The Cost Of Quality Reduction (COQR) On A Cross Country Pipeline Construction Project

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ABSTRACT
In today's increasingly frightful construction companies' competition, enterprises optimization to maximize profits through continuous innovation and minimization of costs to increase their competitiveness in among construction companies. The Cost of Quality method has been widely used in the manufacturing industry / construction project in oil and gas industries to improve product quality and save the cost of quality, however seldomly used in construction projects. The author introduces the successful application of the Cost of Quality method to a cross country pipeline construction project. After evaluation of the cost of quality of an on-going oversea pipeline project, the attention and commitment of top management of the construction company have been drawn. The author started a campaign to reduce the cost of quality by conducting a root cause analysis to find the root causes of quality failures and applying a brainstorm method to construct preventive actions to utilized them in the construction project. With the use of preventive measures, internal & external failures such as rework and repair at work were significantly reduced. After reassessing the cost of quality at the end of the project, the figure shows the overall cost of quality has been reduced from 15.7% to 9.9% of the contract value. The finding of this study can be a very useful lesson to other pipeline construction projects and at the same time help other quality management peers to continuously improve the quality management programs and to increase the profit of their further projects.

Keywords –Improving business results, track the cost of quality and received remarkable benefits.

1. INTRODUCTION
The core competitiveness of large international engineering enterprises is not formed in a day, and the cultivation of core competence is a long-term accumulation process. By comparing the development status of Saudi Arabia construction enterprises in overseas markets with that of large international engineering enterprises, it can be found that there is a crucial problem in the internationalization process of Saudi Arabia construction enterprises: scale enlarged, but poor profitability. Saudi Arabia construction companies over the years in overseas markets, especially in Saudi Arabia, and the Middle East regional market development speed is very quick, the turnover has been increased tremendously, but only a few of them can achieve profits in overseas markets. The purpose of an enterprise is to make profits. If it cannot make profits for a long time, internationalization is bound to be unsustainable. On the other hand, a big mount of well-known international engineering enterprises derives their profits from the international market, and they will not do unprofitable projects unless they are particularly needed. It is quite common to observe that huge re-works or repairs have been done on engineering projects. These unnecessary works increase the cost of quality tremendously, as a result, the cost of the project is over-spending. The cost of quality has been overlooked by many companies in the past due

to the cost of quality is barely accounted in the time-starved engineering project. As per American Society for Quality (ASQ), Cost of quality (COQ) is defined as a methodology that allows an organization to determine 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. Having such information allows an organization to determine the potential savings to be gained by implementing process improvements.

The cost of quality is comprised of prevention costs, appraisal costs, internal failure costs and external failure costs. The majority of COQ comes from the internal and external failure costs due to the imperfection of working processes. Many experiments have proved that reduce the internal and external failure can save the COQ tremendously. To control the cost of quality at the lowest level will benefit the overall cost of the project. To find out the present quality management performance on construction projects, the author of this literature took a case study on a cross-country gas pipeline project carried out by an SISCO of Saudi Arabia. The project locates at oversea. The main scope of the project includes construction and commissioning as per the requirements of the Owner. A project is a temporary endeavor undertaken to create a unique product, service, or result (PMI, 2018). Due to the special characteristics of the project, the project management team is temporary, construction personnel are temporarily recruited from society. This study will address the common poor quality in each process of the project. Analysis and calculate the cost of quality after completion 33% of construction works, use monetary data to bring the attention of the project manager because money is the basic language of upper management. The cost of quality at that time was significantly higher than the budget planned. To make effective measures to improve quality performance, a root cause analysis has been carried out between workers. The cost of poor-quality continues to affect the project cost performance throughout the construction industry. Many companies are improving the project performance by reducing the cost of poor quality.

The project was requested to use a traditional lump sum contract, with an international project management consultant team to act as owners professional repetitive, they will cooperate with owner's own project management team to supervise the EPC contractor together. Project quality cost data is an important indicator of quality defects and a weak point in quality management. The applied quality management strategy will benefit the company from both internal and external. It reduces the quality cost significantly, promotes the construction speed, enhances the costumer's satisfaction level, sets up a good company image and reputation. Eventually, the culture of quality will become more and more favorable. The cost of quality is just a method that can measure the process failures and provide monetary information for project management to make decisions on activities that need to be prevented their occurrence. Furthermore, the cost of quality records about one project can be a very useful lesson learned to the next project. The findings of this study should be helpful to other quality management peers to continuously improve the quality management programs and to increase the profitability of other projects.

