Report On

TQM in Roads and Highways Department; Evaluate an approach-how it improves the performance of supply chain to its organization

By

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An internship report submitted to the BRAC Institute of Governance and Development in partial fulfillment of the requirements for the degree of Masters in Procurement and Supply Management (MPSM)

BRAC Institute of Governance and Development
Brac University
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Declaration

It is hereby declared that

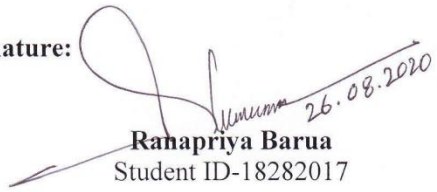
1. The internship report submitted is my own original work while completing degree at Brac University.

2. The report does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The report does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.

4. I have acknowledged all main sources of help.

Student's Full Name & Signature:



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CERTIFICATE

This is my pleasure to certify that Ranapriya Barua, ID No.18282017, Batch No.11, MPSM, BIGD, BRAC University has prepared the dissertation entitled "TQM in Roads and Highways Department, evaluate an approach-how it improves the performance of supply chain to its organization" under my direct guidance and supervision. So far I know, the dissertation is an individual achievement of the candidate's own efforts. I also certify that I have gone through the draft and final version of the dissertation and found satisfactory for submission to BRAC Institute of Governance and Development (BIGD), BRAC University in partial fulfillment of the requirements for the degree of Masters in Procurement and Supply Management (MPSM).

26/8/20

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Dear Sir/ Madam,

This is my pleasure to display my request regarding "TQM in Roads and Highways Department; Evaluate an approach-how it improves the performance of supply chain to its organization" which I was appointed by your direction.

I have attempted my best to finish the report with the essential data and recommended proposition in a significant compact and comprehensive manner as possible.

I trust that the report will meet the desires.

Sincerely yours,

26.08.2020

Ranapriya Barua

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Date: 26 August 2020.

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Executive Summary

The Roads and Highways Department is a government organization under the Road Transport and Highways Division of the Ministry of Road Transport and Bridges. RHD is responsible to enhance the traffic capacity and safety for efficient transshipment of goods as well as passengers trafficked on transnational boundary, national, regional, and Zilla highways. But in recent years the quality of works and other activities has failed to meet the standard required by the specifications. If it is allowed to continue, within a few years a significant amount of the existing RHD road network will deteriorate which seriously hampered customer satisfaction. In this thesis, the objective is to evaluate the use of TQM tools and its systematic application to improve the performance of the supply chain in RHD. Moreover, it is also to be stressed to find out the present and future challenges on roads and bridges construction, procurement, and other sourcing processes.

The thesis work is to be explorative in nature and be used qualitative and quantitative data. Primary data were collected through questionnaires survey from 34 engineers of different grades to identify the level of qualify practice in RHD and find out employees of RHD follow the procedure of TQM or not. Secondary data were collected from the RHD website, journals, magazines, and different publications.

From this thesis. it is concluded that to ensure quality in RHD it is necessary to conduct Quality Assurance Audit (QAA) through a third party. Besides this, an intensive and robust training program regarding TQM must be introduced for all levels of employees in RHD in order to ensure quality works.

Finally. it is recommended that this thesis finding is not limited to take any concrete decision regarding the quality issue in RHD. Moreover, it is an emphasis to conduct a further study with the uses of new technologies like IoT, AI, Blockchain, etc. to improve quality-related difficulties and other supply chain processes in RHD to face upcoming challenges with the help of TQM approach in order to ensure **value for money** for the public fund.

Kew words: Total quality management, Roads and Highways Department, Quality assurance audit, TQM implementation, Public service organization, Value for money.

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List of Acronyms

ACE – Additional Chief Engineer

AE -Assistant Engineer

AH – Asian Highway

ADP – Annual Development Program

BRRL – Bangladesh Road Research Laboratory

BBIN – Bangladesh Bhutan India Nepal

BCIM – Bangladesh-China-India-Myanmar Economic Corridor

BIMSTEC – Bay of Bengal Initiative for Multi-sectoral Technical and Economic Cooperation

BIGD – BRAC Institute of Governance Development

BPSC - Bangladesh Public Service Commission

BoQ – Bill of Quantity

C & B – Communication & Building

CPTU – Central Procurement Technical Unit

CBR – California Bearing Ratio

DCP – Dynamic cone penetrometer

EE -Executive Engineer

ER – Employer's Representative

GOB- Government of Bangladesh

HDM – Highway Development and Maintenance Management System

HRD – Human Resource Development

HQ – Head Quarter

ISO – International Organization for Standardization

LGED - Local Government Engineering Department

MVA – Motor Vehicle Agreement

MRTB – Ministry of Road Transport and Bridges

MIS – Management Information System

MDD – Maximum Dry Density

ME – Materials Engineer

NMV – Non-motorise Vehicle

PWD – Public Works Department

QAP – Quality Assurance Plan

QC – Quality Control

QAG – Quality Audit Guidelines

RHD – Roads and Highways Department

ROW – Right of Way

RTHD - Road Transport and Highways Division

SDE – Sub-Divisional Engineer

SE – Superintending Engineer

SAARC – South Asian Association for Regional Cooperation

SASEC – South Asia Sub regional Economic Cooperation

TQM – Total Quality Management

TOR – Term of Reference

Chapter- One

Introduction

1.1 General

Quality means the degree of excellence. It is closely related to the customer's satisfaction. Total Quality Management (TQM) has been used widely in many organizations, to enhance service quality. In Public services, implementing TQM is not necessarily part of its own activities. The increase of global competition has put pressure on public services to be more efficient like a competent organization. The government wants to implement quality management as a way to provide good service with full customer satisfaction. Rigorous budgets and customer's flourishing demand has forced the government to adopt a modern quality management system. TQM implementation in Public service organizations like RHD is quite challenging. Some argue that TQM can not well implement in public services. However, it is found that TQM brings advantages to Public services. This study examines challenges in TQM application in RHD and agrees that TQM brings good implications in the public sector like RHD to enhance its service quality.

1.2 Background and Rationale

RHD is entitled to provide safe, cost-effective and well-maintained road networks. It is aiming to enhance the traffic capacity and safety for efficient transshipment of goods as well as passengers trafficked on national, regional, and Zilla highways. The government of Bangladesh has entrusted RHD with the responsibility of improving the quality of highways of national importance. But in recent years the quality of work and other activities has failed to meet the standard required by the specification. If it is allowed to continue, within a few years a significant amount of the existing RHD road network will deteriorate, which seriously hampered customer satisfaction. RHD has run its quality management system. It also has sort and long term plans and managing systems to impart quality in the road construction, procurement, and other sourcing processes. The world now has moved forwards towards Total Quality Management. TQM philosophy is to reduce waste and increase efficiency. So it is time for RHD to move forwards with TQM philosophy, to ensure quality everywhere. In order to improve the performance of the supply chain in RHD, it is ensured to evaluate the use of TQM tools and its system application hence the thesis topic is selected.

1.3 Problem Statement

The Thesis title is “TQM in the Roads and Highways Department, Evaluate an approach to how it improves the performance of the supply chain to its organization.”

For the analysis of the TQM approach in RHD, the following question is asked.

- What is the strategic plan for quality control?
- Is the current practice prevail in RHD compatible with other international standards?
- What are the ways to overcome these situations?
- What are the current quality-related challenges in the procurement process?
- Is it possible to introduce TQM philosophy in road construction, procurement, and other sourcing processes?

1.4 Object of the thesis

The Thesis objective is to evaluate the use of TQM tools and its systematic application to improve the performance of the supply chain in RHD. Also find out the present and future challenges on roads and bridges construction, procurement, and other sourcing processes. Evaluate the current “Quality Assurance Plan (QAP)” and find out the challenges and scope of improvement. By this thesis, if quality in road construction, procurement, and other sourcing processes is improved, this will give better steps towards value for money for the public funds.

1.5 Limitation

Time constrain is one of the most limitations of this thesis. It is a little bit difficult to complete this type of work within a stipulated time. Primary data were collected through survey questionnaires from thirty-four (34) engineers of different grade and secondary data were collected from the RHD and different websites, journals, magazines, and internal data of RHD.

Chapter- Two

Literature Review

2.1 General

The literature review conducted focuses on what quality is, quality standards, quality control, Total quality management, and as well as how to assess quality in the Roads and Highways Department. Before going detail on the topic the available literature related to quality is revealed. It is seen that exactly past literature related to RHD is little but regarding public sector organization like RHD are found available. The evaluation and improvements in quality control are also discussed in this chapter. The idea of the latest quality control philosophy like Total Quality Management is also given here. At last, an overview of the Roads and Highways Department is given.

2.2. Definitions of Quality

The international definition of quality is: " the degree to which a set of inherent characteristics fulfills requirements." It is the totality features and characteristics of the product that satisfy consumer needs or intended purpose. It is meant to distinguish one organization, event, product, service, process, person, results, communication, or action, from one another. Different organizations define quality differently. It can be commonly and simply put as delivering the promise so as to ensure customer satisfaction. Quality is one of the factors which are not negotiable.

2.2.1 Quality Means

Conformance to specifications: How well a product or service meets the targets and tolerances determined by its creators. For example, the dimensions of the layers of the road to be constructed, the strength of the layers, and alignment of the road are mentioned in the design the quality road is constructed confirming these points. Conformance to specification is directly measurable, though it may not be directly related to the user's idea of quality.

Fitness for use: A definition of quality it evaluates how well the product or service performs for its intended use. For example, a road constructed should be safe and comfortable for transporting passengers and goods. However, this is a user-based definition in that it is intended to meet the needs of a specific user group.

Value for price paid: Quality defined in terms of product or service users for the price paid. This is the main definition that combines economics with consumer criteria; it assumes that the definition of quality is price sensitive. For example, if a well-constructed road does not contribute to the economy of the country then it is just a waste of public money.

Support services: Quality defined in terms of the support provided after the product or service is purchased or finished. Quality does not apply only to the product or service itself; it also applies to the people, processes, and organizational environment related to it. For example, the quality of RHD is judged not only by the quality of the end product the road but also by the efficiency and accuracy of processing of supply chain.

Psychological criteria: is a subjective definition that focuses on the judgmental assessment of what comprises product or service quality. Different factors subscribe to the evaluation, such as the atmosphere of the environment or the perceived status of the product.

2.2.2 Dimensions of Quality

Eight measurements of item quality administration can be utilized at a key level to dissect quality attributes. The idea was characterized by David Garvin. A portion of the measurement is commonly protected, while others are not-change in one might be to the detriment of others. Understanding the exchange offs coveted by clients among these measurements can help create an upper hand. Garvin's eight measurements can be condensed as taking after:

(i) **Performance:** Performance refers to a product's prime operating characteristics.
This dimension of quality involves measurable attributes; brands can usually be classified objectively on individual aspects of performance.

(ii) **Features:** Features are additional characteristics that enhance the appeal of the product or service to the user.

(iii) **Reliability:** Reliability is the probability that a product will not fail within a specific time period. This is a basic element for users who need the product to work without fail.

(iv) **Conformance:** Conformance is the precision with which the product or service meets the specified standards.

(v) **Durability:** Durability measures the length of a product's life. When the product can be mend, estimating durability is more complicated. The item will be used until it is no longer economical to operate it. This happens when the repair rate and the associated costs increase significantly.

(vi) **Serviceability:** Serviceability is the speed with which the product can be put into service when it breaks down, as well as the competence and the behavior of the serviceperson.

(vii) **Aesthetics:** Aesthetics is the subjective dimension indicating the kind of response a user has to a product. It represents the individual's personal preference.

(viii) **Perceived Quality:** Perceived Quality is the quality attributed to a good or service based on the indirect measure.

2.2.3 Quality in Procurement Process

Quality should be imparted in every step of the sourcing process, as the quality failure cost is much higher than the quality control cost. The procurement and supply cycle is shown in figure 2-1.

Fig.-2-1 The procurement and supply cycle

Quality can be incorporated in every step of the procurement process. Better quality service or product can be provided to the consumers/users if the quality is taken into account in defining the need (planning), design, sourcing, supplier selection, and project management.

2.2.4 Cost of Quality

The reason quality has gained such prominence is that organizations have gained an understanding of the high cost of poor quality. Quality affects all aspects of the organization and has dramatic cost implications. The most obvious consequence occurs when poor quality creates dissatisfied customers /users and eventuality Leads to loss of reputation. However, quality has many other costs' which can be split up into two categories. The first category consists of costs necessary for achieving high quality, which is called quality control costs. These are of two types:prevention costs and appraisal costs. The second category consists of the value consequences of poor quality, which are called quality failure costs. These comprise internal failure costs and external failure costs.

(i) Prevention costs are all costs incurred in the process of preventing poor quality from occurring. They include quality planning costs, like the prices of developing and implementing a top quality plan. Also involved are the prices of product and process design, from collecting customer information to designing processes that achieve conformance to specifications. Employee training in quality measurement is included as a part of this cost, also because of the costs of maintaining records of data and data associated with quality.

(ii) Appraisal costs are incurred in the process of uncovering defects. They include the value of quality inspections, product testing, and performing audits to form sure that quality standards are being met. Also included during this category are the prices of worker time spent measuring quality and therefore the cost of kit used for quality appraisal.

(iii) Internal failure costs are associated with discovering poor product quality before the product reaches to the customers/users. One type of internal failure cost is reworked, which is the cost of correcting the defective item. Sometimes the item is so defective that it cannot be corrected and must be thrown away. This is called scrap, and its costs include all the fabric, labor, and machine cost spent in producing the defective product. Other sorts of internal failure costs include the value of machine downtime thanks to failures within the process and therefore the costs of discounting defective items for salvage value.

(iv) External failure costs are associated with quality problems that occur at the user site. These costs are often particularly damaging because customer faith and loyalty are often difficult to regain. They include everything from customer/user complaints, product returns, and repairs, to warranty claims, recollect, and even litigation costs resulting from product liability issues. A final component of this cost is lost sales and lost customers. External failure can sometimes put a corporation out of business almost overnight.

2.3. Quality Assurance

Quality Assurance (QA) is a way of preventing mistakes or defects in manufactured products and avoiding problems when delivering solutions or services to customers. ISO 9000 defines quality assurance as "An a neighborhood of quality management focused on providing confidence that quality requirements are getting to be fulfilled". It thus differs subtly from quality control.

QA is applied to materials in pre-work to verify what is going to be made meets specifications and requirements, and through road construction runs by validating lot samples meet specified quality control.

Quality Assurance refers to administrative and procedural activities executed during a quality system in order that requirements and goals for a product service or activity are going to be fulfilled. It is the systematic measurement, comparison with a typical, monitoring of processes, and an associated feedback circuit that confers error prevention. This can be contrasted with internal control, which is concentrated on process output. Two principles included in Quality Assurance are: "Fit for purpose", the materials should be suitable for the planned purpose; and "Right first-time" mistakes should be removed.

QA includes management of the standard of raw materials, products, assemblies and components, services associated with the production, and management, production, and inspection processes. Suitable quality is decided by product users, clients, or customers, not by society generally. It is not associated with cost and adjectives or descriptors like "high" and "poor" aren't applicable. For example, a coffee priced product could also be viewed as having top quality because it's disposable where another could also be viewed as having poor quality because it's not disposable.

2.4 Total Quality Management (TQM)

In recent years, Total Quality Management (TQM) has received worldwide attention and is being adopted in many industries, exceptionally in developed economies. TQM has evolved primarily due to the changes within the global economy and also due to demand in the economic process. Although control of quality has been practiced in many industries for several years, the adoption of TQM as a serious preoccupation of companies worldwide is extremely recent. The traditional control methods being implemented in industries to make sure quality hasn't yielded the results that were expected of them. Moreover, rapidly changing technology and customer expectations have already affected organizations worldwide and thus have promoted the necessity for taking a replacement check out quality management. In this study, we shall discuss how TQM is often adopted in organizations that are replacing existing internal control systems to market competition and growth.

2.4.1 Concept of Total Quality Management - Historical Background:

Total quality management is the integration of all functions and processes within an organization's supply chain in order to achieve continuous improvement of the quality of products and services. Deming defined quality as a "never-ending cycle of continuous improvement", Juran defined it as fitness for use (purpose). Bearing in mind that TQM is a long term improvement process that requires significant resources.

It is also important to realize that TQM is a dynamic process, not a static process that is based upon continuous efforts to improve quality. Since there are no deadlines or targets to be met then TQM can never be considered complete which makes it to become a way of life.

During the early years of manufacturing, the inspection was used as a tool to decide if a worker's job or a product met its requirements. In fact, at that time inspection was not done in a systematic way, yet it worked well when the volume of production was low. However, as organizations became larger and more complicated the need for more effective operations became obvious.

In the early 1900s, "The Father of Scientific Management" Frederick W. Taylor helped to satisfy this need. He proposed a framework for the effective use of people in industrial organizations through his book ' The Principles of Scientific Management' which was republished yet again in 2008. One of his concepts was clearly defined as tasks performed under standard conditions. The inspection was one of these tasks and was intended to ensure that no faulty product left the workshop or the factory, it also focuses on the product and detection of a problem in the product, and testing every item to ensure that the product match as the requirements or specifications. This process is carried out at the end of the production process and requires specially trained inspectors. The need to performing this process was the reason that led to the emergence of a separate inspection department which resulted in the emergence of defect prevention concepts which led to quality control.

The roots of Total Quality Management can be traced back to the 1920s when Dr. W. Shewhart developed the application of statistical methods for the management of quality. He demonstrated that variation in the production process leads to the variation in the product, thus by eliminating the variation of the process a good standard of the end product can be achieved. The theory of Statistical Quality Control focuses on the product and detection and control of quality problems that involve testing samples and statistically inferring compliance of all products. This process is carried out throughout the production process and requires trained production people as well as quality control professionals.

Towards the end of the 1920s, the theory was further developed by Dodge and Romig who developed statistically based acceptance sampling as an alternative to 100% inspection.

In the 1940s, the quality guru Deming with his peer co-workers Juran and Feigenbaum continued with the improvement of the theory. However, instead of focusing just on the quality of products the concept rapidly widened to evolve the quality of all issues within an organization i.e. Total Quality Management. During the 1950s, many Japanese products were of low quality and viewed by the world as junk products. Industrial leaders in Japan recognized this problem and decided to produce high-quality products.

In fact, Japanese might have not been able to achieve the aim of high-quality products unless they had had the help of quality gurus such as Deming, Juran, and Feigenbaum (Soin, 1999, p.1). Deming suggested that this aim could be achieved within just five years. As a matter of fact, not many Japanese

believed what Deming claimed. However, they followed his suggestion in order not to lose face and because they respected him.

In the late 1950s, quality control management developed rapidly and became the main theme of Japanese management. Interestingly, the idea did not stop at the management level. In the early 60s, the concept of the quality control circle was first introduced in Japan by K. Ishikawa. A quality circle is a group of workers who meet and discuss issues to improve all aspects of the workplace and make presentations to management with their ideas for improvement. In this way, workers were motivated because they felt that they were involved and listened to (Cole, 1979, p.135). Another advantage was the idea of improving not only the quality of the product but also all aspects of organizational issues, which probably was the start of Total Quality. The term Total Quality was first used by Feigenbaum at the first international quality control conference in Tokyo in 1969.

During the 80s and 90s, a new phase of management and quality control began, which became known as Total Quality Management (TQM). Zairi et al (1994) defined TQM as a "license to practice". Although there are many other different definitions for TQM yet the concept is still the same. Nowadays, TQM may be called Business Excellence and has a more clearly defined approach. Various pioneering researchers have made significant contributions towards the design, development, and application of the TQM system. These people are known as the quality guru, their contribution is shown in the table below :

Name	Duration	Main Concept
1. Walter A. Shewhart (1891-1967)	1920s and 1930s	Grandfather of Quality control Concept of "Control chart"
2. W. Edwards Deming (1900-1993)	1940a and 1950s	Father of Quality Control Concept of "PDCA cycle"
3. Joseph M.Juran (1904-2008)	1950s	Define quality-Fitness for use cost of quality, Quality triology
4. Armand V. Feigenbaum	1960s	Concept of Total Quality Control
5. Philip B Cosby (1926-2001)	1970s	Zero defects philosophy Do it right the first time.
6. Ishikawa (1915-1987)		Cause and effect diagram

Table 2.1 : List of Quality Gurues and their main concept

2.4.2 Elements of TQM

Total quality management can be summarized as a management system for a customer-focused organization that involves all employees in continual improvement. It uses strategy, data, and effective

communications to integrate the quality discipline into the culture and activities of the organization. Many of these concepts are present in modern Quality Management Systems, the successor of TQM. Here are the 8 principles of total quality management:

1. Customer-focused

The customer ultimately determines the level of quality. No matter what an organization does to promote quality improvement-training employees, integrating quality into the design process, upgrading computers or software, or buying new measuring tools-the customer determines whether the efforts were worthwhile.

2. Total employee involvement

All employees participate in working toward common goals. Total employee commitment can only be acquired after fear has been driven from the workplace, when empowerment has occurred, and management has provided the proper environment. A high-performance work system integrates continuous improvement efforts with normal business operations.

