplified way to quality evaluation should be used.

To develop quality key performance indicators following approaches are followed

- 1) The KPI's working group
- 2) CONQUAS (Building and construction authority)
- 3) Conventional checklists based on ISO 9000 and IS codes for construction

#### IV. RESEARCH METHODOLOGY

The study of previous literature about construction quality estimate and construction project metrics has allowed benchmarking and analyzing existing approaches to construction project quality evaluation, highlighting positive and negative issues of each approach.

The research is developed into three phases. In the first phase literature about project metrics and construction projects performance measurement is reviewed. In particular existing and proposed project quality KPIs computation methods are focused. As well as standard laws and codes has referred by the quality evaluation perspective only.

In the second phase the overall project activity quality performance quantification has planned. Work breakdown structure is core tool of project management system. The Work Breakdown Structure is a deliverable-oriented hierarchical decomposition of the work to be executed into work packages that organizes and defines the total scope of the project.<sup>[10]</sup> To ensure efficient quality oriented control processes it is needed a Quality Breakdown Structure (QBS). First it is needed to specify activities of the construction project through a Quality Breakdown Structure (QBS) that identifies work packages. Work packages are group of those activities which can be evaluated on same quality specifications.

For weight distribution of quality key performance indicators found and selecting work packages for as of date quality evaluation based on quality key performance indicators Analytical Hierarchy process has followed. Various working professionals in construction industry have interacted and their opinion has considered for weight distribution of quality key performance indicators. This weighting system is the core process of quality KPIs computation.

In the third phase overall project quality assessment through the as-of date is performed. This is allowed by quality weighting of the WP and Quality Key performance indicators. The weighting system at the project scale is realized taking into account economic, aesthetic or functional aspects of the specific construction project. Than by adding the weighted performance of each activity in work package based on quality key performance indicators quality performance of that WP can find out. By adding the weighted

WP performance of each WP accomplished at the as-of date, the quality project performance status can be evaluated

#### V. OBJECTIVES OF STUDY

- 1) To understand quality related performance requirements and testing procedures.
- 2) To find out critical success factors affecting quality also known as Quality Key performance indicators (KPI's) based on various computing approaches.
- 3) By Analytical hierarchy process (AHP) weight distribution for quality KPI's and further for work packages by QBS.
- 4) To provide Quality Breakdown Structure (QBS) for analyzing quality performance of selected work packages based on Quality KPI's, as of adding them find total quality performance of construction project.

#### VI. CONCLUSIONS

This research indicates critical requirements to maintain the quality performance for an activity. (Quality related KPI's)

This gives the QBS, a hierarchical decomposition of the construction project into Work Packages (WP) that groups the activities which have the same quality requirements and specifications which further helps to assess quality performance of construction project.

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