2. OVERALL RESEARCH METHODOLOGY

2.1 The general preventive actions to improve poor-quality-

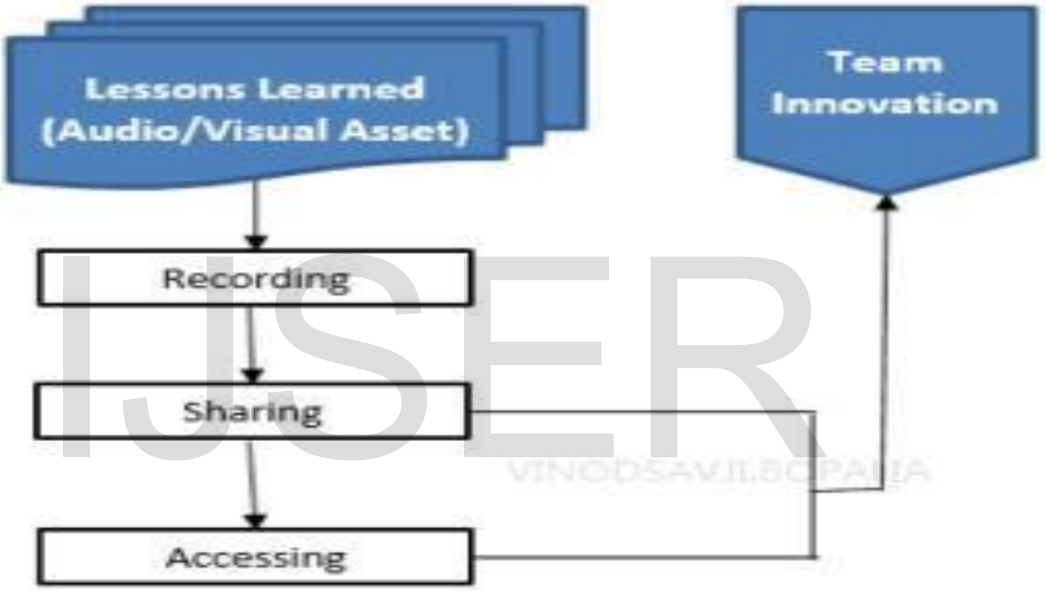
These tools are widely used for creating ideas, engendering planning, analyzing the root causes, creating a wide variety of situations for continuous quality improvement. It can be used in each stage of a construction project. These tools are listed below:

Flowchart, Data collection, Control chart, Histogram, Pareto analysis, Pie chart, Run chart, Scatter diagram, Cause-and-effect diagram, Check sheet.

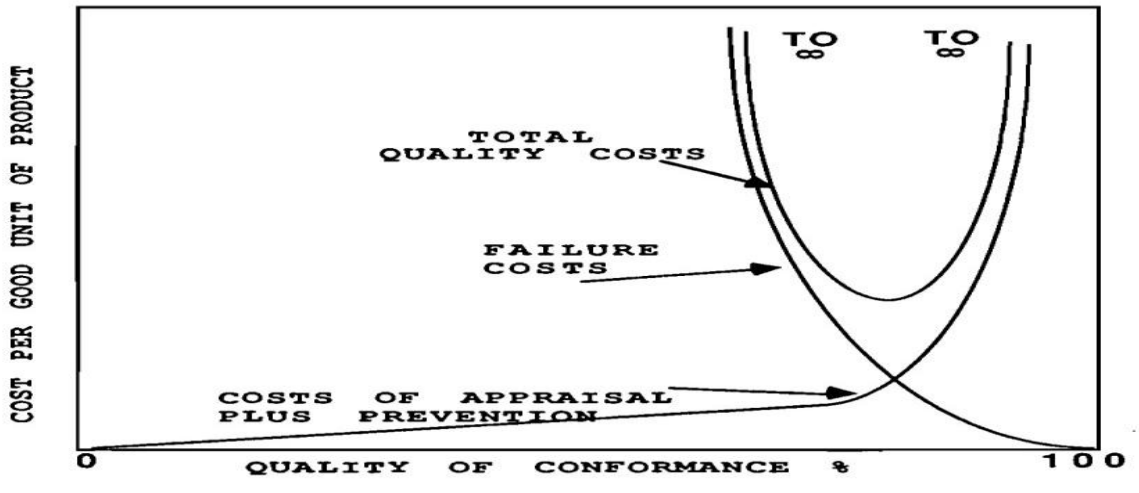
These methods, tools or techniques are widely used at various stages of construction projects to collect data, analyze root causes of rejection and take necessary preventive or remedial action to continuously improve the project quality

Analyze. The reasons for a difference? Root causes for the deviations occurred?
Generalize. What is the learning point? What are the preventive measures that should be done in future activity to avoid the failure or repeat the success part?
Lesson Learned process can be defined in Figure 3, is to record the learning throughout the project and captured detail to all applicable team members.