3. Process-centered

A fundamental part of TQM may be specialize in process thinking. A process is a series of steps that take inputs from suppliers (internal or external) and convert them into outputs that are delivered to customers (again, either internal or external). The steps required to hold out the method are defined, and performance measures are continuously monitored so as to detect unexpected variations.

4. Integrated system

Although a corporation may contain many various functional specialties often organized into vertically structured departments, it's the horizontal processes interconnecting these functions that are the main target of TQM.

• Micro-processes add up to larger processes, and everyone processes aggregate into the business processes required for outlining and implementing strategy. Everyone must acknowledge the vision, mission, and guiding principles as well as the quality policies, objectives, and critical processes of the organization.

• An integrated business system may be modeled after or incorporate the ISO 9000 standards. Every organization features a unique work culture, and it's virtually impossible to realize excellence in its products and services unless an honest quality culture has been stimulated. Thus, a combined system links

business improvement elements in an attempt to continually improve and exceed the presumption of customers, employees, and other stakeholders.

5. A strategic and systematic approach

A critical part of the management of quality is the strategic and structured approach to achieving an organization's vision, mission, and goals. This process, called strategic planning or strategic management, includes the design of a strategic plan that integrates quality as a key component.

6. Continual improvement

A major force TQM is continual process improvement. Continual improvement drives a corporation to be both analytical and artistic to find ways to become more competitive and simpler at meeting stakeholder expectations.

7. Fact-based decision making

In order to understand how well a corporation is performing, data on performance measures are necessary. TQM needs that a corporation continually collects and analyze data so as to enhance decision-making accuracy, achieve agreement, and permit prediction supported past history.

8. Communications

During times of organizational change, as well as part of day-to-day operations, effective communications play a large part in maintaining and motivating employees at all levels. Communications involve strategies, methods, and timeliness. Communication is absolutely essential in TQM. It forms an important a part of management and TQM within the following ways:

(i) Leadership

When the senior managers lead the method from the front, communication forms the vital component. It forms the medium of exchange of information, handing over ideas, suggestions, and orders. It is the senior managers who have to communicate in person to their people why the organization needs continuous improvement and demonstrate that they really care about quality. In fact, without top-down communication, the role of leadership, and thereby, the TQM is afflicted.

(ii) Planning and organization

President Eisenhower says " In preparing for battle I have always found that plans are useless, but planning is indispensable". Planning is an active way of discussing the goals, objectives, strategies, and

tasks that need to accomplish. Plans are the documentation of planning. Planning and organization may be a key element of TQM and is impossible without proper communication from all the amount within the organization. Inputs should be gathered from all levels, thereby following a track of continuous improvement all the way.

(iii) Using tools and techniques

The methods for implementing all the tools and techniques for the improvement in all process in the organization is sought after and then instructed by the managers to the lower levels. This instruction and feedback and queries cannot be addressed without proper communication.

(iv) Involvement

Part of the approach to TQM is to make sure that everybody features a clear understanding of what's required of them, how their process relates to the business as a whole and the way their internal customers are dependent upon them. For developing this understanding communication is vital.

(v) Teamwork

Teamwork provides an opportunity for cooperative action in pursuit of continuous improvement. Only proper communication ensures proper teamwork. It should be ensured that real communication takes place between the members of the team and cross-functional teams. There is also a requirement to acknowledge positive performance and achievement and celebrate and reward success. This must be constantly inspired through active and open communication.

2.4.3 Traditional approach and TQM approach

Quality element	Previous State	TQM
Definition	Product-oriented	Customer-oriented
Priorities	Second to service and cost	First among equals of service and cost
Decisions	Short-term	Long-term
Emphasis	Detection	Prevention
Errors	Operations	System
Responsibility	Quality control	Everyone
Problem solving	Managers	Collaborative
Manager’s role	Plan, assign, control and enforce	Delegate, coach, facilitate and mentor

Table :2.2- Traditional approach and TQM approach

2.4.4 Implementation of TQM

Generic Strategy Model for Implementing TQM Systems

1. Top administration finds out about and chooses to focus on TQM. TQM is recognized as one of the association's techniques.
2. The association evaluates current culture, consumer loyalty, and quality administration frameworks.
3. Top administration distinguishes center esteems and standards to be utilized and convey them.
4. A TQM all-inclusive strategy is created on the premise of steps 1, 2, and 3.
5. The association recognizes and organizes client requests and adjusts items and administrations to meet those requests.
6. Management maps the basic procedures through which the association addresses its clients' issues.
7. Management directs the arrangement of groups to handle change endeavors.
8. The energy of the TQM exertion is overseen by the controlling board of trustees.
9. Managers contribute independently to the exertion through preparing, training, or different strategies.
10. Daily process administration and institutionalization occur and Progress is assessed and the arrangement is modified as required.

2.4.5 Continuous Improvement

Continuous improvement is about many, small developments commenced and implemented by anyone and everybody within the organization to enhance the standard of their working processes and practices. The breakthrough improvement involves major improvements in key business areas. They are often chronic problems solved permanently through focused, dedicated resources working for a limited period of your time.

A growing business requires essentially requires both continuous improvement and breakthrough. Even though it can be argued that any firm requires counts on the continuous improvement it has been making, it can be countered that breakthrough is something that gives the firm an edge over its competitors. This can be established by taking into account the following points:

- When the firms get some valuable breakthrough, it strikes the chronic problems that influence the firm. By encouraging continuous improvement, the occurrences of bad things are minimized and with the course of time.

- Due to the investments in time and attention required, breakthrough development projects are chosen by a management group that typically acts as a steering group. Usually, the capacity for exploration crosses multiple functional boundaries. On the other hand, continuous improvement is acted upon by everyone in the organization.

- Breakthrough improvement projects yield the highest economic payback in the short- to medium-term. Continuous improvement secures a steady return, although it takes time for the initial return. Both integrated will ensure a steady growth rate.

Among the foremost widely used tools for continuous improvement may be a four-step quality model-the plan-do-check-act (PDCA) cycle, also referred to as Deming Cycle:

- **Plan:** Identify a chance and plan for change.
- **Do:** Implement the change on a little scale.
- **Check:** Use data to research the results of the change and determine whether it made a difference.
- **Act:** If the change was successful, implement it on a wider scale, and continuously assess its results. If the change didn't work, begin the cycle again.

Steps in TQM Process

PLAN	**DO**
1. Policies and objects 2. Methods to achieve objects	3. Education and training 4. Implementation of Changes
ACT	**CHECK**
7. Prevent undesired effects 8. Measure for improvement	5. Observe result 6. Analyse result

Table :2.3- Steps in TQM Process

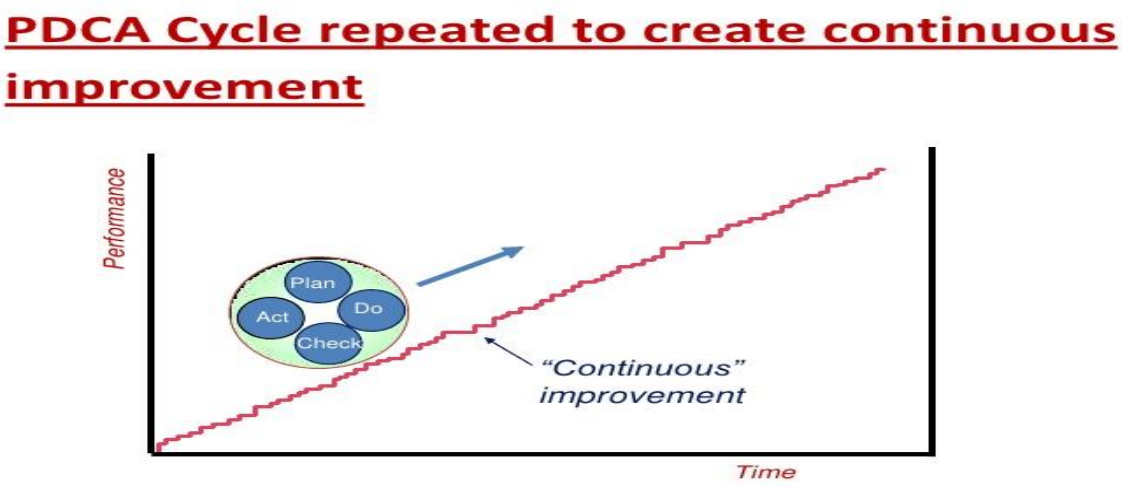


Fig.-2.3 PDCA Cycle Create Continuous Improvement

2.5 Quality Assessment Tools:

Assessing the state of quality of the process, performance or anything of an organization is very important for applying quality control. There are many quality assessment tools available. The Project Management Institute references Seven Basic Tools in A Guide to the Project Management Body of Knowledge as an example of a set of general tools useful for planning or controlling project quality. The Seven Basic Tools of Quality may be a selection given to a hard and fast set of graphical techniques recognized as being most helpful in troubleshooting issues associated with quality. They are called basic because they're suitable for people with little formal training in statistics and since they will be wont to solve the overwhelming majority of quality-related issues. The Seven Basic Tools substitute contrast to more advanced statistical methods like survey sampling, quality control, statistical hypothesis testing, design of experiments, statistical method, and various methods developed in the field of operations research. Some of the quality assessment tools will be used to evaluate the quality position of RHD, for this reason, seven basic tools for quality are discussed in the following sections.

2.5.1 Cause-and-Effect Diagrams

Cause-and-effect diagrams (also called Ishikawa diagrams, fishbone diagrams, herringbone diagrams, or Fishikawa are causal diagrams created by Kaoru Ishikawa (1968) that show the causes of a selected event.

Ishikawa diagrams were publicized by Kaoru Ishikawa, who pioneered quality management processes within the Kawasaki shipyards, and within the process became one among the founding fathers of recent management. Common uses of the Ishikawa diagram are product design and quality defect prevention, to spot potential factors causing an overall effect. Each cause or reason for imperfection may be a source of variation. Causes are usually grouped into major categories to spot these sources of variation. The categories typically include:

- People: Anyone involved with the process
- Methods: How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations, and Jaws
- Machines: Any equipment, computers, tools, etc. required to accomplish the job
- Materials: Raw materials, parts, pens, paper, etc. used to produce the final product
- Measurements: Data generated from the process that is used to evaluate its quality
- Environment: The conditions, such as location, time, temperature, and culture in which the process works

The basic concept was first utilized in the 1920s and is taken into account one among the seven basic tools of internal control . It is referred to as a fishbone diagram due to its shape, almost like the view of a fish skeleton. Causes within the diagram are often categorized, like to the 6 M's described below. Causes-and-effect diagrams can reveal key relationships among various variables, and therefore the possible causes provide additional insight into process behavior.

- Machine (technology)
- Method (process).
- Material (Includes Raw Material, Consumables, and Information.)
- Man Power (physical work)/Mind Power (brain work): Kaizens, Suggestions
- Measurement (Inspection)
- Milieu/Mother Nature (Environment)

2.5.2 Check Sheet

The check sheet may be a form (document) wont to collect data in real-time at the situation where the info is generated. The data it captures are often quantitative or qualitative. When the knowledge is quantitative, the check sheet is usually called a tally sheet. The defining characteristic of a check sheet is that data are recorded by making marks ("checks") thereon.

A typical check sheet is split into regions, and marks made in several regions have different significance. Data are read by observing the situation and the number of marks on the sheet.

Check sheet typically employs a heading that answers the Five Ws:

- Who filled out the check sheet
- What was collected (what each check represents, an identifying batch or lot number)
- Where the collection took place (facility, room, apparatus)
- When the collection took place (hour, shift, day of the week)
- Why the data were collected

2.5.3 Control Charts

Control charts, also well known as Shewhart charts (after Walter A. Shewhart) or process- behavior charts, in statistical process control are tools used to set on if a manufacturing or business process is in a state of statistical control. The control chart is one of the seven basic tools of internal control.

Typically control charts are used for time- series data, though they can be used for data that have reasoning comparability, however, the type of chart used to do this requires consideration.

2.5.4 Histograms

A histogram. is a graphical representation of the distribution of knowledge. It is an estimate of the probability distribution of an endless variable (quantitative variable) and was first introduced by Karl Pearson. To construct a histogram, the primary step is to "bin" the range of values -- that's, divide the whole range of values into a series of small intervals -- then count what percentage values fall under each interval. A rectangle is drawn with height proportional to the count and width equals to the bin size, in order that rectangles about one another. A histogram can also be normalized displaying relative frequencies. It then shows the portion of cases that fall under each of several groups, with the sum of the heights equaling 1. The bins are usually specified as successive, non-overlapping intervals of a variable. The bins (intervals) must be adjacent and typically equal size. The rectangles of a histogram are drawn in order that they touch one another to point that the first variable is continuous.

2.5.5 Pareto Chart

A Pareto chart, named after Pareto, maybe a sort of chart that holds both bars and a line graph, where individual values are constituted in descending order by bars, and the cumulative total is represented by the road. The left vertical axis is the frequency of events, but it can alternatively represent cost or another important unit of measure.

The right vertical axis is the cumulative percentage of the entire number of occurrences, total cost, or a complete of the actual unit of measure. Because the explanations are in decreasing order, the cumulative function may be a concave function.

2.5.6 Scatter Diagrams

Scatter diagrams are graphs that show how two variables are associated with each other. They are particularly useful in detecting the amount of correlation' or the degree of a linear relationship, between two variables. For example, increased production speed and number of defects might be correlated positively; as production speed increases, so does the amount of defects. Two variables could also be correlated negatively so that an increase in one of the variables is associated with a decrease in the other. For example, increased worker training could be related to a decrease in the number of defects observed. The greater the degrees of correlation, the more linear are the observations in the scatter diagram. On the other hand, the more scattered the observations in the diagram, the less connection exists between the variables. Of course, other types of relationships can also be seen on a scatter diagram, such as an inverted U. This may be the case when one is observing the connection between two variables like oven temperature and variety of defects since temperatures below and above the ideal could lead to defects.

2.5.7 Flowcharts

A flowchart is a simplified diagram of the sequence of steps involved in an operation or process. It provides a visible tool that's easy to use and understand. By perceiving the steps involved in an operation or process, everyone develops a clear idea of how the operation works and where
problems could arise.

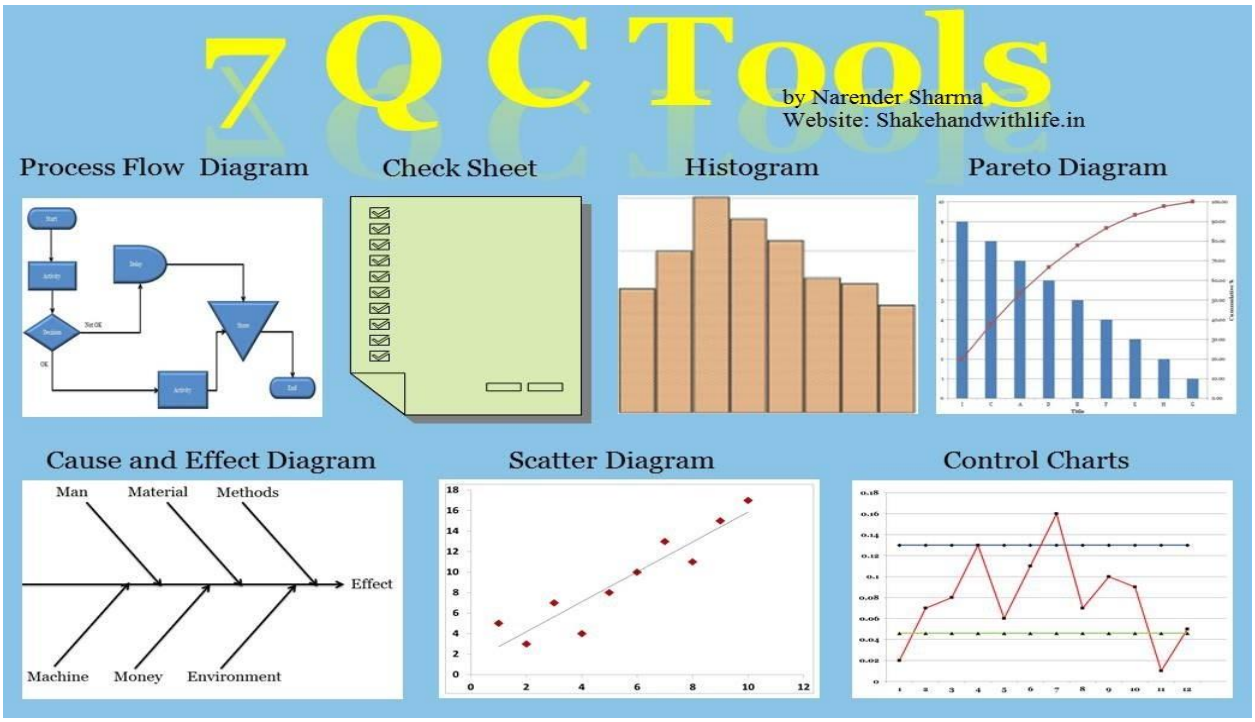


Fig-2.4 : Seven Quality Control Tools

2.6 Overview of RHD

2.6.1 Overview

The Roads and Highways Department (RHD) was created in 1962 when the old 'Construction & Building (C&B) organization was divided into 2 separate bodies (the other is Public Works Department (PWD). RHD is responsible for the construction and maintenance of the major road network of Bangladesh. Since the Department was established the size of the major road network in Bangladesh has grown from 4,500 km to the present network of 22,363 km.

The RHD is headed by a Chief Engineer who is supported by a variety of Additional Chief Engineers and also support by multilayer engineers. As for example SE, EE, SDE, AE & SAE. It is responsible for an annual budget (2019-20) of Taka 20556.44 crore. Among them Development Budget Taka 18682.92 crore & Revenue Budget Taka 1873.52 crore. The total number of posts in the Department is almost 9431.

2.6.2 Objectives

The departmental goal is that "The Roads and Highways Department is able to provide the People of Bangladesh with a safe, cost-effective and well-maintained road network". And the purpose of the RHD is stated as follows:

"The Roads and Highways Department has a sustainable capacity to plan, manage, and deliver its full range of responsibilities in respect of the main road and bridge network and to be accountable for these duties".

2.6.3 Organisation

The structure for RHD consists of five Headquarters Wings/Zones and ten Field Zones, each headed by an Additional Chief Engineer who reports directly, to the Chief Engineer. This structure involves the formation of two new Head Quarter Wings, namely the "Bridge Management Wing" and the "Management Services Wing" and many more detailed changes to the existing organization.

2.6.4 Personnel

The current sanctioned staff of the Department totals 9431 ' comprising 688 Class I, 888 Class II, 964 Class III, and 6891 Class IV post. But recently RHD has proposed 22380 posts of different grades to meet future challenges like SDG's goal, regional road connectivity, etc.

2.6.5 Assets

RHD has at its disposal a huge amount of assets in the form of roads, bridges, land, ferries, equipment, and buildings. The combined value of which has been conservatively estimated at Taka 1.50,000 Crore. Of this, by far the greatest proportion consists of the 22363 kilometers of road and the 19218 bridges / Culverts. This total asset value is the largest of any individual organization in Bangladesh and indeed probably exceeds the combined total of all private sector businesses operating in the country as a whole. Clearly, maintaining the value of these assets is a fundamental requirement that is vital to the economy of Bangladesh and should be treated as one of the highest priorities of the Government. This places a great responsibility on the Roads and Highways Department.

2.6.6 Contracts and Quality

Pressures to expand the road network and the scarcity of funds quality has in recent years not played a major role in construction works in Bangladesh. Whilst neglecting quality may give an appearance of rapid progress it is in fact a very wasteful use of funds. There are many excuses put forward for poor quality such as, small inexperienced contractors, shortage of equipment, and no testing facilities. Most of these excuses do not stand up to scrutiny as high-quality works have been achieved in Bangladesh using the smallest of contractors with the minimum of equipment and only very simple testing facilities.

The Departments' Strategy is based on the fact that quality must become a key issue for all RHD work. Reporting, monitoring, and payment systems should require proof of quality for all contracts.

2.6.7 Construction :

Excessive earth cutting during construction and the neglect of quality may save money today but will leave a legacy of costs for the future. A well-constructed facility may cost more than a poorly constructed facility but will be much cheaper over its full lifetime.

2.6.8 Maintenance :

Maintenance is the most cost-effective expenditure as a small amount of money spent on time can protect massive original investments. As a road network nears completion maintenance assumes greater importance and the expenditure maintenance will then soon outstrip that of new construction. The RHD network, excepting zill roads, is close to this situation.

2.6.9 Whole life costs :

Poor design construction can lead to future cost which is for greater than the savings at the time of construction WLC also takes road user cost into account and these are much lower on roads with good ride quality. Disposal and recycling costs can also be included in WLC. As for example in Scarify, mix and recompact item RHD used old salvage materials. By using this type of recycle materials can reduced total construction costs and also reduced environmental impact in road construction activities.

2.6.10 The Current situation and way forward :

RHD’s responsible for road construction and maintenance. Ministry is concerned with policy issues relating to administration. Planning and development whilst the executing department are responsible for the day to day operations.

An important task for the ministry is to re-dating its tasks to concentrate more on strategic issues in all sectors and spend less time on detailed issues. The development of a long-term strategic plan to cope with future transport demands must be a high priority.

There is an urgent need for a comprehensive Management Information System(MIS) to assist in planning and management functions.

There is an opportunity for the Government to maximize revenue collection in the transport sector by linking the RHD budget to improvement in revenue collection and service standards.

RHD is to be prepared to meet future demands by introducing a number of initiatives. These include improved and modernized tools techniques like IoT, AI, Blockchain, new inspection, and testing systems and improved service standards. These will help to enhance the service quality of RHD and ensure users' satisfaction.

Fig.-2.5: Road Network of RHD

Chapter- Three

The Present and Future challenges of RHD

3.1 Introduction: The Roads and Highways Department (RHD) was created in 1962 when the old 'Construction & Building' (C & B) organization was split into 2 separate bodies, being Public Works Department. RHD is responsible for the construction and maintenance of the major road and bridge network of Bangladesh.

3.1.1 Vision of RHD: To build a Modern, Technology-based, and sustainable road network.

3.1.2 Mission of RHD: To build a safe, cost-effective, sustainable, and environment-friendly road network by developing, expending, rehabilitating, and maintenance of highway in order to ensure the socio-economic development of peoples.

3.1.3 Objectives of RHD: To ensure development, rehabilitation, and maintenance of road network

- To ensure & expand the fast-moving public transport system.
- To ensure safe road infrastructure
- To established axle load control station to reduce pavement damaged

3.2 Organisational Structure: The current structure of RHD consists of five wings, ten field zones, each headed by an Additional Chief Engineer who reports directly to the Chief Engineer. RHD Wings are Management Service Wings, Planning and Maintenance Wings, Bridge Management Wings, Technical Service Wings, and Mechanical Wings. Management Service Wings is to provide integrated management of common services such as Human Resources. Financial system Administration, Training, Management Information system estates & legal proceeding, and security. Planning and Maintenance Wing is to contribute to the overall strategy of RHD by providing a high level of service, in the effective planning and management of a program of works on the RHD road network. This involves close liaison with the RTHD, MRTB, the planning commission, and RHD field divisions to ensure that the work is managed from conception to physical completion whilst ensuring value for money. This wing consists of Programming, Monitoring, Maintenance, Procurement, Economics, and HDM Circle. It is responsible to maintain an up to date accurate and reliable inventory, contribute to the organization's policies and long term development plans by using available road and bridge data including traffic, economic, and social parameters. Bridge Management wings are to contribute the overall strategy of RHD by providing a high level of service, in the effective planning, design, and management of bridgework on the road network.

Technical Service Wing is to ensure the best practices in RHD by establishing design and construction standards and providing in house and out-sourced services in road design, environmental and social impact mitigation, road safety, quality control, and research. The main outputs of the Technical Services Wing are

- To maintain updated road design and other standards for all RHD operations.
- To provide design services for road rehabilitation, improvements, and new constructions.
- To seek to raise standards of construction through research and quality control and the implementation of appropriate design standards, technical specifications, and contract documents.
- To identify and developed design and quality standard (geometric, pavement, environment and resettlement, safety, etc.)
- To establish and periodically update standard test procedures for quality control of all standards and types of work.
- To develop and apply quality control audit systems on all RHD project (both developed and maintenance).

Technical Service Wings consists of fours circle, there are Road design and safety circle, BRRL, Social and environment circle, and Arboriculture.

Mechanical Zone is responsible for the provision, operation, and maintenance of equipment, vehicles, and ferries required to undertake the activities of RHD. The main output of the Mechanical Zone is to establish a plant pool in accordance with a defined business plan and to provide a safe, cost-effective, and reliable ferry fleet.

3.2.1 Zonal Operation: The operations of RHD are carried out through ten zonal offices which manage and execute operational work at the field level through the circle, divisional and sub-divisional offices. The zonal offices supervise 22 circle operational offices which in turn control 65 divisions and 136 sub-division. Zonal offices are to ensure works programs are carried out according to standardized procedures and that the budgets are spent effectively and ensuring quality design all phases of construction.

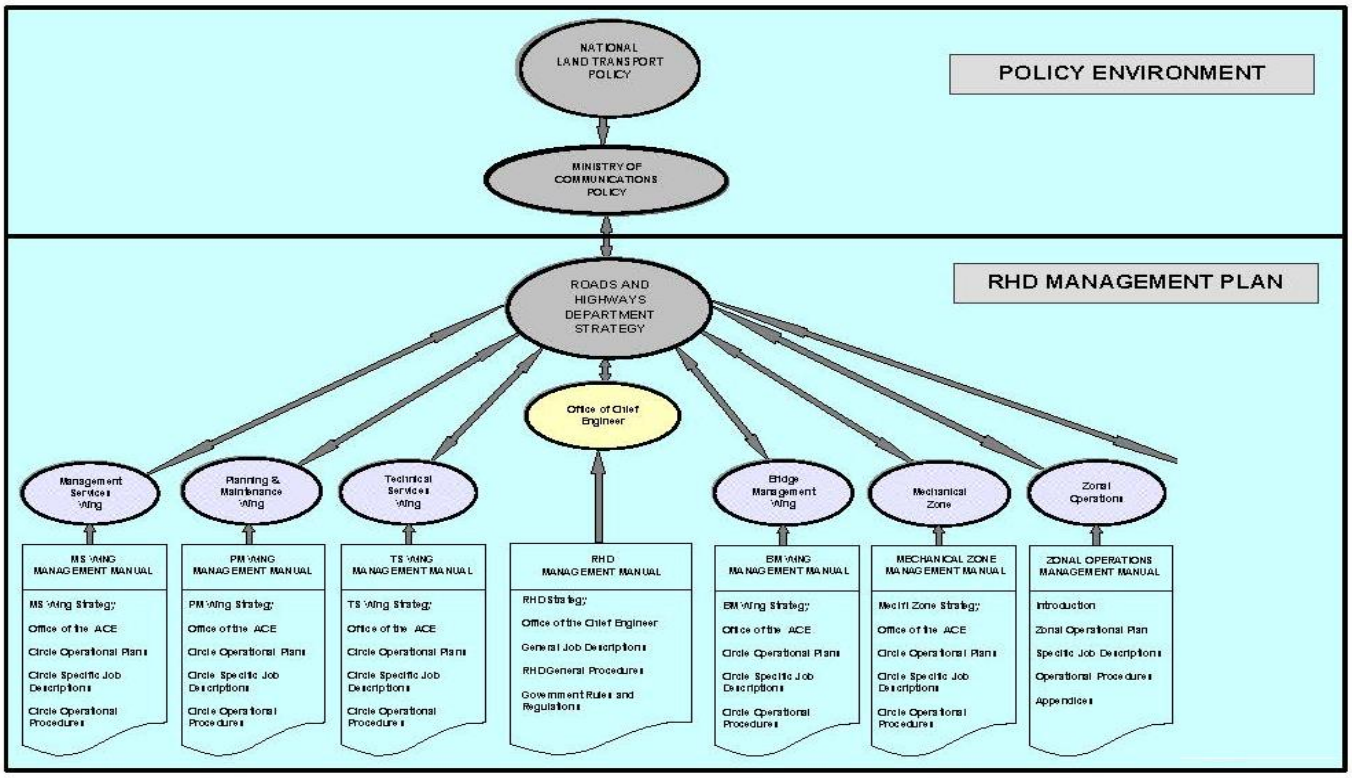


Fig.- 3.1: RHD Documentation Framework

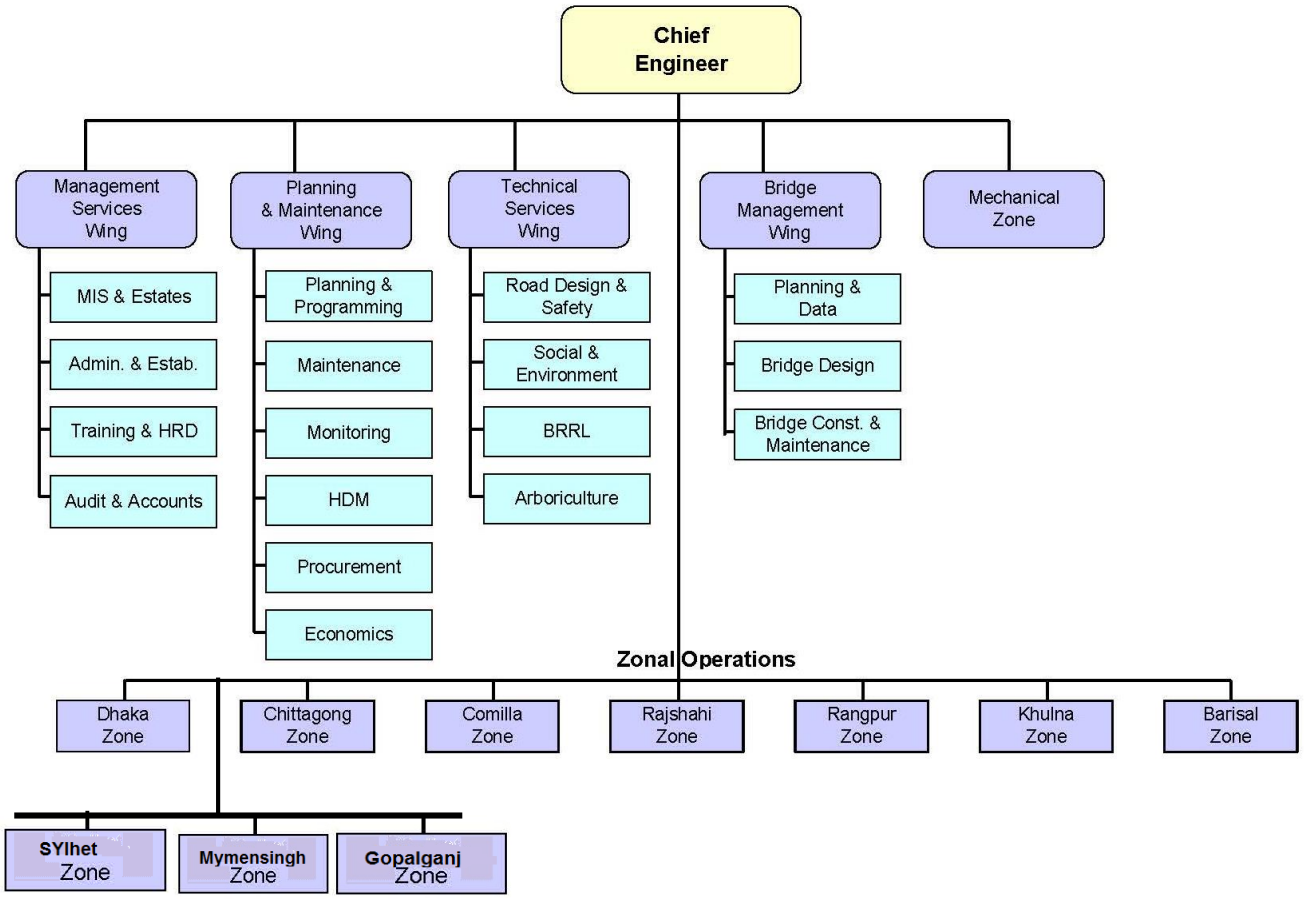


Fig.- 3.2 : Organogram of RHD

3.2.2 Personal: The current sanctioned staff of the department totals 9431 comprising 688 class I, 888 class II, 4548 class III, and 3307 class IV post. However, RHD has a proposal total of 22380 nos. post in the new organization set up which consists of 2053 class I, 2554 class II, 9000 class III, and 8773 class IV employees.

The existing and proposed post are given below :

Grade	Existing Post	Proposal Post
Grade-1	1	1
Grade-2	3	3
Grade-3	13	23
Grade-4	53	93
Grade-5	133	292
Grade-6	220	564
Grade-9	265	1078
Grade-10	888	2554
Grade-11	28	56
Grade-12	103	347
Grade-13	179	843
Grade-14	654	1157
Grade-15	769	925
Grade-16	2615	5565
Grade-17	24	65
Grade-18	481	1468
Grade-19	179	42
Grade-20	2823	7305
Total	9431	22380

Table : 3.1-Grade wise existing and proposed post of RHD

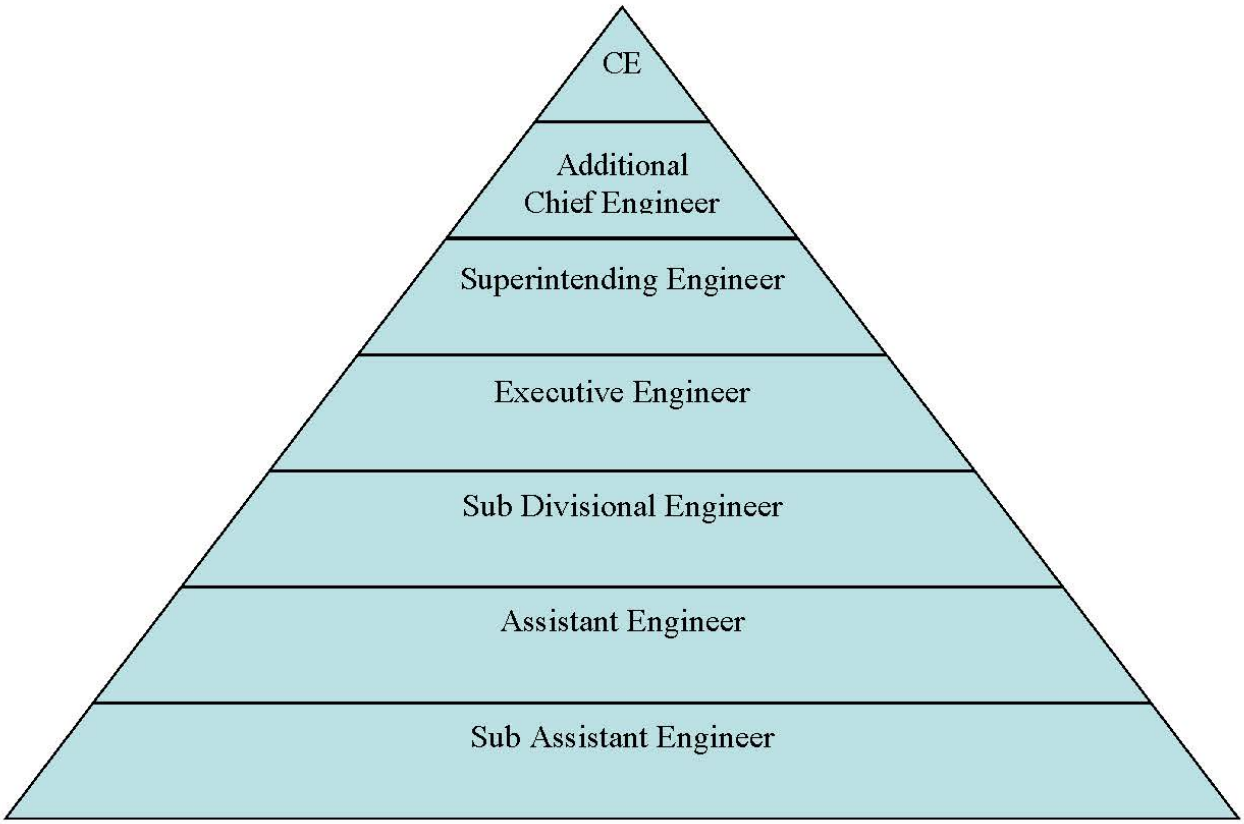


Fig.- 3.3: Organization Hierarchy of RHD

3.2.3 Budgets and Funding: RHD spend a significant amount of government money for the development and maintenance of the road network. Maintenance and rehabilitation budgets will be based on the outputs of the HDM system. The department is also responsible for an annual budget of approximately Tk. 20556.44 crore of which about Tk.18682.92 Crore is for the Annual Development Budget and Tk.1873.52 crore for the revenue budgets in the financial years 2019-2020.

Five years ADP allocation, Maintenance allocation and income from toll are given below :

Sl. No.	Financial Year	Nos. of ADP Project	ADP Allocation	Maintenance Allocation	Income from Toll-Bridge/Road/Ferry	Remarks
1	2015-2016	132	5990.32	1468.45	549.66	
2	2016-2017	134	8199.28	1490.00	631.06	
3	2017-2018	140	14144.68	2250.52	706.37	
4	2018-2019	179	16118.85	2083.11	862.89	
5	2019-2020	206	18682.92	1873.52	767.31	

Table : 3.2 Five years ADP allocation, Maintenance allocation and income from toll

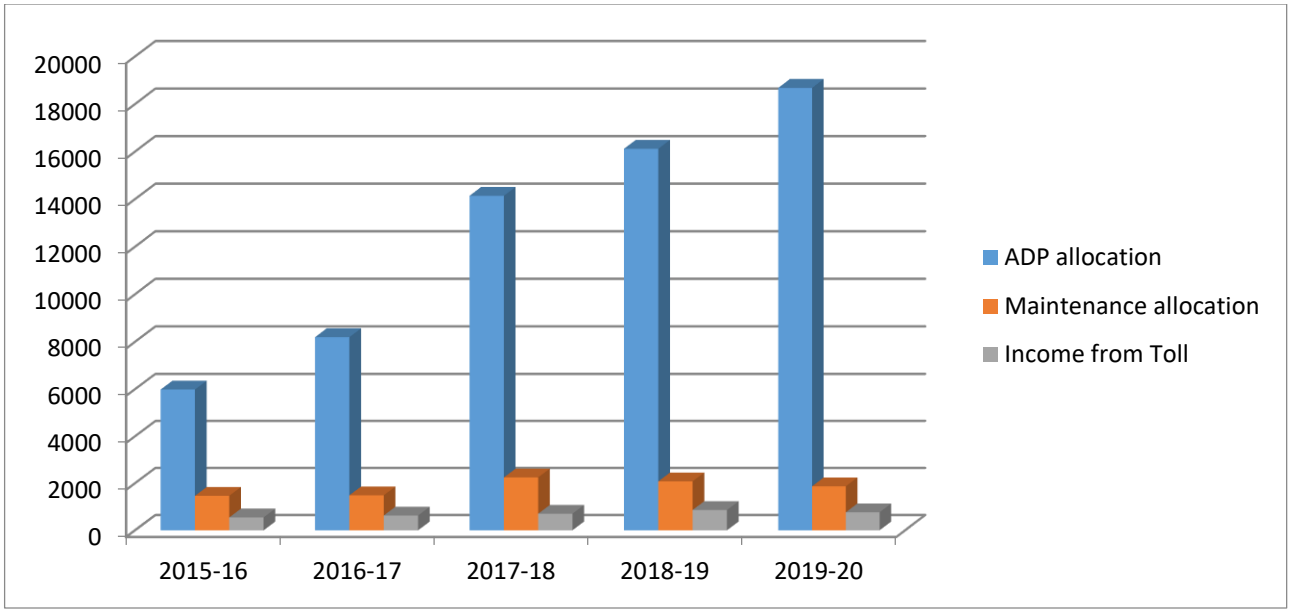


Fig.- 3.4: Bar chart shows Five (5) year ADP, Maintenance allocation and income from Toll

3.3 Existing and future challenge of RHD: Highway network carries nearly about 70% of all road-based traffic in the country. Government-approved National Land Transport Policy (NLTP) in April 2004, where a long-term (20 years) Road Master Plan was emphasized. Accordingly, RHD prepared Road Master Plan under the guidance of ministry. It serves as a guiding document for the road sector investment priority Programme. It provides a physical plan for new road construction, rehabilitation, and maintenance programs. The present state of the RHD road network and the problems being faced in their effective development and maintenance. It was observed that the large sections of the network have inadequate structure strength, there is the wide-scale deterioration of the network due to lack of proper maintenance, many of the damaged and narrow Bridge and Culverts need an immediate replacement, road pavement continues to get severely damaged by vehicle overloading, lack of adequate road safety has already reached an alarming level, faster and smooth movement along the highways is not possible due to presence of a large number of hats and bazaars right on the edge of the road. Traffic growth is also expected to be quite high.

Present problems and future challenges of RHD are summarised as :

- Roads and bridges are continuously damaged from a lack of adequate maintenance and vehicle overloading
- Continuing traffic growth that will exceed the capacity of many National Highways.
- A mix of motorized and non-motorized traffic, and encroachment onto the road, leading to high accident rates.
- The country's rural centers are not fully connected with the main road network and
- The large number of rivers that are still crossed by ferries hampers the smooth movement of traffic.
- Quality Challenges.

3.4 Assessment of Current Situation: The Roads and Highways Department (RHD) in Bangladesh is responsible for over 22000 Km. of roads which are classified in Table 3.3

Road Class	Definition	Length (km)
National Highways (103 nos.)	Highways connecting National capital with Divisional HQ's or sea ports or land ports or Asian Highway.	3943.686 Km.
Regional Highways (148 Nos.)	Highways connecting District HQ's or main river or land ports or with each other not connected by National Highways.	4882.94 Km.
Zila Roads (708 Nos.)	Roads connecting District HQ's with Upazilla HQ's or connecting one Upazilla HQ to another Upazilla HQ by a single main connection with National/Regional Highway, through shortest distance/route.	13536.195 Km.
Total Roads (959 Nos.)		22362.821 Km.

Table 3.3 : Roads and Highways road network definition and lengths

3.5 Road Classification: The Key functional in Bangladesh (capital, divisional, headquarters, sea, and land port) should be connected to the National Highways network.