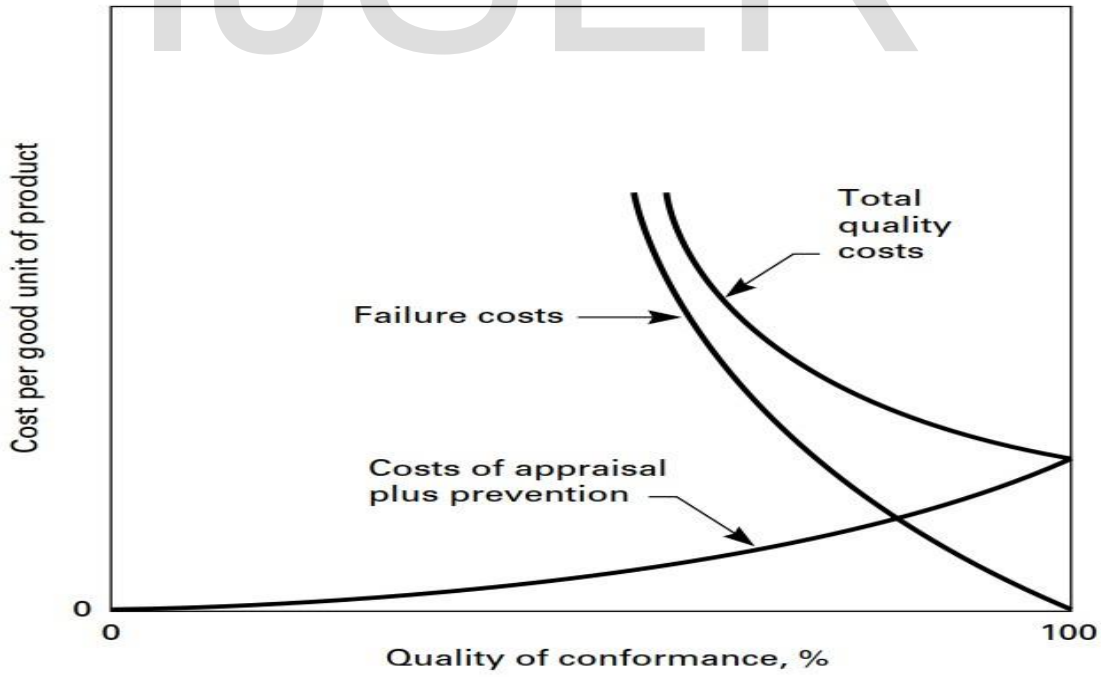
A recorded lesson learned can be captured in an audio, video or document upon the subjects. Audio is probably the best media method of recording lessons-learned meeting minutes due to the low cost and flexibility. The project team could utilize conference call recording facility to record meeting minutes. This also involves storing e-mails, presentations, etc. in a central folder. The method used to share a lesson learned does not require high tech. It can be knowledge sharing' Lessons Learned session with a wide group or sent notification to all employees.