Place	**Function**	**Connections**
Dhaka	Capital	N1, N2, N3, N4, NS, N8
Chittagong	Divisional Headquarters	N1
Rajshahi	Divisional Headquarters	N6
Khulna	Divisional Headquarters	N7
Sylhet	Divisional Headquarters	N2
Barisal	Divisional Headquarters	N8
Chittagong	Sea Port	N1
Mongla	Sea Port	N7
Benapole	Land Port	N706
Banglabandh	Land Port	NS
Burimari	Land Port	NS09
Hili	Land Port	ZSS03,ZS8S6
Sonamasjid	Land Port	Z6801
Tamabil	Land Port	N212
Akhaura	Land Port	Z1216
Haluaghat	Land Port	Z2371
Bhomra	Land Port	N715
Bibirbazar	Land Port	N101
Teknaf	Land Port	N1

Table 3.4 : National Highways functional connection

3.6 Impacts of road condition, geometry and road furniture on operational efficiency

It is well recognized that road conditions, geometry, and road furniture have a direct impact on the capacity of the highway as well as on operational efficiency. The network could be divided into five different categories as shown in Table 3-4.

Category	Definition of road condition
Very Good	Road sections having nearly perfect condition of pavement and hard shoulders, suitable for high degree of performance. The centerline, edge marking and other types of road markings, sign /signals etc available along almost entire length of the road. No hindrance from traffic congestion due to haats and bazaars or poorly designed intersections. Sight distances are also nearly perfect and adequate cross drainage is properly maintained.
Good	Road sections having an acceptable degree of road geometry and other features and where the riding quality reasonable. All types of road marking, sign/signals, advance distance signboard , etc. are available but not entirely adequate . Sight distance in case of curves is appropriate and cross drainage is OK. Congestions are infrequent.
Fair	Road geometry and road furniture are of reasonable condition. Riding quality is reasonably good. Occasional traffic congestions are encountered in certain stretches of the road, particularly during weekly market days. Level of operation, in totality, cannot be said to be good enough.
Poor	Riding quality is not good. The paved surface is partly deteriorated e.g. ruts, cracks, potholes, undulations and roughness of the surface are noticeable. Hard shoulder is damaged or missing and earthen shoulder is also undulated and poorly maintained. Traffic congestions are also frequent.
Very poor	Such case may arise in the National Highways when the road geometry, surface and other features are greatly damaged which may be due to natural calamity or disaster like flood or cyclone etc. This category shall indicate that traffic cannot operate on such roads without great difficulty and the level of operation is therefore, graded as very poor.

Table 3.5 : Summary of Road Operating Categories

3.7 Sustainable Development Goals: In SDG's Mapping RHD entrusted for 3 lead targets and 4 associate target lead target are 3.6, 9.1 and 11.2 and the associated target is 9.4, 9.a, 9.b and 12.7

Sustainable Development Goal and associated Target	Actions to achieve the SDG targets	List of Existing Policy Instrument (Acts/Policies/Strategies etc.)	Remark
3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents	• Take measures to maintain the roads • Provide special attention while planning and designing for construction of a road • Gradual increase in socio-economic activities of the growing population for road widening • Improving on transport safety standards to reduce incidence of accidents by implementing safety audit periodically. • Improvement of road safety engineering in rural roads to minimize road accidents. • achieving 50% reduction in road traffic accident fatalities by 2020 in line with the UN Decade of Action for Road Safety	Motor Vehicle Ordinance 1983; Road Transport Act, 2018	
Target 9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	• Continue to repair, maintain, improve and expand existing roads on a priority basis • Conversion of nationally important highways into four lanes gradually • Connect important economic activity hubs such as Payra Port and Economic Zones to National Highways. • The development of a balanced 3R (Rail, River & Road) based multimodal transport infrastructure system. • Timely completion of critical transport links (roads, bridges, railways and river waterways) related to regional and multiregional connectivity. • Combining inland water, transport with the existing road transport system as well as ensuring a healthy road alignment. • Priority to regional transport connectivity • Reducing maintenance frequency and thereby recurring cost of roadways, utmost attention should be given to make road infrastructure durable.	Bangladesh National Building Code (BNBC); Bangladesh Public Private Partnership Act 2015; Bangladesh Accreditation Act 2006; Road Master Plan (2010-30); Integrated MultiModal Transport Policy 2013	

	• Develop middle-income enabled quality infrastructures with high-		

	speed mobility facilities. • Emphasis should be given to build necessary access control infrastructures as well as to enforce different conflicting usages of right of way (r.o.w.) throughout the transport corridor. • Construction of 300 km four lane roads • Construction of 340 km roads other than four lane • Improvement/ Rehabilitation of 2,500 km roads • Construction of 7, 000 meter Flyover/Overpass • Construction of 14,800 meter bridges/culverts • Reconstruction of 6,800 meter bridges/culverts • Coordinate the Roads, Railway and inland water cargo linkages to strengthen the performance of Chittagong Port and the competitiveness of the manufacturing sector.		
11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	• Bus rapid transit (BRT) for mass transit • Implementation of revised STP for Dhaka,- two BRT and 5 MRT lines Feasibility studyfor construction of Sub-way (underground railway) in Dhaka city	The Metro Rail Act, 2015 Bus Rapid Transit Act 2016; Revised Strategic Transport Plan 2016	

Table- 3.6: SDG's goal target and existing policy

3.8 Regional Road Connectivity: In the process of globalization, the world has experienced surges of regional initiative in the last century. Strong connectivity not only strengthens the intra and inter-regional trade but also generates higher income and prosperity. Increased connectivity between South and South-east Asia can play an important role in achieving efficiency and enhanced productively. Transport connectivity along with trade facilitation measures may spur regional trade and commence by reducing the cost of transportation and logistics located in an advantageous geographical position.

Bangladesh can play a crucial and strategic role in connecting South and South-east Asia. Accordingly has undertaken a wide range of programs to upgrade its highway and transport network to facilitate trades and cross-border movement of vehicles. Now Bangladesh emphasized corridor based road development with a view to accommodating regional as well as international traffic in Bangladesh.

In the process of promoting regional cooperation and integration; RHD is actively involved in different regional connectively initiatives namely, Asian Highway Network, South Asia Sub-regional Economic Cooperation (SASEC) Road corridors, Bangladesh-China-India-Myanmar Economic Corridor (BCIM-EC), Bay of Bengal Initiative for Multisectoral Technical and Economic Cooperation (BIMSTEC) Road Corridor, SAARC Highway Corridor, and Bangladesh, Bhutan, India, Nepal Motor vehicles agreement (BBINMVA)

3.8.1: Asian Highway: all in Bangladesh, there are three Asian Highway Routes namely, Asian Highway-1 (AH1), Asian Highway-2 (AH2), and Asian Highway-41 (AH41). Of these three routes, AH41 remains within Bangladesh but could be extended to neighboring countries. The total length of the AH routes in Bangladesh is 1771 kilometers.

AH1 Route inside Bangladesh : {Guwahati (India) - Dawki (India)}/Tamabil-Sylhet- Shaistaganj - Narshingdi-Katchpur-Dhaka-Mawa-Charjanajat-Bhanga-Bhatiapara-Kalna Ferry Ghat-Narail-JessoreBenapole / {Petrapole (India)} .Total Length is 492km.

AH2 Route inside Bangladesh : {Guwahati (India) - Dawki (India)} - Tamabil - Sylhet - Shaistaganj - Narshingdi - Katchpur - Dhaka South (Jatrabari) – Dhaka North (Banani Rail Crossing) – Joydevpur - Kaliakoir - Elenga -Hatikamrul - Bogra - Rangpur - Beldanga - Panchgarh - Banglabandha/[Fulbari (India)]. Total Length is 517 km (excluding a common part of 294 km of AH1).

AH41 Route within Bangladesh: Teknaf - Cox'sBazaar - Keranirhat - Feni - Moinamoti - Katchpur - Dhaka (Jatrabari)- Dhaka North(Banani Rail Crossing) - Joydevpur - Kaliakoir - Hatikamrul - Banpara - Dasuria - Paksey - Kushtia -Jenaidah - Jessore - Khulna - Mongla. Total Length is 762 km (excluding a common part of 162 km of AH2).

3.8.2: SAARC Highway corridor involves in Bangladesh:

	Corridor	Countries	Basis of Selection
SHC 1	Lahore – New Delhi – Kolkata – Petrapole/Benapole – Dhaka – Akhaura/Agartala	Pakistan, India & Bangladesh	Potential to carry major intraregional traffic and Potential to providing shorter route leading to transport cost
SHC 4	Kathmandu–Kakarvitta–Phulbari–Banglabandha–Mongla/Chittagong	Nepal, India & Bangladesh	Access to landlocked Nepal to Bangladeshi ports
SHC 5	SandropJongkhar–Guwahati–Shillong– Sylhet–Dhaka–Kolkata	Bhutan, India & Bangladesh	Potential to providing shorter route leading to transport cost savings
SHC 6	Agartala–Akhaura–Chittagong	India & Bangladesh	Shorter access to Chittagong port for Indian North Eastern
SHC 8	Thimphu–Phuentsholing–Jaigaon–Burimari–Mongla/Chittagong	Bhutan, India & Bangladesh	Access to landlocked Bhutan to Bangladeshi ports
SHC 9	Maldha–Shibganj–Jamuna Bridge (Bangladesh)	India & Bangladesh	Potential to provide direct connectivity to carry future

Table: 3.7: SAARC Highway corridor involve in Bangladesh

3.8.3: SASEC Road Corridor: The Bangladesh section of this corridor follows the route below:

• Banglabandha - Panchagarh - Baliadanga - Rangpur - Bogra - Hatikamrul - Banpara - Dasuria - Paksey - Kushtia - Jhenaidhah - Jessore - Khulna - Mongla (659 kilometers)

• Banglabandha - Panchagarh - Baliadanga - Rangpur - Bogra - Hatikamrul - Elenga - Kaliakoir – Joydevpur-Dhaka - Katchpur - Feni - Chittagong (736 kilometers)

SASEC Corridor 4: The Bangladesh section of this corridor follows the route below:

• Burimari - Teesta - Rangpur - Gobindaganj - Bogra - Hatikamrul - Banpara - Dasuria - Paksey - Kushtia - Jhenaidhah - Jessore - Khulna - Mongla (601 kilometers)

•Burimari - Teesta - Rangpur - Gobindaganj - Bogra - Hatikamrul - Elenga - Kaliakoir - Joydevpur - Dhaka - Katchpur - Feni - Chittagong (678 kilometer)

SASEC Corridor 5A: The Bangladesh section of this corridor follows the route below:

• Benapole–Jessore-Khulna- Mongla (161 kilometers)

• Benapole–Jessore-Magura-Rajbari-Dhaka-Chittagong (491 kilometers)

BCIM-EC: More options for BCIM alternative corridor inside Bangladesh could be the following:

• Dhaka – Chittagong - Keranirhat - Thanchi - Rimakri - Modwok - Likri (Bangladesh) - Napraitaung (Bangladesh - Myanmar Border) - Daletme (Myanmar) - Kyauktaw (Myanmar) - Mandalay (Myanmar) - Lashio (Myanmar) - Ruili (China) - Kunming (China).

3.8.4: BIMSTEC Road Corridor:

No.	BIMSTEC Road Corridor (BRC)	Length (km)	Countries
1.	Kolkata-Petrapole (India)/Benapole (Bangladesh) -Dhaka-Akhaura-Agartala	478	India & Bangladesh
4.	Kathmandu-Kakarvita-Phulbari(India)/ Bangladesh (Bangladesh)- Mongla / Chittagong	Mongla 1314 Chittagong 1394	Nepal, India & Banglabandha
5.	Samdrupjongkhar (Bhutan)-Shillong(India)-Sylhet(Bangladesh)-Dhaka-Kolkata	906	Bhutan, India & Bangladesh
6.	Agartala-Akhaura-Chittagong	227	India & Bangladesh
8.	Thimphu (Bhutan)-Phuenthsholing-Jaigon-Chengrabandha (India)/ Burimari (Bangladesh)-Chittagong/ Mongla	Chittagong 966 Mongla 880	Bhutan, India & Bangladesh
9.	Maldha-Shibgang-Bangabandhu Bridge, Bangladesh	253	India & Bangladesh
11.	Chittagong-Ramu (Cox's Bazaar)-Teknaf-Maungdaw	225	Myanmar & Bangladesh

Table: 3.8: BIMSTEC Road Corridor

3.8.5: BBIN-MVA :

Bangladesh Part

1. Teknaf - Cox Bazaar - Chittagong - Dhaka - Hatikamrul - Rangpur.
2. Mongla - Khulna - Jessore - Kushthia - Hatikamrul - Rangpur - Burimari.
3. Teknaf -Cox Bazaar - Chittagong - Dhaka - Hatikamrul - Rangpur - Banglabandha / Phulbari.
4. Mongla - Khulna - Jessore - Kushthia - Hatikamrul - Rangpur – Banglabandha/ Phulbari.
5. Agartala/Akhaura - Ashuganj - Joydevpur - Chandra - Nabinagar - Paturia - Magura - Jessore - Benapole

Although several initiatives are underway to promote regional connectivity. Challenges still remain to make regional connectivity initiatives partly and fully functional. In order to establish effective regional transport connectivity among the countries, some important issues need to be addressed.

Chapter- Four

The present state of Quality Control in RHD

4.1 General: During the last 10 years a rapid expansion of the road network has taken place in Bangladesh. Now many of the roads and bridges that make up this network are in need of rehabilitation, major maintenance, or improvements.

In recent years the quality of work by some of the contractors retained by RHD for road and bridge contracts has failed to meet the standards required by the RHD Specifications, and in many cases, this has resulted in the premature failure of these works. If this is allowed to continue, within a few years a significant amount of the existing RHD road network will deteriorate to the point whereby it is unusable due to insufficient funds being available to maintain it. Although the allocation of funds for works on RHD roads and bridges may increase over time, clearly every effort must be made to obtain the best value for money from whatever funds are made available.

The quality of works undertaken by contractors must be improved and amongst other things, this will require improved supervision of their works by RHD personnel. Although all contractors are responsible for achieving the standards required by the RHD Specification, it is nevertheless the responsibility of the RHD supervision staff to check their compliance with those standards and to reject any sub-standard work. In particular, the designated Engineer for each contract is ultimately responsible for ensuring that contractors comply with the requirements of their Contracts.

To assist in achieving this goal the following basic Quality Assurance Plan has been developed in RHD in 2005. Compliance with this Quality Assurance Plan will go a long way towards improving the quality of works currently obtained from RHD contractors, and thereby enable RHD to maintain or improve more of the roads under their control with the limited funds available to them.

4.2 Quality Assurance Plan :

This Quality Assurance Plan has been prepared to assist the Divisions in achieving the required quality in RHD contracts for roadworks and minor structures. The QA Plan is for general application to all RHD roadwork contracts that are funded by GoB and supervised solely by RHD staff.

The QA Plan covers the major issues that affect the quality of works achieved within RHD contracts, namely the preparation of contract documents and quality control during the works. Responsibility for checking and approving all designs, tender documents, and quality control tests on-site rests with the Engineer for the Contract and through him the Engineer's Representative.

Within this QA Plan, quality control procedures are needed at each stage as follows:

4.2.1 During Contract Preparation

- All proposed works are to be confirmed on-site as is necessary, appropriate and adequate by the Engineer for the Contract
- New road pavements must be designed, with such designs being checked and approved by the Engineer for the Contract
- Where new surface water drainage is to be provided channel profiles are to be designed with such designs incorporated in the Contract Documents
- Where appropriate BQ items must be supported by field measurements and calculations
- Tender Documents are to be prepared to adopt the CPTU Standard Tender Documents

4.2.2 During Works Contracts

- The Contractor is required to perform quality control tests on all materials and workmanship of the type and frequency called for under his Contract
- These are to be undertaken in accordance with the RHD Standard Test Procedures, such tests being witnessed and countersigned by an RHD representative
- Off-site laboratory tests are to be undertaken by the Contractor on-site samples where appropriate testing equipment is not available at his on-site laboratory (e.g. bitumen extraction, Marshall tests, etc)
- Site samples are to be tested in an independent off-site laboratory to confirm (or otherwise) tests undertaken by the Contractor
- The Contractor may only proceed with successive road pavement layers subject to authorization by the Engineer following satisfactory and certified quality control tests on the underlying layer
- Interim Payment Applications from the Contractor must be supported by relevant quality control test reports certified correct by the Engineer's Representative
- Road contracts will be subject to post-construction tests on a sampling basis to check compliance with. the specification and Contract Documents

This QA Plan defines the roles and responsibilities of the key RHD staff involved in road contracts and outlines the procedures that should be adopted by them to achieve the required quality control in these contracts.

4.3. Quality control in contract preparation:

4.3.1 General

The quality of completed works is dependent on the quality of the design and on the quality of the works (materials used and workmanship) carried out. If the design of the works defective then even if the works are carried out to a high standard they will prematurely fail.

In recent years RHD has developed design standards, manuals, specifications, standard drawings, and design advice notes. If followed by the Divisions they will result in designs and contract documents for works that are appropriate.

If complied with during construction they will result in works of a high standard that will perform well for their full design life and will be cost-effective. It is essential that the works are correctly designed and specified during the contract preparation, and it is the responsibility of the Engineer for the contract to check and approve these prior to the Employer's Representative floating tenders for the Works.

4.3.2 Design of the Works

For routine or minor maintenance works (e.g drainage of water, crack sealing, pothole repairs, palasiding, etc) RHD standard designs have been prepared and these should be adopted. Although minor in nature it is essential that these works are carried out to the required standards to avoid premature failure.

For example, if potholes are properly repaired to the required standard then the more expensive periodic maintenance of a road can be deferred for many years. On the other hand if cracks or potholes are not repaired effectively they will prematurely and progressively fail, making periodic maintenance impractical and require early and costly rehabilitation works to the road.

With respect to the periodic maintenance of roads, an initial assessment of the treatment they require will have been made by HDM4 in the RHD Annual Roads Needs Assessment Report. This Report, in effect, prioritizes the roads for periodic maintenance within the available budget for this type of maintenance. This does not relieve the Engineer for the works from his responsibility to check and approve the actual works that should be carried out.

Where full reconstruction is required, and for all new road construction (including widening), road pavements must be designed, with the design calculations being checked and approved by the Engineer and subsequently filed by him as part of the document control system.

In particular, the new road pavements must be designed to be above the relevant Highest Flood Level (HFL) as defined in the RHD Pavement Design Guide.

For all road contracts where a new surface is to be laid a design must be undertaken for the required new carriageway markings and traffic signs. These must be designed in accordance with the BRTA Traffic Signs Manual.

4.3.3 Drawings

Divisions have limited capacity for the production of engineering drawings. For this reason, RHD Standard Drawings have been prepared, and these should be referred to and be included as part of every road Contract.

The Divisions have available to them GIS mapping on request from HDM Circle. These maps should be used to create a location drawing for each contract showing, for example, the start and endpoint of road contracts or the location of a new structure. This location drawing must be included in every contract.

In addition, in the absence of topographical mapping and plan layouts, every road contract must include the location and extent of the major work items showing the start and end chainages (in bar chart form).

Where surface water drainage is required and is to be included in a works contract, a longitudinal plan showing the gradients and outfalls must be included within the contract documents.

Where special minor structures are to be included in road contracts for which standard drawings are not available (e.g. large retaining walls) then design drawings approved by the Engineer must be included within the contract documents.

4.3.4 Bills of Quantities

For every item of work within a Contract where an estimate has to be made of the quantities involved, calculations must be made that are checked and approved by the Engineer and filed in the document control system. Where appropriate such calculations must be supported by field measurements, in particular with respect to earthworks, pothole repairs, and bituminous base course regulating course. Where a nominal thickness of bituminous surfacing forms part of the Works, then the corresponding item in the BoQ must specify the compacted thickness that the Contractor is to provide.

All BoQ items must correspond to the relevant pay items in the RHD Specification or the Particular Specification for the Contract. Under no circumstances should a BQ item include any form of

specification for either materials or workmanship. All BoQs must be prepared using the Field Module of the Central Monitoring System.

4.3.5 General and Particular Specification

In May 2001 RHD Standard Tender Documents were issued that included Volume 3: Technical Specifications. In due course, this will be revised and re-issued as the RHD General Specification. In the meantime, all RHD Contracts must include a statement that Volume 3: Technical Specifications is deemed to be the RHD General Specification.

This General Specification must form the basis of all RHD road contracts supplemented where necessary by a Particular Specification for an individual contract. Due to the time that has elapsed since the publication of the RHD Standard Tender Documents various amendments to the Technical Specifications have been proposed.

It is now mandatory that within the Particular Specification the attention of the Contractor is drawn to the quality control tests that must be carried out by him on both his materials and workmanship as part of the Contract. In addition to this, it is necessary to specify that the site laboratory is to be located within the limits of the Works contract or at such other location as agreed by the Project Manager in writing.

4.3.6 Tender Documents

In due course, the CPTU Standard Tender Documents that are to be used by RHD are to be supplied to the Divisions in an electronic format that will be compatible and integral with the RHD Central Monitoring System.