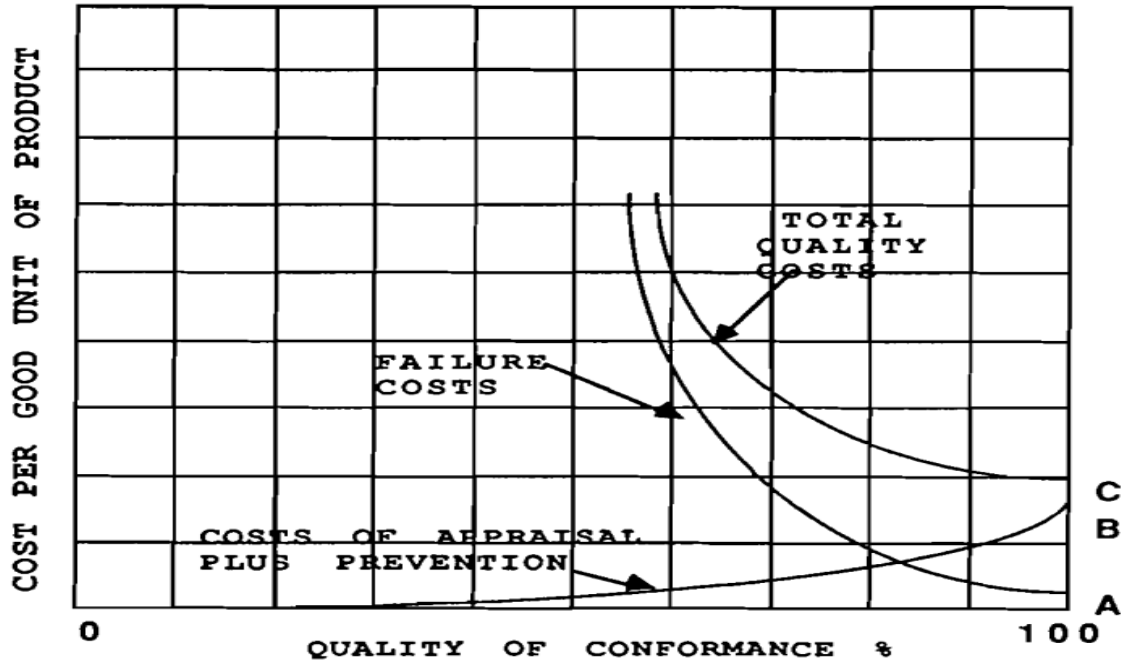
It is preferred to easy searching for a relevant lesson learned for future use from the stored asset location (either physical or online content). Using lessons learned as a valuable tool to avoid repetition of similar mistakes in other projects to improve the quality and saving quality costs, it should be a principal content of an organizational culture committed to continuous improvement.
Traditionally the total cost of quality (TQC) is claimed as the sum of the prevention costs, appraisal costs, internal and external failure costs incurred. As can be found, the lowest COQ will occur at the intersection point of the failure and prevention plus appraisal cost curves.



The failure costs: When the product is defect-free, the failure costs are zero, then increase to infinity when the product is 100 percent defective.
The costs of prevention and appraisal: These costs are zero when 100 percent defective, and rise when the perfection of the product is approached.
Total quality costs: These costs are the sum of curves 1 and 2, indicated as the third curve represents the total cost of quality per good unit of product.
From this revised quality cost model, it can be seen that the lowest level of total quality costs occurs when the quality of conformance is 100 percent, i.e., perfection. This may not always happen in the real world. Due to the fallible nature of human beings, to attain perfection at finite costs in the Twentieth century is impossible. Furthermore, the inability to quantify the impact of poor quality on revenue resulted in underestimating the failure costs.
To gain the 100 percent conformance is a trend that will extend to more products and services of greater complexity. However, it is crucial to evaluate whether quality improvement activities have reached the economic limit, we have to compare the benefits gain from lower defect against the investment made to achieve these benefits, think it cost-effectively. If the investment put in prevention and appraisal costs have no longer got any feedback, the optimum point has been reached.



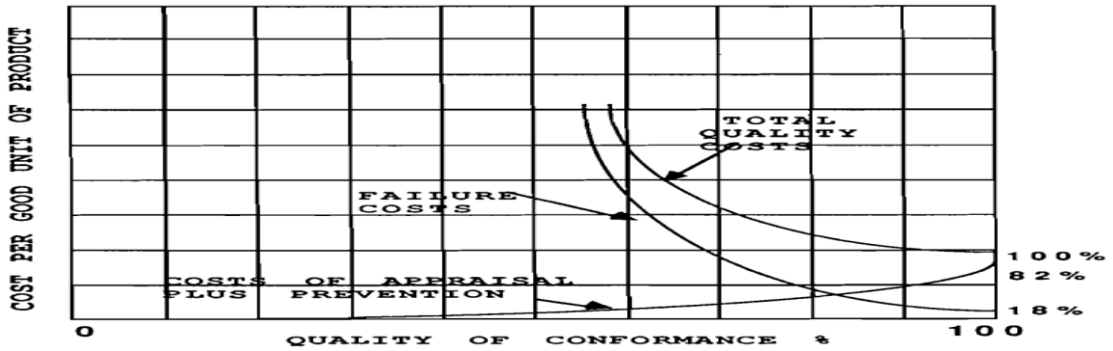
The set up a ‘’Operative quality cost model” for manufacturing/Construction firms.