These standard documents will incorporate the standard clauses and conditions required by RHD in every contract and will simply require the Procuring Entity to insert the contract specific details for the works contract for which tenders are to be invited. The standard clauses required by RHD will cover such issues as the employment of females on contracts, health and safety requirements, environmental controls, and other contract requirements approved by CE; RHD from time to time.

4.4. Quality Control in Construction:

4.4.1 General

Unless strict quality control is maintained during construction or maintenance contracts, premature failure of the works will inevitably occur. In this respect, quality control includes the quality of the materials that are used and the standard of workmanship provided by the Contractor in undertaking the Works.

The requirements for these are clearly stated in the RHD General Specification. Whilst it is the responsibility of the Contractor to achieve the specified standards, it is the responsibility of the Engineer to ensure that the Contractor meets these requirements.

The overall procedures for quality control testing are contained in flowcharts in Fig.- 4.1 and 4.2. The main principles are:

- The Contractor may only bring materials onto the site after obtaining approval for the use of those materials from the Engineer in writing. Approval will be based on samples of the materials meeting the requirements of the specification and a production process that assures consistent quality
- Throughout the Contract all materials brought onto the site must be tested for compliance with the specification. Materials that fail to meet the specification requirements must be rejected by the Engineer and removed from the site by the Contractor
- The Contractor must obtain the approval of the Engineer in writing before commencing each stage of the Works. Approval will be based on satisfactory quality control tests on the preceding stage and/or other requirements of the specification.

The RHD Specification requires quality control tests to be undertaken by the Contractor at every stage and on all aspects of the Works.

Many of the quality control tests can be undertaken on-site using fairly basic testing equipment. Others will need to be carried out in an off-site laboratory that has been approved by the Engineer and that contains more advanced testing equipment. In either case, the quality control tests required by the RHD Specification are to be undertaken by the Contractor at his own expense, the cost of such testing being deemed to be included in his rates for the relevant work items.

Additional tests, including checks on the calibration of the testing equipment used by the Contractor, should be carried out as directed by the Engineer at Zonal or other independent laboratories for quality control audit purposes.

A detailed description of each test procedure and how it should be undertaken is contained in the RHD Standard Test Procedures and blank forms for recording test results can be downloaded from the website.

The results from all tests carried out both on-site and at off-site laboratories should be submitted to the Engineer's Representative using the standard forms. Where any test result fails to meet the requirements of the Specification the ER must be notified immediately by telephone with a copy of the failed test report despatched to him without delay.

In order that no works are undertaken where the underlying layer, or preparatory works, do not meet the requirements of the Specification, the Contractor must seek written authority from the ER to carry them out. The ER will require satisfactory laboratory tests reports on the underlying layer or other requirements before such authority will be given.

4.4.2 Quality Control Tests

The quality control tests are the tests required by the RHD General Specification. Where works are to be undertaken that are not covered by the RHD General Specification then the Contract must include a Particular Specification for such works, including the tests, frequencies, and required results for those tests, both for the materials and workmanship for these works.

In addition to these tests, where the Contract requires particular materials to be used but the specification does not require tests to be carried out on those materials, then it will be the responsibility of the Engineer to ensure that the Contractor provides those materials to the requirements of the specification.

Quality control tests fall into three categories:

- Tests on materials prior to and during construction
- Tests on the quality of workmanship during construction
- Tests on the finished works after construction

In the event that the quality control tests demonstrate that the materials or workmanship do not meet the requirements of the specification, the Engineer's Representative has no alternative but to reject them and instruct the Contractor to replace them at his own cost. All quality control tests must be carried out at the earliest opportunity both to avoid delays to the Contractor and to minimize any abortive works.

4.4.3 Quality control tests on material samples

Prior to the commencement of the Works, tests must be carried out by the Zonal laboratory on material samples (or mix designs) submitted to the Engineer for his approval by the Contractor in advance of them being taken on to the site. Given that the Zonal laboratory may be testing samples from a number of different contracts at the same time, it follows that within the laboratory itself there must be a management system to ensure that samples are correctly registered, tagged, tested, and recorded for the separate contracts.

Similar tests must be carried out by the Contractor on all such materials subsequently delivered to the site in the site laboratory (supervised by the Materials Engineer) with additional tests on those materials carried out on a sampling basis at the Zonal laboratory as a quality control check.

4.5 Quality Control Tests on Workmanship

To a large extent, these tests are required to ensure that the approved construction materials are correctly mixed, placed, and compacted during the works. With respect to road pavements, it is essential that each layer is tested and approved before the Contractor is allowed to place the next layer since the failure of an underlying layer will inevitably result in failure of the layers above it.

Accordingly, the Contractor may only be permitted to commence work on a particular layer when the underlying layer has been approved in writing by the Engineer's Representative.

4.5.1 Mixing of Materials

Where on-site mixing is employed by the Contractor, the grading and proportioning of the materials must be strictly controlled so that at all times the final mix complies with the design mix that has been approved by the Project Director/Project Manager. To this end, careful batching of the materials must be employed by the Contractor prior to placing them in the mixer. Under no circumstances should the proportioning of mixes be undertaken by laborers taking materials from stockpiles on a random basis.

Where granular materials are mixed on-site to form sub-base or base material, and prior to the addition of bitumen or cement to granular mixes to form bituminous surfacing or concrete, samples of the granular mix should be taken in the presence of the ER's support staff for grading and other tests in the site laboratory.

Whether mixed on-site or off-site, the ER's support staff must take samples of all bituminous and concrete mixes for testing at the Zonal laboratory in accordance with the requirements of the Specification. Inevitably the results of these tests will not be known until a considerable period of time has elapsed after

the materials have been placed and compacted. Where the results of these tests demonstrate that the materials do not comply with the Specification further intrusive and /or non-destructive tests must be carried out on the completed works for the Project Director/Project Manager to decide whether or not to reject the works.

Concrete target strengths are to be calculated using the statistical approach set out in the Contract.

4.5.2 Placing and Compacting of Materials

Premature failure of the works will occur unless the materials are correctly placed and compacted (where appropriate) in accordance with the specifications. In the case of road widening work, premature failure will also occur if required cross drainage structures or drainage layers are not provided.

With respect to road pavements, this essentially means the compaction of each layer to the required density (typically 98% of MDD) to achieve the necessary CBR to support the next layer. In the case of Dense Bituminous Surfacing or carpeting, the required degree of compaction can only be achieved when rolling takes place while the material is still hot and within the specified temperature range for compaction.

Accordingly, the ER must ensure that field density measurement are taken by the Contractor at the appropriate times to demonstrate that the underlying layers are properly compacted (or corrective measures are taken if not), and that rolling of the bituminous surfacing is undertaken within the correct temperature range.

4.5.3 Quality Control Audit of Completed Works

The RHD General Specification requires cores to be taken from completed bituminous surfacing work and for laboratory tests to be undertaken on these samples to determine whether or not they comply with the requirements of the specification. Amongst other things these tests will include Marshall stability, determination of bitumen content, and the grading of aggregates in each sample. In addition to this the laboratory will measure the compacted thickness of the bituminous layer for compliance with the design or relevant BoQ item in the Contract. The taking of cores is to be undertaken by the Contractor and all tests on those cores are to be undertaken by an off-site laboratory approved by the Engineer, with all costs associated with this testing being borne by the Contractor.

Where cores have been taken from road pavements Dynamic Cone Penetration (DCP) tests are to be undertaken for the underlying layers through to the sub-grade to determine both the thickness of these layers and their respective CBR values. These tests are to be undertaken by the ER or his support staff.

In the event that the DCP tests show that the underlying pavement layers do not have the required thickness or CBR or if the bituminous cores do not meet the requirements of the specification or thickness required by the Contract, the Engineer will immediately notify CE/RHD questing that an inquiry is held to determine what course of action should be taken.

4.6. Document Control

4.6.1 General

For every Contract, it is essential that a document control system is established that includes all documents relating to the Contract. This is important both for the quality control of the Works and to comply with Public Procurement act / rules. Amongst other things, the rules require full documentation relating to all contracts to be maintained for review by independent consultants and CPTU. Specifically, the rules require that documentation relating to a particular contract must be properly filed, maintained and readily accessible for a period of five (5) years or more beyond completion of the contract.

The document control system for a Contract must be a 'stand-alone' comprehensive system. Inevitably this may mean that some documents, in particular correspondence, may need to be duplicated between the Employer's Representative and the Engineer and possibly copied to or from other document control systems within RHD.

Frequently the Employer's Representative and the Project Director/Project Manager are one and the same for a Contract (e.g. the Executive Engineer for a Division).

4.6.2 Site Laboratory

Under all RHD contracts, a site laboratory is to be established by the Contractor who is responsible for carrying out quality control tests on his materials and workmanship to demonstrate compliance with the specifications for the Contract. This laboratory should be established before the Works commence and within the limits of the Works area. Subject to the approval of the Engineer some of the tests may be carried out at an alternative laboratory containing more advanced testing equipment.

All tests must be witnessed by the ER or someone appointed by him for the purpose (the 'Materials Engineer'). Appropriate test forms must be used and both these and the test result forms must be signed by the person carrying out the test and representatives of both the Contractor and the Engineer.

The ER must check on a weekly basis that the required tests on all materials delivered to the site and the Contractor's workmanship have been carried out and that the results of such testing are correctly recorded and filed within the site laboratory.

Fig 4.1 Flowchart for earthworks, sub-base and base

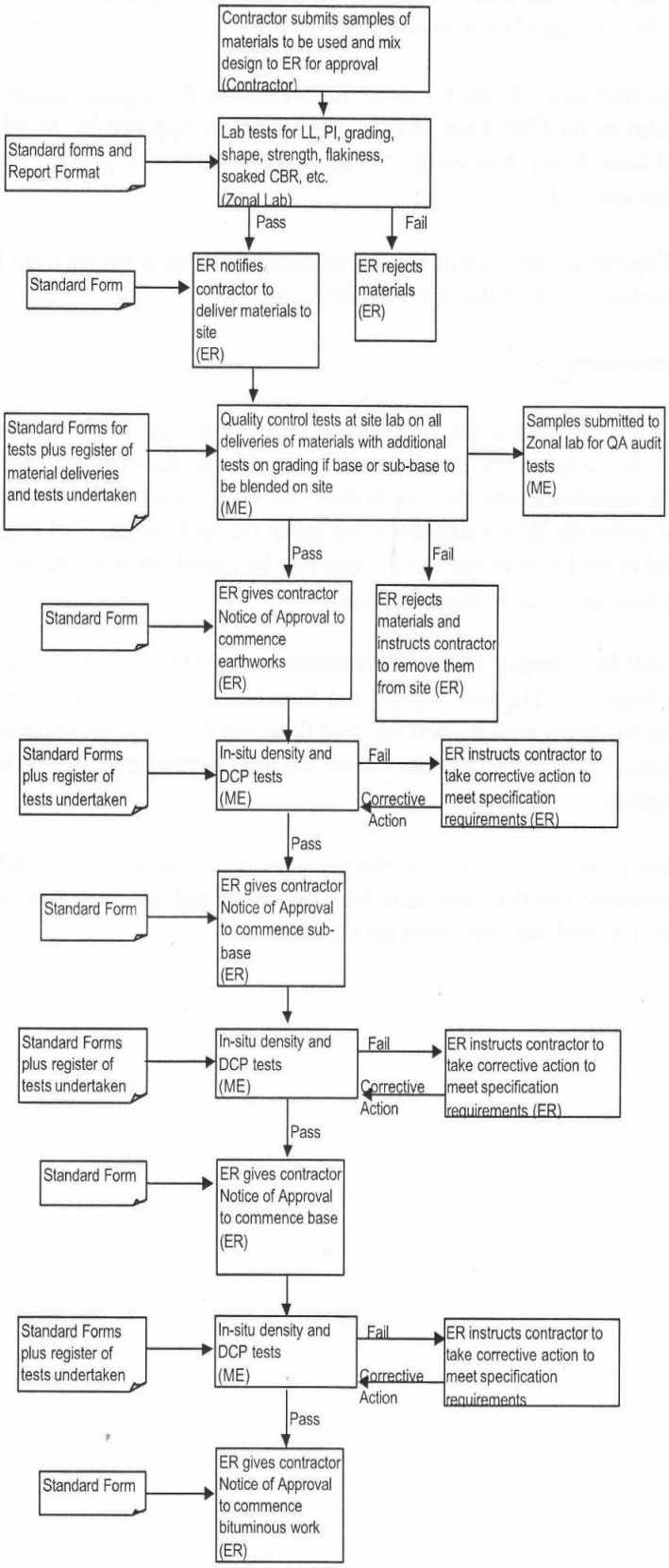


Fig 4.2 Flowchart for bituminous surfacing

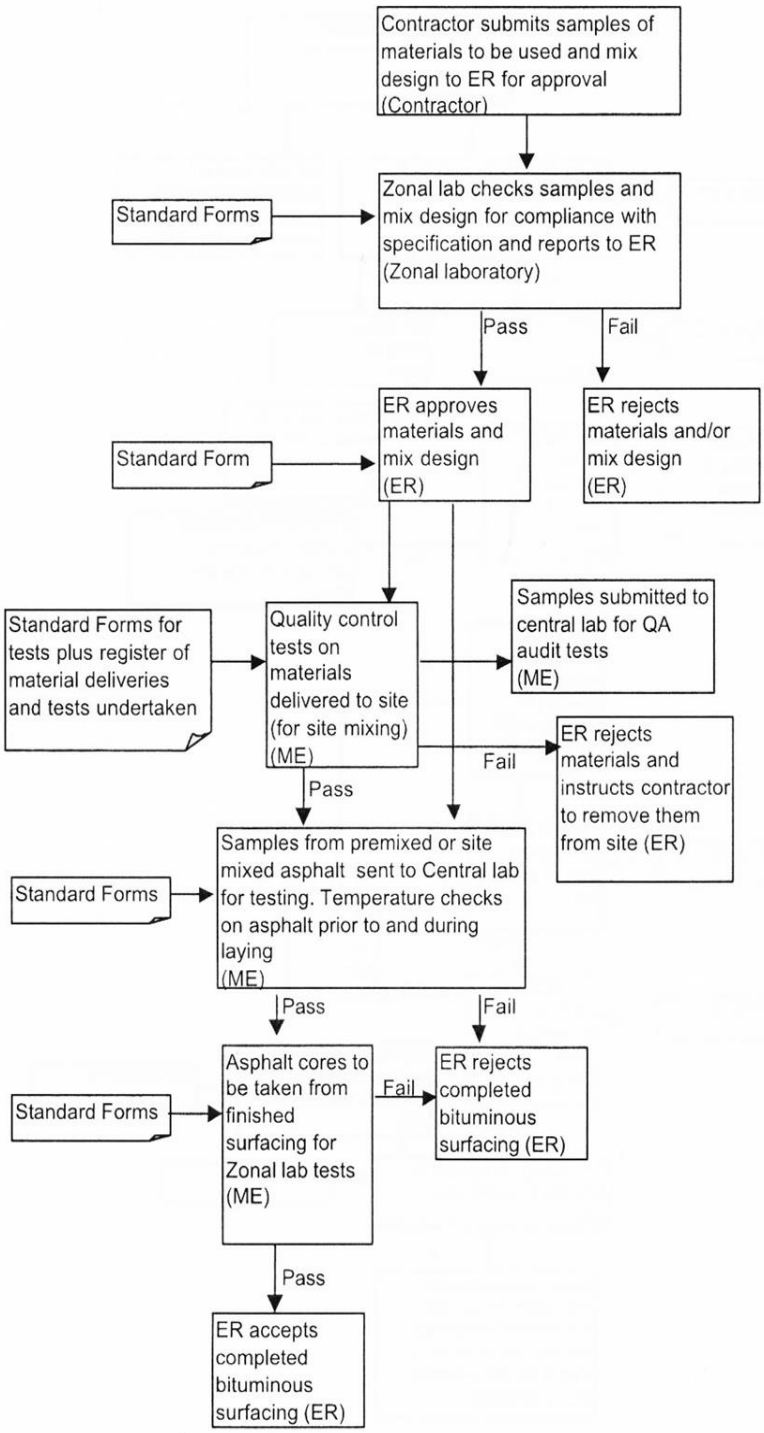
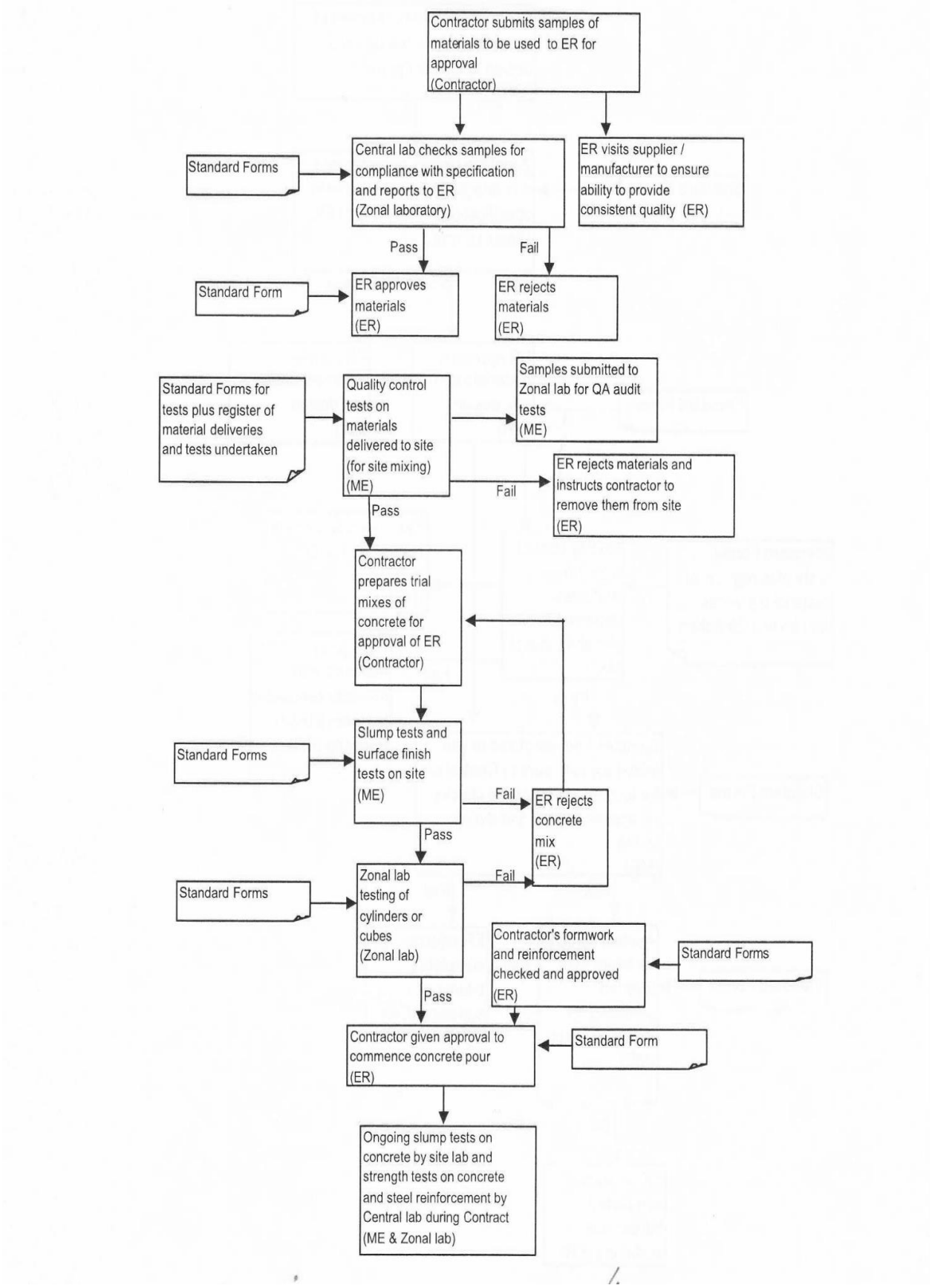


Fig 4.3 Flow chart for structures



Chapter- Five

Scope of Improvement regarding Quality Issue in RHD

5.1 General

RHD is responsible for improving the quality of national importance. Moreover, the Government has taken certain policies to modernize the transport networks. To realize SDE's goals, the road sector needs massive expansion. It is necessary to improve the quality control system in RHD. These scope of improvement issues are discussed in the following section.

5.2 Organizational Aspects

Most of the quality-related issues arise within the organization. For this reason, the organization should be analyzed in various aspects to determine quality-related problems. The main aspects to be considered are human resource, procurement, management.

5.2.1 Human Resource Development

Human resources are the main resource of an organization. The government of Bangladesh Recruits the workforce and provides the required facilities. The facilities are mostly depend on Government strategies. The first-class officers of RHD are recruited by Bangladesh Public Service Commission BPSC. The recruitment is done for the entry first-class post of Assistant Engineer. BPSC also recruits second class officers Sub Assistant Engineers. The first and second class officers recruited following rules and rules of the government and they are the main workforce of RHD for implementing the construction and maintenance work. The higher posts are filled by promotion. The second class officers also get promoted to first class post, 33% of Assistant Engineer post is filled by promotion. Third and Fourth class employees are for support and recruited by the government.

Training is important for HRD. RHD has a training center. It is providing training on technical various financial and management issues. RHD Training Center is giving training on various topics but quality-related training is absent. There is also a scope of training for staff at home and abroad. But the training is not uniformly distributed among the staff. Another problem is 3rd and 4th class employee gets less or no training.

5.3 Organizational Position

Organization position can be determined by SWOT (Strength, Weakness, Opportunity, and Threat) analysis. The SWOT analysis of RHD is performed below:

Strength	**Weakness**
• Highly competent Engineers • Experience of the organization • Modern procurement system (e GP) • Attracts huge amount of FDI • Introduction of HDM by model	• Budget scarcity • Reputational Problems • Outdated equipment • Absence of Quality Audit • Lack of required training in technical field
Opportunity • Regional connectivity • Widening and upgrading of roads • New concepts of highway around the world • Adoption of latest technologies • Rigid pavement concept in	Threat • Weather of the country (prolonged rainy season) • Lack of personnel in future • Right of Way encroachment • Works of RHD performed by other organizations.

Table 5-1: SWOT Analysis of RHD

To develop a safe, cost-effective, and well-maintained road network RHD should overcome the weaknesses and work with integrity to minimize threats. From the analysis above it can be seen that it has the ability to perform its mission.

5.4 Planning

5.4.1 Long Term Planning

Roadmaster plan is a quality long term plan for quality road construction. It has identified and given a solution to many of the problems. The roadmaster plan was for 20 years, after five years from 2009 the initial projects taken are not completed. The roadmaster plan suggested many priorities, which still remains a problem. These things should be considered immediately. Following are the prioritization fixed in the Master Plan,

- Recurrent (maintenance) expenditure should have the first priority, and full needs should be planned for on an annual basis;
- The rehabilitation of National Highways, Regional Roads and Zila Roads must be considered a priority, as delay will increase the costs of recovery;
- Road and bridge projects that are related to traffic growth should be programmed according to dates that they are needed;
- Bridge replacement and repair programs are a priority, but have to be phased in order to respect human capacity constraints in RHD; and
- Axle load control is of the utmost priority.

The rest of the projects suggested have to be completed within the next fifteen years. To fulfill the commitment learning is necessary. The suggestion of roadmaster plan like axle load control is not fully operational yet, just the law and regulation if formulated. Maintenance given the most priority but still maintenance has limitations. Rehabilitation of the major national and regional highway is not complete.

5.4.2 Short Term Planning

The short term planning like project planning consumes time due to the bureaucratic nature of the processes. It cannot be avoided as any part of the government RHD, ministry and planning commission are involved in planning. Cross-functional teamwork is needed to improve efficiency. But the planning and design are done maintaining the international standards. The maintenance planning as said earlier is not given the topmost priority.

5.4.3 Procurement

The introduction of e-GP has limited the corrupt and fraudulent practice by the officers and the contractors. Now RHD has performed 100% e-GP tendering. The processes of the tendering followed are standard. The documents and standards are derived from European standards like the International Federation of Consulting Engineers, FIDIC, and New Engineering Contract, NEC. But there is lacking in the rules, PPR-2008 suggests the lowest bidder is to be awarded by the tender evaluation committee. If the tender evaluation committee does not approve his bid then statue law permits him to go to court. Then the whole process will be hanged.

5.5. Quality Audit Guidelines (QAG) :

One of the most important tools for quality improvement is quality audits. It is necessary to engage impartial third-party audits to ensure the performance of contract as well as whole organization.

5.5.1 Introduction :

The Government of Bangladesh (GOB) through Roads & Highways Department (RHD) is aiming to enhance the traffic capacity and safety for efficient transshipment of goods as well as passengers trafficked on a national and regional highway section. The government of Bangladesh has entrusted Road and Highways Department (RHD) with the responsibility of improving the quality of highways of national importance.

The primary mandate of RHD is time and cost-efficient sustainable improvement of national highways from two-lane to four-lane, construction of new expressway, major bridges, fly over‟s, new

grade-separated intersections and major underpasses on the national network. The maintenance of arterial roads, bridges, and culverts is to be completed in line with the quality of the highest standard. At present, the RHD owns the following national road network including bridges/ culverts.

Financial auditing of public-funded projects is performed under the present auditing system. But it is the quality audit which had not received any attention in the past. The need for quality auditing arose from the fact that some of the recently implemented road construction projects have shown signs of either pre-mature failure and/or are in the process of failure before the design period.

This quality auditing of road projects is a step in the right direction towards ensuring that the road projects undertaken in Bangladesh are appropriately designed and constructed. This quality provides a framework for conducting an audit.

The quality system is an internationally respected method for facilitating improvement efforts by providers of the Ministry of Road Transport and Bridges (MRTB), and for providing the public with a level of assurance that the quality of our transport infrastructure is being attended to through external review.

5.5.2 Legal basis and objective of quality audit

- This quality audit will be done in accordance with the mandate given by the RHD to Bangladesh Road Research Laboratory (BRRL). BRRL will perform the quality audit annually by engaging consultants/independent consultants or by any other means. Concerning types of government establishes two main types: financial and quality/ performance audit.
- Financial audit focuses on determining whether an entity‟s financial information is presented in accordance with the applicable financial reporting and regulatory framework. This is accomplished by obtaining sufficient and appropriate audit evidence to enable the auditor to precise an opinion on whether the financial information is free from material misstatement due to fraud or error. This financial audit shall be conducted outside of RHD jurisdiction.
- RHD through BRRL will conduct quality/performance audit that focuses on whether interventions, programs, and institutions are performing in accordance with the principles of economy, efficiency and effectiveness and whether there is room for improvement.

RHD field level offices need continuous BRRL support in solving complex technical problems. Professional ethics is assumed as the basis of the condition of the contract. Likewise, professional ethics is assumed in conducting technical audits.

This concept is very important since a technical audit cannot inspect every detail of the road and bridge works. Majority of the tasks to ensure the quality of the works inevitably vested upon the staff of

the implementing agency, especially the RHD field office which is responsible for the administration/execution of the project.

5.5.3. Preliminary audit

This phase should be carried out as soon as the contractor is properly established the base camp but within the first 3/ 4 months or 20 percent of the contract period, whichever is less. This phase should be administered after construction has commenced in order that all of the right procedures are often established from the start of the project. In the first on-site audit, attention should specialise in project management issues and construction methodologies. This will incorporate:

- A review of the SRE/ Resident Engineer's pro-activity, control, and approval procedures;
- Adequacy of the materials field laboratory;
- Specific experience of staff;
- Site communications;
- Knowledge of condition of contract;
- Construction quality of work completed;
- Efficient performance attitude towards the project.

The auditor would also ensure/ verify that the assessment of the contractor has been done satisfactorily by the Engineer, regarding the following issues and aspects:

- Quality and appropriateness of the plant and equipment;
- Operator skills;
- Methods of working;
- Materials and source of materials supply;
- Site organization and site management;
- Quality and detail of the construction program;
- Site safety;
- Quality assurance procedures, and
- The contractors project management processes and procedures.

5.5.4. Intermediate audit

The auditor should carry out an intermediate audit that concentrates on conformance with the specification and matters of effectiveness and ensures that the procedures that had been set up initially are running correctly. This audit will be carried out at a time approximately halfway through the project but not more than 6/ 7 months after completion of a preliminary audit. On large projects, it may be necessary to carry out more than one intermediate audit and the timing and frequency of these should be specified in the Terms of Reference (TOR) for the appointment of the technical auditor. The following should be addressed during the intermediate audit/ audits.

- Review the preliminary audit and the subsequent actions by the SRE/RE and contractor resulting from the preliminary audit.
- Review of as-built records, relevant correspondence and minutes of meetings;
- Inspect and check both the completed work and work in progress.
- Completed work should conform to the typical plans;
- Assess the consultant's quality assurance procedures, in particular the laboratory equipment, test methods, and general procedures;
- Road works:

5.5.5. Final Audit

This should commence at least four weeks before the issuance of the substantial completion certificate and should be completed before the site staff is completely demobilized from the site. If an earlier starting time for the final audit is possible without causing disruptions to the project, then it should be encouraged. The purpose of the ultimate audit is to work out conformance with all aspects of the contract. The principal sources of data are going to be the as-built plans, test records, measurement and payment data, site correspondence, and minutes. Both the actions of the Engineer and the contractor should be assessed. A principal output of the ultimate audit should be a recommendation for any longer testing that's required to assess the standard of the works (post-construction audit). The required field and laboratory investigation would follow this immediately and should be concluded within 6 to 8 months of issuing the substantial completion certificate. This is necessary so that deficiencies identified by the post-construction audit can be taken up with the contractor prior to the expiry of the defects liability period. A full report on the project would be presented to the client summarizing any longer testing needed and indicating any contractual obligations that haven't been fulfilled by either the Engineer or the contractor or the other outstanding matters.

5.6 Data Requirements

5.6.1. General

During any quality audit, all available information must be collected for evaluation. The four phases of a technical audit summarized and discussed more fully below lead up to defining the extent of any possible post-construction technical audit, following the final audit. A full technical audit, after construction, has been completed (post-construction), is the only phase that would require extensive laboratory and fieldwork.

5.6.2(i) Laboratory test results

Routine laboratory test results should be inspected to ensure that the correct materials are being utilized, the materials are generally within specification and the laboratory testing is of the expected frequency and quality (QC/ QA). The auditor should inspect the laboratory equipment for calibration and check the test procedures methodology for compliance with the project specifications.

5.6.2(ii) Construction records

Daily/weekly/monthly construction progress records should be inspected to identify problems resulting in slow progress as well as periods with greater than expected progress. Unless additional resources were employed, very rapid progress could also be indicative of short cuts being taken.

5.6.2(iii) Evaluate hot-mix asphalt pavements work process review

Prior to observing work, examine the prepare meeting minutes. Use these notes to become familiar with work processed to be observed. Discuss procedures established to maintain continuous and effective inspection at all points of work and proper liaison between quarry, plant, and paving operations. Verify that plant production has been designed to meet delivery, lay down, and compaction rates (i.e., continuous production with minimal stops and starts)

• Equipment, to determine whether its type, size, and operation comply with the contract requirements, if applicable.
• Backup equipment in case of breakdowns,
• Procedures for checking and maintaining payment records for asphalt and the asphalt mix and for documenting that all items paid for are actually incorporated into the pavement; pay particular attention to
criteria established to define acceptance.
• Diaries, plant and reports, and other day-to-day records of the operations.
• Use of control charts operations.
• Mixing time

.

• Substrata condition ahead of the placement of the hot-mix asphalt (i.e., tack or prime coat, cleaning, patch in, absence of raveling, etc.)
• Continuity in the delivery lay down, and compaction (minimal stops and starts).
• Temperature of the mix versus required range (plant and lay down).

• Thickness and calculated the spread rate.
• Density results.
• Finished section smoothness, cross-section, and transitions.
• Work zone safety and control.
• Uniformity of gradation, asphalt content, and other mixed properties.

5.6.2(iv) Paving operations work process review

Allow sufficient time to become reasonably familiar with all the operations involved; this should include the beginning and end of the day's operations. Verify:
• Type of equipment used and if in compliance with contract requirements.
• Mixing and delivery time is in compliance with contract requirements.
• Adequacy of batch design and batch control.
• Tests for the slump, or consistency, and curing concrete test specimens; when possible, witness flexural or
compressive tests.
• Frequency and adequacy of control tests.
• Theoretical yield against actual yield to ensure conformity with the specified mix proportions.
• method of placing concrete.
• Finishing operations including micro and macrotexture.
• Curing operations.
• Surface smoothness.
• Pavement thickness as determined from core measurements.

5.6.2(v) Quality assurance data

Routine density/compaction, thickness, and quality control/assurance measurements should be inspected to ensure that the correct quality was achieved. Calibration and control records of nuclear density testing equipment should be inspected. The auditor may take samples or carry out testing to check construction quality if so dictated by his assessment.

5.6.2(vi) Measurement and payment certificates

- Measurement and payment certificates should be compared with the tendered bills of quantities for confirmation of work done;

- It is essential to ensure that all of the specified layers are properly done as per contract specifications.
- Sample payment certificates should be checked and related to the supporting documentation;
- Calculations for delays and contract price adjustment should be in accordance with the conditions of the contract. The rates used to calculate amounts must be either the tendered rates or agreed rates with supporting documentation;
- Payments for extensions of time and unforeseen conditions must agree with the approval given by the Engineer;
- All quantities should be measured in accordance with the pay items.
- Each certificate should be cross-referenced with the Engineer's and the contractor's measurements;
- Dimensions of works from typical plans should be checked;

5.7. Final audit

The final audit carried out when construction is nearing completion makes use of all the information collected during the earlier phases to justify and identify the need for additional investigations. Problems identified and rectified during the initial and intermediate audits should minimize problems likely to be revealed in the final audit.

In addition to the information already available from the earlier audits, it is necessary that the following also be evaluated:

- Consultant's construction/completion report;
- Performance of the road to date;
- Deflection and riding quality.

The completion report is usually not available immediately after completion of construction. Attempts should, however, be made to have it submitted as soon as possible.

5.7.1 Construction/ completion report

It is essential that the Engineer submits a full completion report as soon as possible after construction has been completed, certainly within 6 months. This should contain all the relevant information regarding the progress of the project including all quality control records and test results. This document must be very carefully evaluated.

5.7.2 Performance of the road to date

The performance of the road in the first few months following its opening to traffic can be a crucial indicator of the quality of construction. Usually, parts of the project will have been opened sometime

prior to completion and the performance of these sections should be assessed. The road could perform well, for instance, if it is opened to traffic during the dry season but problems resulting from poor materials or construction could manifest as soon as the wet season starts or later during periods of higher than average rainfall. Aspects to be considered during the assessment of the initial performance of the road include:

- The number of areas requiring patching or reconstruction;
- The overall riding quality of the road and evidence of functional distress, e.g. bleeding, raveling;
- Early evidence of structural distress, e.g. deterioration of riding quality, rutting, fatigue cracking, shear failures, potholes, etc.;
- The overall finish of the road a neat, well-finished project is usually, but not always, indicative of a well-executed project;
- Erosion of side slopes and drainage works.

A similar inspection of concrete structures should be carried out to ensure that the concrete quality is (at least visually) acceptable.

5.7.3 Deflection and riding quality surveys

It is standard practice, to carry out the deflection and riding quality surveys on all roads as part of the road management system. These are generally carried out at about 2/3 year intervals. It is recommended that these surveys be conducted on all new projects within 6 months of construction (subject to the season as discussed below) by an independent party, in order to assist with the technical audit. The deflection and riding quality surveys shall be carried out as directed by the client.

Deflection surveys should always be carried out at or towards the end of the wet season when the pavement is at its weakest, at intervals of about 100 meters.

5.8. Reporting

5.8.1. General

All aspects of the technical audit should be carefully and fully reported. In many cases, the results of the technical audit could be the most important document affecting the outcome of arbitration or legal proceedings.

In general, technical audit reports tend to contain large quantities of information but should not repeat contract data. To ensure that they are optimally utilized, they should be carefully structured.

All reports should be comprehensive without being excessively lengthy. It is important that well-considered to the point executive summaries are included with all reports.

It is essential that audit reports are submitted as soon as possible in order for the client to institute corrective action. All audit reports should be submitted within 3 weeks of completion of the respective audits.

5.8.2. Intermediate audit

The report presented after the intermediate audit should be handled in the same manner as the previous report. In this case, however, emphasis should be placed on the material and construction techniques and whether all the issues identified in the earlier phases of the project have been addressed.

5.8.3. Final audit

The report on the final audit will summaries the total project and make recommendations on any further investigation (post-construction audit) deemed necessary by the auditors.

Quality Audit Plan

Event	Needed documents or documents to be created	Persons/ Departments
Audit start-Introduction, opening meeting	-	At Project Director's Office
Verification of the system of the organization regarding: Management system documentation Project Review Processes and interactions Objectives of the organization Internal audits Performance data	- Management guidelines. - Project quality assurance plan. - Project super vision Consultant agreement. - Contractor quality Assurance plan. - RHD Organization with authority and responsibilities. - Client correspondence - Environmental management plan - Approved method statements. - Approved QC plan. - Approved ITP's (inspection and test plan in construction). - Consultant review reports. - Internal audit reports. - NCR's details. - Corrective Actions record. - Preventive action records.	SE/EE/RE office
Verification of the system of the organization regarding: Project review Processes and interactions Plant and equipment On site activities inspection Performance data	- Contractor quality assurance plan. - Approved method statements. - Calibration reports - Site order book - Approved - Approved QC plan. - Approved ITP's. - Test reports & MTC's (mill test certificate.) - Equipment break down reports - Equipment ideal time reports - Test reports & MTC's (mill test certificate.)	SE/EE/RE office

Table-5.2: Quality Audit Plan

5.9. Towards Total Quality Management (TQM)

Total Quality Management, TQM is a new concept. It is being widely used in private sector organizations. Public sector organizations have not yet considered it in their operations. Total Quality Management, TQM is to impart quality in every value-adding point in an organization. For imparting TQM in RHD the main causes of the problem are identified and showed in the cause-effect diagram below :

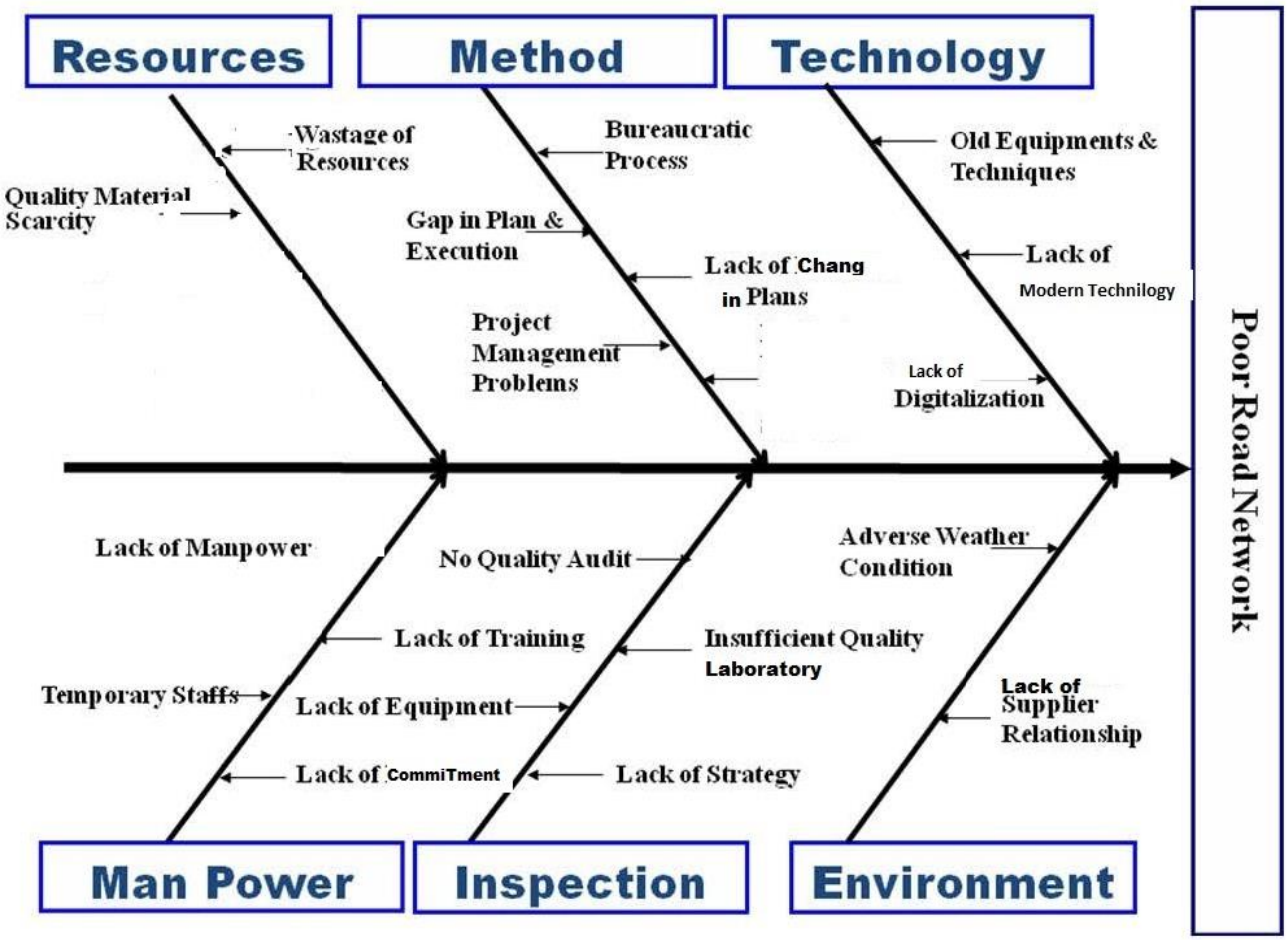


Figure 5-1: Cause-Effect Diagram for Poor Road Network

Mentioned earlier RHD has a Quality Assurance Plan. It only deals with the quality in construction and has compatibility with other world standards. It comprises of proper flow charts for quality construction. But still, there are quality problems; this is because of the lack of integration with other functions of the organization. So considering all the problems a Total Quality Management Plan for RHD should be developed.