The difference in this cost model is that when 100% quality of conformance is reached, there are still some failure costs (point A). Hence, the total cost of quality (point C), does not equal prevention and appraisal (point B), is the sum of both these costs (point A + B). Under is the situation, it is recognized that, as a practical matter, some failure costs will occur despite the concerted efforts to prevent them. This minimum is likely to be different in each company.

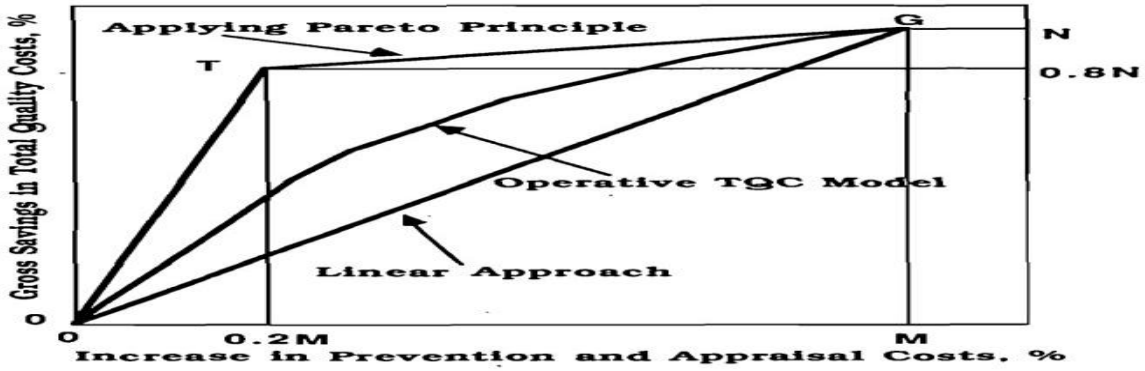
The figure can be assumed to be the average number for the industry of which the

It can be seen from this graph that at 100 percent quality of conformance, there still has 18



percent of failure costs exist. Therefore, the total cost of quality is the sum of 18% failure costs and 82% of appraisal plus prevention costs. In this case, the total cost of quality is not only appraisal and prevention costs anymore when 100 percent of quality of conformance is reached. Here, 18% of the total cost of quality (measured as a percentage of sales) is specified as being equal to the realization of zero failure cost. This number is the percentage expressed to us by quality practitioners in manufacturing firms who thought it to be the lowest realistic failure cost percentage that could be achieved.

100% quality of conformance is shown to intersect at 18% of total quality cost. Correspondingly, the prevention and appraisal costs have to be 82%; the sum of these costs

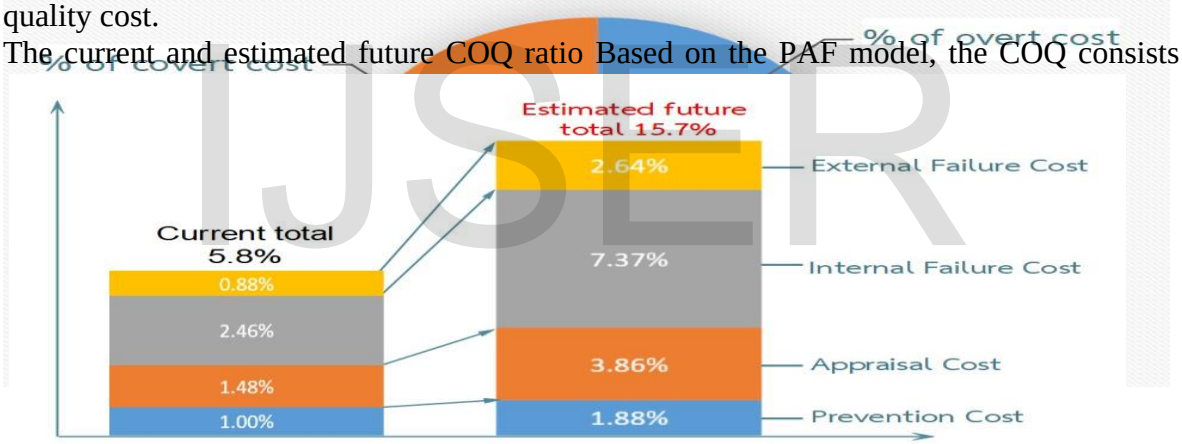


represents the total quality cost which can be anticipated at the defined optimum achievable quality level**.**

Figure to be an operative total cost of quality model applicable for manufacturing firms.