6.0. Conclusion

To achieve SDG's goal, implementation of roadmasters plan, and regional connectivity, the rapid development of sustainable quality transport infrastructure is the top priority. The most critical part is the implementation of a quality infrastructure implementation of a quality control management system in RHD will assist in achieving quality work. Quality audit is an important part of the quality control implementation system. So, it is Keen urgent of RHD to introduce quality audits by an impartial third party.

Chapter- Six

Total Quality Management Practices in RHD: A Case Study

6.1 Introduction :

The total quality management (TQM) process is considered as a modern system in the field of quality after quality control, quality assurance, and ISO in the public sector. Recently many public organizations have utilized the implementation of total quality management, with a view to evaluate the level of quality and to improve it. A quantitative research approach was adopted in this study, where the questionnaires were distributed to 60 engineers through 'Google form' but questionnaires returned with completed form from 34 engineers. For analyzing purpose chi-square tests, frequencies, and response rates are used in this report. RHD has a sustainable capacity to plan, manage, and deliver its full range of responsibility in respect of the main road and bridge network and to be accountable for these duties. RHD's supply chain is extremely fragmented; its process is somehow different. Total Quality Management has proved to be a useful tool in ensuring the achievement of set standards and successful serviceability improvement in the public service sector. It is believed that the benefits of higher user satisfaction, better quality in road construction are often obtained following the adoption of TQM by the public sector like RHD.

6.2 Materials and Methods :

There are around 400 engineers work in RHD. Data was collected from these engineers with respect to the objectives and aims of this study. Out of the 60 Questionnaires that were the distribution to engineers, 34 engineers returned the questionnaires completed; giving the response rate 57%.

6.3 Development of Questionnaires:

To find out TQM practice in RHD, in questionnaires, 38 nos of questions were prepared, which consist of six parts. Part one for the general information of respondent, part two for concern for TQM, part three considers a Quality perspective organizational improvement, part four for Data Acquisition of TQM, part five for Improvement strategy regarding quality and part six for others.

6.4 Requirements of Data :

The requirements of data collected were dictated by the method of data analysis for this study. In view of the analysis procedures, the data as collected from different grades of engineers of RHD by using structured questionnaires. The questionnaires were distributed to 34 engineers of RHD questions regarding the quality and TQM practice in RHD. Each questionnaire was divided into six parts consisting of thirty-eight questions. The data collected were analyzed using the chi-square values, ranking, percentage, arithmetic mean, and frequency and with the level of significance at 0.05. Each part of the questionnaires is explained thus:

Part one of the questionnaires (5 questions) for general information like Name, Job title, job role, present position, and overall experience.

Part two of the questionnaires (8 Parameters) pertains to the concern about TQM gives the parameters relating to the best definitions of quality, quality management tools, understand TQM, quality accountability, long-term quality outcome. TQM works in RHD, the purpose of TQM, TQM program in RHD.

Part three of the questionnaires(7 Parameters) captures parameters relating to the Quality perspective organizational improvements- i.e perception of quality, the importance of service quality, measure user satisfaction, gathering user suggestions, rate the potential for improving quality improvement program, prefer in order of importance.

Part four of the questionnaires (6 Parameters) depicts the variables that help in data acquisition of TQM for the organizations; methods such as collect data to measure the performance, how the organization solves the quality-related problems how to rate user satisfaction. Are employee empowered to make signified changes, percentage of employee awareness of the importance of quality, types of quality improved program organization have.

Part five of the questionnaires (7 Parameters) present the improvement strategy regarding quality asking questions about formal training gives to the employees, are organization rated supplier, employee involvement in TQM implementation, about the quality audit.

Part six of the questionnaires (5 Parameters) presents the others asking questions about the approach of the organization during construction, approach in decision making, Contractor's quality approach, time-based management system, and finally obstacles in the implementation of TQM program.

6.5 Collection of Data :

The data collected from 34 engineers of different grades of RHD as detailed below and information has been utilized for further analysis. Table 1 shows the status of questionnaires that were distributed to the engineers. The response rate is 57 percent which is considered to be acceptable.

6.6 Data Analysis :

The Chi-square test of independence was used in this study for data analysis. In response to the object to this study, chi-square values and the arithmetic mean were calculated for all five parts of the questionnaires relating to the effectiveness of the implementation of TQM rules and principles, the chi-square value identifies the significance level of the statistical indication of data analyzed. If the draw out chi-square values more or equals the scheduled chi-square values at the indication level of (0.05) which equals 3.84, this means that there are differences of statistical indication in favor of the higher repetition of the answer and indicates also that the said the higher answer is affecting more than other answers but if the chi-square values are less than the scheduled chi-square values amounting to 3.84, this means that there are no differences of statistical indications and that all answers are having the same effect.

6.6(i) Part One : General Information :

RHD is a specialized department of Government of Bangladesh, which main responsibility is to build roads, bridge and culvert, and ferry operations. At present, there is a different grade of graduate engineer works in RHD. They are Assistant Engineer, Sub-Divisional Engineer, Executive Engineer, Superintending Engineer, Additional Chief Engineer, and Chief Engineer. A total number of sanction post for graduate engineer were 523, but regular graduate engineer are around 400. So, distributed questionnaires to 60 number engineers and questionnaires return from 34 number of engineers. In General Information there are name, job title, job role, present position, and overall experience. Distributed questionnaires to Assistant Engineer to Additional Chief Engineer. But as Executive Engineer, are working in mainly field level 22% of responded is Executive Engineers.

6.6(ii) Part Two: Concern about TQM:

In order to establish the knowledge base of the respondent in the field of TQM, the respondents were asked to identify answers to questions asked based on their experience. From Table 6.2.1, it is observed that sixty-seven (67%) engineers defined quality as conformance to standards. It could be perceived from this analysis that conformance to standards must become the focus of overall thinking for continuous process in improving quality. Twenty three (23) engineers believe that RHD has formal quality management tools, while twenty-seven respondents (79%) have an idea about long-term quality outcomes. However, only 12% of engineer respondents that fit for purpose defines quality. When the engineers were asked the question " Do you think that TQM will work in RHD?, seventeen i.e half of respondents (50%) felt that TQM will work to some extent, while thirty-eight (38%) of respondents believed that TQM will work very well in RHD.

Most of the Engineers (94%) believe that the TQM program will be beneficial to the organization. 73% of them said that TQM can be used in construction management and 21% stated that it can be used to improve project design.

According to Table 6.2.2: question eight 'do you understand word TQM? obtained rank one as it is chi-square value reached 56.87 as a result of the higher repetition answers by respondents, whereas the second rank was occupied by question nine; Do you know quality accountability? as its chi-square value reached 51.38 and the most frequent variable was "Yes". The most frequent variable for question twelve 'what is the purpose of TQM in RHD to improve' was "construction management" obtaining the third rank as its chi-square value reached 45.76.

The fourth rank was question seven 'Has RHD a formal quality management tools "as its chi-square value reached 34.84. The most frequent variable for question eleven; 'Do you think that TQM will work in RHD?' was to some extent obtaining the fifth rank as its chi-square value reached 34.26. The sixth rank was question six " which words best define quality?", as it's chi-square value reached 33.53. Question ten "Do you have an idea about the long-term outcome?" obtaining the seventh rank as its chi-square value reached 32.63, and finally question thirteen ' would a TQM program be beneficial in your organization, which obtained the eight rank as its chi-square value reached 26.48 that is the lowest significance.

Table 6.1.1: Total Number of Questionnaires distributed to the Engineers

Grande of Engineers	Total No. of Engineers	Questionnaires Distributed	Questionnaires Returned and Analyzed
Different grade	400	60	34

Question no. 1 to 5 as Name, Job title, Job role, Present position and overall experience

Table 6.2.1: Concern about TQM

No. Question	Freq.	Ranking	Response Rate
6. Which words best define Quality			
1. Conformance to Standards	23	1. Conformance to Standards	67 %
2. Satisfying User	5	2. Satisfying User	15 %
3. Fit for Purpose	4	3. Fit for Purpose	12 %
4. Others	2	4. Others	6 %

No. Question	Freq.	Ranking	Response Rate
7. Has RHD a formal quality management tools ?			
1. Yes	23	1. Yes	67 %
2. No	6	2. No	18 %
3. Can't say (Undecided)	4	3. Can't say	12 %
4. Others	1	4. Others	3 %

No.	Question	Freq.	Ranking	Response Rate
8.	Do you understand word TQM ?			
	1. Yes	32	1. Yes	94 %
	2. No	2	2. No	6 %
	3. Can't say	0	3. Can't say	0 %

No.	Question	Freq.	Ranking	Response Rate
9.	Do you know quality accountability ?			
	1. Yes	31	1. Yes	91 %
	2. No	2	2. No	6 %
	3. Can't say	1	3. Can't say	3 %

No.	Question	Freq.	Ranking	Response Rate
10.	Do you have idea about long-term Quality outcome?			
	1. Yes	27	1. Yes	79 %
	2. No	3	2. No	12 %
	3. Can't say	4	3. Can't say	9 %

No.	Question	Freq.	Ranking	Response Rate
11.	Do you think that TQM will work in RHD ?			
	1. Very well	13	1. To some extent	50 %
	2. To some extent	17	2. Very well	38 %
	3. Won't work	2	3. Won't work	6 %
	4. Can't say	1	4. Can't say	3 %
	5. Others	1	5. Others	3 %

No.	Question	Freq.	Ranking	Response Rate
12.	What is the purpose of TQM in RHD to improve ?			
	1. Project design	7	1. Construction Management	73 %
	2. Cost estimating	0	2. Project design	21 %
	3. Construction Management	25	3. Others	6 %
	4. Others	2	4. Cost estimating	0 %

No.	Question	Freq.	Ranking	Response Rate
13.	Would a TQM program be beneficial to your organisation ?			
	1. Yes	32	1. Yes	94 %
	2. No	0	2. Can't say	6 %
	3. Can't say	2	3. No	0 %

Table 6.2.2: Ranking Dimension of Concern about TQM by using chi-square value

Q.No.	Question Statement Dimension / Variable	Arithmetic Mean	Chi-square Values	Level of Significances	Rank
8.	Do You understand word TQM	11.30	56.87	Significance	1
9.	Do you Know Quality accountability	11.30	51.38	Significance	2
12.	What is the purpose of TQM in RHD to improved?	8.50	45.76	Significance	3
7.	Has RHD a formal quality management tools	8.50	34.48	Significance	4
11.	Do you think that TQM will work in RHD	6.80	34.26	Significance	5
6.	Which words best define quality	8.50	33.53	Significance	6
10.	Do you have idea about long-term outcome	11.30	32.63	Significance	7
13.	Would a TQM Program be beneficial in your Organisation	17.00	26.48	Significance	8
	General Arithmetic Mean	10.40			

Table 6.3.1: Quality Perspective organisation improvement

No.	Question	Freq.	Ranking	Response Rate
14	What is RHD perception of quality ?			
	1. Elimination of defects	16	1. Elimination of defects	47 %
	2. A tool to increase profits	2	2. A Competitive advantage	32 %
	3. A Competitive advantage	11	3. Others	15 %
	4. Others	5	4. A tool to increase profits	6%

No.	Question	Freq.	Ranking	Response Rate
15.	How would you rate the importance of service quality ?			
	1. Very important	28	1. Very important	82 %
	2. Important	4	2. Important	12 %
	3. Somewhat Important	6	3. Not important	3 %
	4. Not important	1	4. Can't say	3 %
	5. Can't say	1		

No.	Question	Freq.	Ranking	Response Rate
16.	How do you measure user satisfaction ?			
	1. Questionnaire survey	16	1. Questionnaire survey	47 %
	2. By the number of complaints	11	2. By the number of complaints	32 %
	3. Other method	3	3. Not measurable	12 %
	4. Not measurable	4	4. Other method	9 %

No.	Question	Freq.	Ranking	Response Rate
17.	Do you have a system for gathering user suggestion ?			
	1. Yes	14	1. No	47 %
	2. No	16	2. Yes	41 %
	3. Can't say	3	3. Can't say	9 %
	4. Others	1	4. Others	3 %

No.	Question	Freq.	Ranking	Response Rate
18.	Rate the potential for implement within the following process?			
	1. On site supervision	8	1. On site supervision	21 %
	2. Testing procurement and job site	7	2. Testing procurement and job site	20 %
	3. Certification of materials	5	3. On-site safety management	20 %
	4. On-site safety management	7	4. Certification of materials	16 %
	5. Personal Management of employees	3	5. Coordination with other members of project	14 %
	6. Coordination with other members of project	4	6. Personal Management of employees	9 %

No.	Question	Freq.	Ranking	Response Rate
19.	Does RHD have a quality improvement program?			
	1. A quality improvement program implemented recently	89	1. Such plan is under consideration	29 %
	2. Such plan is under consideration	10	2.5. Can't say	27 %
	3. No	6	2.5. A quality improvement program implemented recently	27 %
	4. Can't say	9	4. No	17 %

No.	Question	Freq.	Ranking	Response Rate
20.	Which one would you porter in order of importance ?			
	1. Cost	8	1. Quality	30 %
	2. Scope	7	2. Safety	24 %
	3. Time (Schedule)	5	3. Time (Schedule)	23 %
	4. Quality	7	4. Cost	15 %
	5. Safety	4	5. Scope	10 %

Table 6.3.2: Significance of Dimensions Quality Perspective Organisation Improvement by Using Chi-square Value

Q.No. in Questionaries'	Question Statement Dimension / Variable	Arithmetic Mean	Chi-square Values	Level of Significances	Rank
15.	How would you rate importance of service Quality	6.80	83.94	Significance	1
17.	Do you have a system for gathering user suggestion	8.50	20.36	Significance	2
14.	What is RHD Perception of Quality	8.50	13.77	Significance	3
16.	How do you measure user satisfaction	8.50	13.30	Significance	4
18.	Please rate the potential for improvement with the following processes	5.67	3.41	Not Significance	5
20	Which one would you prefer in order of importance	6.80	3.36	Not Significance	6
19.	Does RHD have a quality improvement program	8.50	1.06	Not Significance	7
	General Arithmetic Mean	7.61			

Table 6.4.1: Data Acquisition of TQM

No.	Question	Freq.	Ranking	Response Rate
21.	Do you collect data to measure the performance of RHD ?			
	1. Yes	14	1. No	53
	2. No	18	2. Yes	41 %
	3. Can't say	2	3. Can't say	6 %

No.	Question	Freq.	Ranking	Response Rate
22.	How does your organisation solves quality related problem ?			
	1. Assign individual to solve	6	1. Set-up multidisciplinary team for each problem	41 %
	2. Set-up multidisciplinary team for each problem	14	2. A permanent team is available	23 %
	3. A permanent team is available	8	3. Assign individual to solve implemented recently	18 %
	4. Other	6	4. Other	18 %

No.	Question	Freq.	Ranking	Response Rate
23.	How would you rate user satisfaction ?			
	1. Very important	19	1. Very important	56 %
	2. Important	11	2. Important	32 %
	3. Somewhat important	3	3. Somewhat important	9 %
	4. Not important	1	4. Not important	3 %
	5. Can't say	0	5. Can't say	0 %

No.	Question	Freq.	Ranking	Response Rate
24.	Are employees empowered to make significant changes in construction, operation or methodology ?			
	1. Full empowered	13	1. Only key personal are empowered	41 %
	2. Only key personal are empowered	14	2. Full empowered	38 %
	3. Empowered is not need	0	3. Can't say	12 %
	4. Can't say	4	4. Others	9 %
	5. Others	3	5. Empowered is not need	0 %

No.	Question	Freq.	Ranking	Response Rate
25.	Percentage of employees who are aware of the importance of quality ?			
	1. 100 %	9	1. 50 %	36 %
	2. 50 %	12	2. 100 %	27 %
	3. 25%	6	3. 25 %	18 %
	4. 0%	1	4. Others	16 %
	5. Others	6	5. 0 %	3 %

No.	Question	Freq.	Ranking	Response Rate
26.	What type of quality improvement program do you have ?			
	1. TQM	0	1. QC/QA	94 %
	2. ISO 9000	2	2. ISO 9000	6 %
	3. QC/QA	32	3. TQM	0 %
	4. Others	0	4. Others	0 %

Table 6.4.2: Significance of Dimensions of Data Acquisition of TQM by using chi-square Value

Q.No. in Questionaries'	Question Statement Dimension / Variable	Arithmetic Mean	Chi-square Values	Level of Significances	Rank
26.	What type of quality improvement program do you have	8.5	5.07	Significance	6
23.	How would you rate user satisfaction	6.8	23.34	Significance	3
24.	Are employees empowered to make significance changes in operations	6.8	12.27	Significance	4
21.	Do you collect data to measure the performance of RHD	11.30	86.94	Significance	1
25.	Percentage of employees who are aware of importance of quality	6.8	9.82	Significance	5
22.	How does your organisation solves quality related problem	8.5	38.35	Significance	2
	General Arithmetic Mean	8.12			

Table 6.5.1: Improvement strategy regarding quality

No.	Question	Freq.	Ranking	Response Rate
27.	Are RHD rated suppler ?			
	1. Yes	13	1. No	45 %
	2. No	15	2. Yes	39 %
	3. Can't say	4	3. Can't say	12 %
	4. Others	2	4. Others	4 %

No.	Question	Freq.	Ranking	Response Rate
27.	It defects in works are identified then contractor are contractually liable to correct this ?			
	1. Yes	32	1. Yes	94 %
	2. No	1	2. No	3 %
	3. Can't say	0	3. Others	3 %
	4. Others	1	4. Can't say	0 %

No.	Question	Freq.	Ranking	Response Rate
29.	Is formal training in TQM or other quality improvement philosophies give to employees ?			
	1. No. training is given	7	1. Some training is given	68 %
	2. Some training is given	23	2. No. training is given	20 %
	3. A formal training program is given	4	3. A formal training program is given	12 %
	4. Others	0		

No.	Question	Freq.	Ranking	Response Rate
30.	Employee involvement is critical to successful TQM implementation ?			
	1. Yes	19	1. Yes	56 %
	2. No	9	2. No	26 %
	3. Can't say	6	3. Can't say	18 %

No.	Question	Freq.	Ranking	Response Rate
31.	Training and development of staff is integral to effective TQM implementation ?			
	1. Yes	31	1. Yes	91 %
	2. No	1	2. No	6 %
	3. Can't say	2	3. Can't say	3 %

No.	Question	Freq.	Ranking	Response Rate
32.	Do you heard about quality audit ?			
	1. Yes	32	1. Yes	94 %
	2. No	2	2. No	6 %
	3. Can't say	0	3. Can't say	0 %

No.	Question	Freq.	Ranking	Response Rate
33.	Do you believe that quality audit improve the performance of RHD ?			
	1. Yes	31	1. Yes	91 %
	2. No	1	2. Can't say	6 %
	3. Can't say	2	3. No	3 %

Table 6.5.2: Significance of improvement strategy regarding quality by using chi-square Value

Q.No. in Questionaries '	Question Statement Dimension / Variable	Arithmetic Mean	Chi-square Values	Level of Significances	Rank
28.	If detect in works are identified then contractor are contractually liable for correct this	8.50	86.71	Significance	1
32.	Do you heard about quality audit	11.30	56.87	Significance	2
33.	Do you believe that quality audit improve the performance of RHD?	11.30	51.38	Significance	3.5
31.	Training and development of staff is integral to effective TQM implementation	11.30	51.38	Significance	3.5
29.	Is formal training in TQM given to employees	11.30	18.47	Significance	5
27.	Are RHD rated supplier	8.50	14.70	Significance	6
30.	Employee involved is critical to successful TQM implementations?	11.30	8.21	Significance	7
	General Arithmetic Mean				

Table 6.6.1: Others

No.	Question	Freq.	Ranking	Response Rate
34.	Which of the following approach RHD is taken during construction works ?			
	1. Quality Control	10	1. Quality assurance	47 %
	2. Quality assurance	21	2. Quality Control	44 %
	3. Others	3	4. Others	9 %

No.	Question	Freq.	Ranking	Response Rate
35.	What approach RHD follows in decision making ?			
	1. Top-down	27	1. Top-down	79 %
	2. Bottom-up	5	2. Bottom-up	15 %
	3. Employee himself	0	3. Others	6 %
	4. Others	2	4. Employee himself	0 %

No.	Question	Freq.	Ranking	Response Rate
36.	Is there any contractor's quality approach ?			
	1. Yes	9	1. No	53 %
	2. No	18	2. Yes	26 %
	3. Can't say	6	3. Can't say	18 %
	4. Others	1	4. Others	3 %

No.	Question	Freq.	Ranking	Response Rate
37.	Is there any time based management system in RHD ?			
	1. Yes	17	1. Yes	50 %
	2. No	10	2. No	29 %
	3. Can't say	6	3. Can't say	18 %
	4. Others	1	4. Others	3 %

No.	Question	Freq.	Ranking	Response Rate
38.	Obstacles in the implementation of TQM program ?			
	1. Rigid attitude of RHD engineers	2	1. Lack of education and training	35 %
	2. Lack of education and training	12	2. Lack of expertise	26 %
	3. Too much document / commitment	2	3. Lack of employee Commitment	18 %
	4. Lack of employee Commitment	6	4. Others	9 %
	5. Lack of expertise	9	5. Rigid attitude of RHD engineers	6 %
	6. Others	3	6. Too much document / commitment	6 %

Table 6.6.2: Significance of others dimension's by using chi-square Value

Q.No. in Questionaries	Question Statement Dimension / Variable	Arithmetic Mean	Chi-square Values	Level of Significances	Rank
35.	What approach RHD following in decision making?	8.50	55.17	Significance	1
36.	Is there any contractor's quality approach	8.50	18.01	Significance	2
37.	Is there any time bound management systems	8.50	16.06	Significance	3
38.	Obstacles in the implementation of TQM program	5.67	15.07	Significance	4
34.	Which approach RHD is taken during constructions works	11.30	6.58	Significance	5
	General Arithmetic Mean	8.50			

6.6(iii) Part 3: Quality Perspective Organization Improvement:

The Quality Perspective Organization Improvement is important to proper TQM practice as such, it was a measure to identify the visions of the respondents on quality. From Table 6.3.1 it is observed that when engineers asked about organization "perception of quality 47% believe that it elimination defects". When engineers were asked about how you rate the importance of service quality 82% felt that they rate it very important. While 47% of engineers considered that they measure user satisfaction through questionnaires survey. Sixteen respondents (47%) indicated that they have no system for gathering user suggestions however 41% believe that they have a system for gathering user suggestions. sixteen engineers (21%) considered that the potential for improving processes is on-site supervision. When respondents asked about quality improvement program ten engineers (29%) replied that such a plan is under consideration. Finally, they were asked to rank in order of importance, 30% engineers rank the importance as quality, 24% engineer prefer safety 21% prefer time, 15% prefer the cost and 10% prefer scope as importance.