Due to the covert quality costs that have not been distinguished and labeled by the accounting team, thus the quality costs recorded in the accounting system can not fully represent the real quality costs. The covert quality costs have been calculated. From the summary report of COQ, it can be seen that only 56% of total COQ is overt quality cost, the remaining 44% is covert quality cost.

The current and estimated future COQ ratio Based on the PAF model, the COQ consists of



prevention cost, appraisal cost, internal failure cost and external failure cost. The COQ distribution status shows in Figure

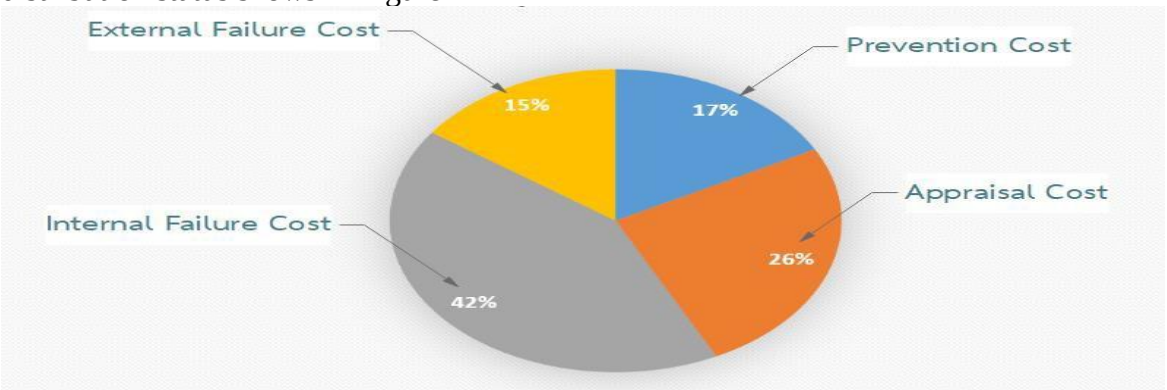


Figure The COQ distribution

The above chart illustrates that in Project MGS Phase-II OPMF company SISCO Limited has spent 17% of COQ on the prevention activities, 26% on the quality appraisal, 42% of COQ was consumed on internal quality failure, and 15% was costed by external quality failure, . As per the project contract, company SISCO Limited has to establish a quality assurance system

that complies with the principles of ISO 9001 and other project requirements. Thus, a project QA/QC organization shall be established by sufficient qualified staff to constantly monitor and control all the quality aspects of the work. To fulfill the contract requirements, company SISCO Limited spent 43% of COQ as prevention and appraisal cost as per the project execution plan, these costs have been considered. On the other hand, 57% of COQ is internal and external failure costs which have not been considered or pre-planned. These costs cause a negative impact on to project budget. The distribution of internal and external quality failures shows in Figure.

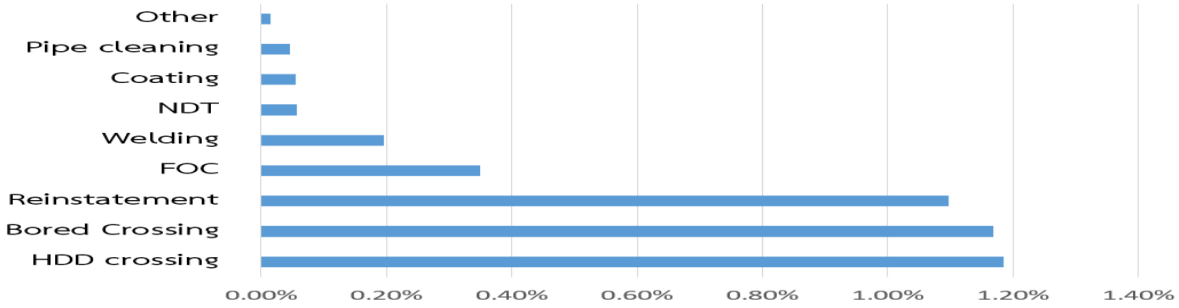


Figure The distribution of internal and external quality failures

From the internal and external failure cost data analysis, we also learned that the majority of the quality failures comes from different discipline of works, shown in the above Figure. The majority of quality failures come from HDD crossing, bored crossing and reinstatement works, almost equal to 83% of the total quality failures. Therefore, a clear improving target has been set up to reducing or eliminate the reworks or repairs from these disciplines.

Summary of root cause analysis.

Item	Description	Agree
1	Shortage of support from Engineering team for HDD design	95%
2	Change suitable bored crossing equipment	79%
3	Need more quality training	89%
4	Over workload assignment	74%
5	Need policy of recognition of good quality performance.	77%
6	Increasing wages	95%
7	Improve the document control system, receives the latest drawing timely	84%

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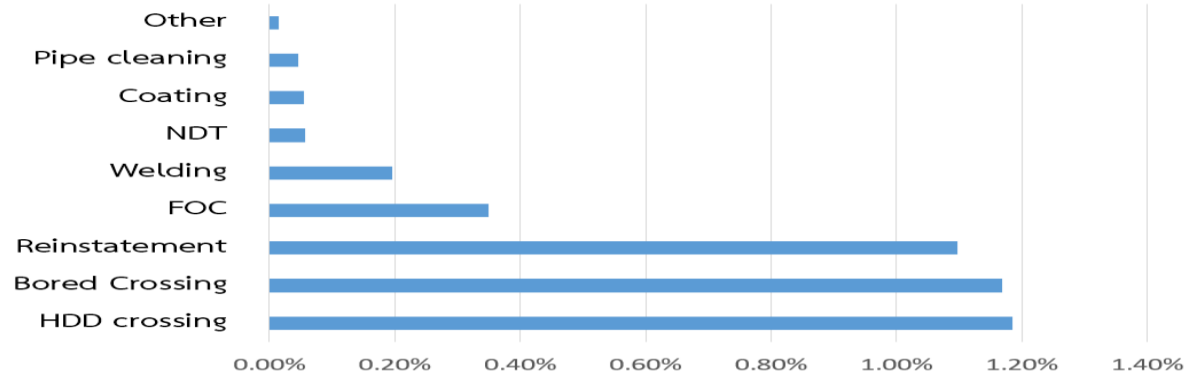

Figure Quality failure distribution by the discipline of work

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CONCLUSIONS

The QM team of company SISCO Limited has applied the COQ method to successfully draw the attention and commitment of project manager by monetary data, and easily identified the quality improving target. After located the root causes of internal and external quality failures, preventive measures have been produced and put in force. They found that the poor qualities are different in size, and a relatively vital few of the poor qualities account for the majority of the costs. A major function of the evaluation of COQ is to identify these vital few quality failures. This results in setting priorities to assure the effective use of investments.

The majority of quality issues are produced due to a shortage of engineering support and training for the construction crews. Normally, a detailed engineering contractor is not responsible for optimization or deviation on-site; therefore, construction teams should hire their professional engineer to fulfill the optimization purpose, otherwise either the works will be delayed or reworked. Due to the fast track of project management, lots of construction works have been started without the design have been officially approved, make sure all the lasted revision of designs on- site, and all the comments on the drawing or procedure have been incorporated during construction works.

The main findings of this thesis are summarized below:

1. In project MGS Phase II OPMF, 44% of the covert COQ has been overlooked by the accounting team and the project manager.

2. High construction quality failures can cause serious negative impacts to project cost and schedule, it is the key to project management, it determines the success or failure of the project because quality failures are rarely considered or planned during the bidding phases.

3. COQ system should be used on quality management of pipeline construction project; it can draw the attention and commitment of project managers by summarized monetary data. Put investment in prevention activities, to tremendously reduce the internal and external quality failure costs.

4. The comprehensive training plan should be prepared and applied, 100% of the employee should be trained and competent for the works they are assigned.

5. Engineering supports are essential for site construction teams, especially dealing with site optimization and changes.

6. Not always subcontract the works to lowest-price bidders, their proposed construction resources should be considered, such as equipment and key personnel.
7. Set up a quality reward and punishment system, encourage and recognize the good quality performance by capital which have been saved from the reduction of COQ.

8. An efficient document control system should be on-site, and audited periodically and randomly. It is preferred that the engineering work can be done ahead of construction, to reduce the potential changes during or after the construction.

9. The classic project management iron triangle can be broken, if the majority of poor-quality issues have been reduced or eliminated, the good quality performance of the construction team can save the budget and time of the project tremendously than it was planned.

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