Table 6.3.2 below shows that: question fifteen " How would you rate the importance of service quality" obtained rank one as its chi-square value reached 83.94 and the most frequent variable was "very important". Whereas the second rank was occupied by question seventeen ' Do you have a system for gathering user suggestions? as its chi-square value reached 20.36. When engineers were asked about RHD perception of quality, 47% believe that it eliminates of detects. When they were asked ' How do you measure user satisfaction sixteen engineers (47%) replied that they came to know through questionnaires survey while eleven engineers (32%) argue that they know it by the number of complaints. Questions 18, 20, and 19 obtained the lowest rank as its chi-square value reached 3.41, 3.36, and 1.06 respectively showing that the questions are not significant.

6.6(iv) Part-4: Data Acquisition of TQM:

Data acquisition is an important part of quality measurement and management; as such it was important to measure the effectiveness of data acquisition methods adopted. With reference to Table 6.4.1 below. As eighteen engineers (53%) believe that don't collect data to measure the performance of the organization. Whereas fourteen engineers (41%) said that they collect data to measure its organizational performance. When asked question, "How does organization solve quality-related problem" fourteen (41%) engineers of the respondents set-up multidisciplinary team for each problem eight (23%) of them answered that a permanent team is available to solve the quality-related problem and only six (18%) believe that organization solves the problem by assigning an individual to the solve problems. The majority (56%) of engineers replied that the user satisfaction rate is very important whereas only (9%) of them mentioned that it is not important for the organization.

When engineers were asked ‘ Are employees empowered to make a significant change to operations?” Fourteen (41%) of the respondent said only key personnel is empowered. Twelve engineers (36%) believe that 50% of employees aware of the importance of quality. Whereas the majority (94%) answered that organizations have a QC/QA type quality improvement program.

Table 4.2: Data Acquisition of TQM: The significances of data acquisition of TQM used by the engineers were analyzed in this part. Table 6.4.2 below shows that question twenty-six ‘ what type of quality improvement program do you have? Thirty-two engineers (94%) answered that RHD has the ‘Quality Control / Quality Assurance’ Program and this obtained rank one as its chi-squire value reached 86.94 with a resultant higher repetition. Whereas the second rank was occupied by question twenty-three ‘ How would you rate user satisfaction? as its chi-square value reached 38.35. For question twenty-four. Are employees empowered to make a significant change in operation; as such rank is occupied by the question twenty one?

Do you collect data to measure the performance of RHD, as its chi-square value reacted 12.27 while question twenty-five; percentage of employees who are aware of importance of quality? obtained the fifth rank as it is chi-square value reached 9.82. Question twenty-two obtained the lowest significance. The significance of the data acquisition method used by the engineers was analyzed in this part. Table 6.3.2 below shows that question fifteen “ How would you rate the importance of service quality obtained rank one as its chi-square value reached 83.94 and the most frequent variable was “ very important”. Whereas the second rank was occupied by question seventeen ‘ Do you have a system for gathering user suggestions? as its chi-square value reached 20.36. When engineers were asked about RHD perception of quality, 47% believe that it eliminates of detects. When they were asked. How do you measure user satisfaction sixteen engineers (47%) replied that they came to know through questionnaires survey while eleven engineers (32%) argue that they know it by the number of complaints. Questions 18, 20, and 19 obtained the lowest rank as its chi-square value reached 3.41, 3.36, and 1.06 respectively showing that the questions are not significant.

6.6(v) Part-5: Improvement strategy regarding quality:

As depicted in Table 6.5.1, fifteen respondents (45%) indicated that RHD does not rate suppliers, whereas thirteen respondents (39%) said that RHD rated suppliers. The majority (94%) of engineers agreed that defects in works are identified and then contractors are contractually liable to correct this. Twenty-three respondents (68%) answered that some training regarding TQM has been given to employees while seven (20%) of them said that they got no training regarding TQM. When they were asked, “ employee involvement is critical to successful TQM implementation?” 56% of the respondent gives consent ‘Yes’. For the question ‘Training and development of staff are integral to effective TQM implementation”; the majority (91%) felt that ‘Yes’.

Question regarding the quality audit, 94% of respondents told that they heard about the quality audit. When they ware asked ‘ Do you believe that quality audit improves the performance of RHD? Thirty one engineers (91%) replied that they believed that introducing quality audits is necessary to improve the performance of RHD.

According to Table 6.5.2, question twenty-eight “It defect in works are identified then the contractor is contractually liable for correct this” obtained rank one as it is chi-square value reached 86.71 with a resultant higher repetition. The second rank was occupied by question thirty-two ‘ Do you heard about a quality audit?’ as its chi-square value reached 56.87, as a result of the most repetition, the answer by the respondents was ‘Yes’, whereas the third rank was occupied by question thirty-three ‘Do you believe that quality audit improves the performance of RHD? and question thirty-one. ‘ Training and development of felt are integral to effective TQM implementation ? as both of its chi-square value reached 51.38. For question twenty-nine ‘ Is formal training in TQM gives to employees’ obtain rank five as its chi-square value is 18.47. The sixth rank is occupied by question twenty-seven, “ Are RHD rated supplier? as its chi-square value reached 14.7, while question thirty ‘ Employee involvement is critical to successful TQM implementation?” obtained the seventh rank as it is chi-square value reached 8.21.

6.6(vi) Part-6: Others:

As depicted in Table 6.6.1 forty-seven respondents (47%) indicated that RHD follows quality assurance(QA) approach during construction works, on the other hand, forty-two (42%) believe that RHD follows Quality Control (QC) approach during construction work. When They were asked ‘ What approach RHD follows in decision making? twenty-seven (79%) of respondents answered that RHD follows the ‘Top-down’ approach in decision making, whereas only 15% said that it follows the Bottom-up approach. When engineers were asked ‘ Is there any contractor’s quality approach? 53% believe that there is no contractor’s quality approach, however, 26% answered that there is a contractor's quality approach, When asked ‘ Is there any time-based management system in RHD?

seventeen engineers (50%) felt that RHD has time-based management, whereas ten respondents (29%) believe that is no time-based management in RHD. Finally when they were asked ‘Obstacles in the implementation of TQM program’ twelve engineers (35%) agreed that it is lack of education and training, nine respondents (26%) believe that it is lack of expertise, only six engineers (18%) answered that it is lack of employee commitments.

Table-6.2 Others: This part analyses the significances of other dimensions in the organizations. Table 6.6.2 below shows that question thirty-five ‘ What approach RHD follows in decision making? obtained rank one as its chi-square value reached 55.17; as a result of the higher repetition, the answer by the respondents was “ Top-down”. The second rank was occupied by question thirty-six. “Is there any contractor’s quality approach? as its chi-square value reached 18.01 with the most frequent variable replied by engineers as ‘No’. For question thirty-seven ‘ Is there any time-bound management system?” 50% of respondents replied yes as such it obtained the third rank as it’s chi-square value reached 16.06. The fourth rank is occupied by question thirty-eight‘ obstacles in the implementation of the TQM program? as its chi-square value reached 15.07. The fifty ranks are questioned thirty-four, ‘Which approach RHD is taken during construction work? obtained the lowest significance as its chi-square value reached 6.58.

6.6 Result and Discussion

From the findings of this research, the following abstraction is drawn :

6.6.1 Concern about TQM:

The perception of Quality was centered on conformance to standards as the majority of the engineer defined quality as a measure of conformance to standards. This affirmation the consequence of conformance to standards to the reaching of TQM in RHD. However, it is distress to observe that 33% of engineers believe that RHD has no formal quality management tools, and whereas 67% said that RHD has quality management tools. The reason for this might arise from the fact that there is a little misunderstanding of their belief that TQM will work in RHD; as a fifty percent(50%) respondent replied that it works to some extent. It is, therefore, necessary for the authorities of RHD to emphasize the practice and improvement of TQM in its policies and regulations to ensure that all employees should be involved in it. Most of them (94%) argued the benefits of TQM to there organization.

6.6.2 Quality Perspective Organisation Improvement:

The engineers perceive product/service quality as important to the success of RHD. The perception of quality is such that they believe quality means the elimination of defects. Moreover, the majority (82%) of them replied that service quality is very important to their organization. From this survey, it is shown that engineer emphasis on-site supervision (21%), whereas only 9% importance on personal management of employee, for quality improvement, it is also noted that respondent ranked quality, safety and time as more important than cost and scope in project success.

6.6.3 Data Acquisition of TQM:

Majority (53%) engineers replied that they don't collect data to measure the performance of RHD. For quality-related problems, 41% of engineers answered that they set-up a multidisciplinary team. Regarding user satisfaction, most of them (56%) said that it is very important for organizational improvement. It is observed that employees are not usually empowered to make significant changes to operations as only key personnel is (41%) and some feel that they are fully empowered (38%). This is to say rest employees have no say in decision making. They are just to carry out the duties assigned to them by their superiors. It is encouraging to note that 36% of respondents are aware of the importance of quality and the majority of engineers (94%) replied that RHD has QC/QA type qualify improvement program. This means that a lot of engineers of RHD are not aware of TQM in quality improvement programs in operational processes.

6.6.4 Improvement Strategy Regarding Quality:

It was observed that no formal training is given to employees regarding TQM. It is only 12% whereas the majority (56%) engineers believed that employee involvement is critical to successful TQM implementation. Regarding quality audit, most of the respondents (94%) answered that they heard about quality audit and they firmly believed that (91%) quality audit improve the performance of RHD.

6.6.5 Others:

Most engineers (47%) answered that RHD is taking the QA approach during construction works, whereas (44%) replied that RHD is taken a QC approach. However, 79% of engineers believed that RHD follows the 'Top-down' approach in decision making. From this study, it is observed that RHD is a bureaucratic organization whereas maximum decisions come from top-level management. Regarding the contractor's quality approach the majority of respondents said that there is no contractor's quality approach. When asked about obstacles in the implementation of the TQM program, it is seen that the respondent's emphasis on lack of education lack of expertise and lack of employee commitment are more important than the rigid attitude of engineers and too much documentation in the implementation of TQM program.

6.7 Conclusion:

In conclusion, it can be said that RHD engineers are very much aware of TQM philosophy and the dimensions of TQM in their organization to some extent. However, they are well convergence with the benefit of TQM implementation and long-term outcome of TQM in RHD. It is clear from the results achieved that most of the engineers understand quality, quality improvement tools, and conformance specifications. But due to lack of proper training regarding TQM, they are not fully competent to implement TQM technique in their organization's operational processes. It is also seen that many public service organizations like RHD are pressurized by the government to try to implement the principles and rules of TQM to some extent. It is observed that most of the respondent engineers have a good knowledge and perception of Total Quality Management.

Generally, it can be said that the TQM program can work in RHD, hence they consider conformance to specification as the best means of achieving quality.

It has also been observed that there is a shortcoming in training programs and a shortage in the data acquisition method. This is because in RHD there are no formulated systems for gathering user and employee's suggestions. Most of the engineers rely on empowered key personal to make a significant change in RHD operation, employees are not given the opportunity to impute their suggestions to the organization's service quality and progress.

Finally, it is suggested that chaining the culture and policy of training plan, data acquisition method, and involving the third party for quality audit as key factors to the success of TQM implementation in RHD. It is hoped that this study has added extensive contributions to highlight the shortage and weakness in the management practice in RHD.

Chapter- Seven

Conclusion and Recommendation

7.1 Conclusion: To achieve the Sustainable Development Goals in 2030, the rapid development of sustainable quality transport infrastructure is the topmost priority. The most critical part is the implementation of quality infrastructure. Implementation of quality control management systems like TQM in RHD will assist in achieving quality work.

It is observed from this study that within 10 years (2020-2030) RHD has to take huge pressure in terms of implementing the Road Master Plan, SDE's goal, and target and regional connectivity. In order to face these types of challenges, RHD should think of different approaches to provide its service to users, stakeholders in the utmost efforts. TQM is one of the approaches that RHD can take it to improve its quality-related challenges with the strategic leadership of Chief Engineer, RHD. The application of TQM may help RHD to assess the level of quality and to improve it. As RHD engaged in road and bridge construction and it is known that construction is one kind of production and its products are highly complex, its supply chain is extremely fragmented; its processes are somewhat different. So, TQM is to be a useful tool in ensuring the achievement of set standards and successful improvements in the new construction, rehabilitation, and maintenance of road networks. It also improved customer satisfaction, teamwork, communication, efficiency, achieving greater success against performance indicators than other public service organizations.

Moreover, TQM is a way of thinking about goals, organization, processes, and people to ensure that the right things are done right the first time; and an approach to improving the competitiveness, effectiveness, and flexibility of the whole organization.

7.2 Recommendations: Following are the recommendation of the study :

i) RHD should think about carrying out third party quality audits of roads and bridge projects for ensuring continuous improvement in quality-related issues and as well as maximum benefit to the user/stakeholders.

ii) RHD should take a robust and incentive training program regarding TQM implementation for all levels of employees for ensuring desired services from them.

iii) RHD should introduce a "Performance Certificate" not completion certificate to the contractor after completion of the Defect Liability Period of road or bridge construction project, and this performance certificate should incorporate as qualification/selection criteria of bidders evaluation processes in procurement.

iv) RHD should install 28 weighbridge across the country due to the control axle load of the vehicle. The government should ban the import of 2 axle trucks with an unladen weight of more than 5 tonnes.

v) RHD should think about Land Acquisition and utility shifting procedures, as these are main obstacles to implement projects in stipulated time and it should be completed before the start of construction work, otherwise it will greatly be hampered to achieve quality cultures.

vi) Developing and improving the existing QAP to a TQM plan. The TQM plan will increase quality in every wing of RHD. Introduce dress code for all employees of RHD, which encourages employees to do their daily activities with more care and steady.

vii) Every office should have a clear complaint/advice box so that anyone can give advice regarding delivery of services.

viii) RHD should think about to improve its junction points with the construction of interchangers like cloverleaf/Diamond/trumpet and construction of NMV lane with crossing facility in all national Highway to increase mobility in transportation Sector

ix) RHD should place all necessary sign signals and awareness slogan along the road alignment to increased road safety measures.

x) RHD should conduct a further study with the uses of new technologies like IoT, AI, Blockchain, etc. to improve quality-related difficulties and other supply chain processes in RHD to faced upcoming challenges.

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Appendix-A

BRAC Institute of Governance and Development (BIGD), BRAC University

Survey Questionnaire

Research : TQM in Roads and Highways Department, Evaluate an Approach-how it improves the Performance of Supply Chain to its Organization.

Dear respondent, a very good day , I have been doing a research titled "TQM in Roads and Highways Department , Evaluate an Approach-how it improves the Performance of Supply Chain to its Organization" This work is a part of fulfillment requirement of Masters in Procurement & Supply Management (MPSM) program under BRAC Institute of Governance and Development. BRAC University . The main object of the study is to find out the TQM approach in RHD, its opportunities and drawbacks to resolved present and future challenges.

The information you provide will be used absolutely for academic purpose. Participation in this study is voluntary and you are free to withdraw at any stage. All information gather from you, will be confidential and no way will personally identifiable information be made available without your consent.

Part- 1 : General Information

01. Name :

02. Job Title :

03. Job Role :
    a. Senior Management
    b. Mid Level Management
    c. Junior Level Management
    d. Others

04. Present Position:
    a. Senior Level (SE and above)
    b. Mid Level (EE)
    c. Junior Level (SDE/AE)

05. Over all Experience:
    a. 0-5 years
    b. 6-10 years
    c. 11-15 years
    d. 15+ years

Part- 2 : Concern about TQM

(Please tick any one, otherwise indicate in questions)

06. In your opinion, which words best define quality?

- ☐ Conformance to Standards
- ☐ Satisfying Public/User/Stakeholder
- ☐ Fits for purpose
- ☐ Others (Please Specify).....

07. Has RHD a formal quality Management Tools ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

08. Do you understand word TQM ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

09. Do you know quality accountability ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

10. Do you have idea about long-term quality outcome ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

11. Do you think that TQM will (or does) work in RHD?

- ☐ Very well
- ☐ To some extent
- ☐ Won’t work
- ☐ Can’t say (undecided)

12. What is the purpose of TQM in RHD to improve ?

- ☐ Project Design.
- ☐ Cost estimating.
- ☐ Construction Management.

13. Would a TQM program be beneficial to your organization?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

Part- 3 Quality Perspective organizational improvement

14. What is RHD perception of Quality?

- ☐ Elimination of defects
- ☐ A tool to increase profits
- ☐ A competitive advantage
- ☐ Others (Please Specify).....

15. How would you rate the importance of product/service quality?

- ☐ Very important
- ☐ Important
- ☐ Somewhat important
- ☐ Not important
- ☐ Can't say

16. How do you measure Public/User/Stakeholder satisfaction?

- ☐ Questionnaire surveys.
- ☐ By the number of complaints
- ☐ Other method (please specify)
- ☐ Not measured

17. Do you have a system for gathering (Public/User/Stakeholder) suggestions?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

18. Please rate the potential for improvement within the following processes :

	Scale 1 to 5, 1: Low 5: High	High Low	No.
1.	On site supervision	5 – 4 - 3 – 2 - 1	0
1.	Testing Procurement at job site	5 – 4 - 3 – 2 - 1	0
1.	Certification of Materials	5 – 4 - 3 – 2 - 1	0
1.	On-site safety management	5 – 4 - 3 – 2 - 1	0
1.	Personal management of employees	5 – 4 - 3 – 2 - 1	0
1.	Coordination with other members of project	5 – 4 - 3 – 2 - 1	0

19. Does RHD have a ,quality improvement program ?

- ☐ A quality improvement program has been implemented recently
- ☐ Such a plan is under consideration.
- ☐ No
- ☐ Can't say (undecided)

20. Which one would you prefer in order of importance:

		High Low
1.	cost.....	5 – 4 - 3 – 2 - 1
2.	Scope.....	5 – 4 - 3 – 2 - 1
3.	Time (Schedule).....	5 – 4 - 3 – 2 - 1
4.	Quality.....	5 – 4 - 3 – 2 - 1
5.	Safety.....	5 – 4 - 3 – 2 - 1

Part-4 : Data Acquisition of TQM

21. Do you collect data to measure the performance of RHD ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

22. How does your organization solves quality related problem ?

- ☐ Assigns individual to solve.
- ☐ Set up a multi disciplinary team for each problem.
- ☐ A permanent team is available.
- ☐ Other (Please Specify).....

23. How would you rate Public/User/Stakeholder satisfaction?

- ☐ Very important
- ☐ Important
- ☐ Somewhat important
- ☐ Not important
- ☐ Can’t say

24. Are employees empowered to make significant changes, to construction operations or methodology ?

- ☐ Full empowered (As Per DOFP)
- ☐ Only key personal are empowered
- ☐ Empowerment is not needed
- ☐ Can’t say (undecided)

25. Percentage of employees who are aware of the importance of quality?

- ☐ 100%
- ☐ 50 %
- ☐ 25 %
- ☐ 0 %

26. What type of quality improvement program do you have?

- ☐ Total Quality Management (TQM)
- ☐ ISO9000
- ☐ Quality control/ Quality Assurance
- ☐ Other (please specify).....

Part- 5 : Improvement strategy regarding quality

27. Are RHD rated contractor / supplier ?

- ☐ Yes
- ☐ No
- ☐ Can't say (Undecided)

28. If defects in works / service are identified then contractors are contractually liable for correct this?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

29. Is formal training in TQM or other quality improvement philosophies given to employees?

- ☐ No training is given
- ☐ Some training is given
- ☐ A formal training program is given
- ☐ Others (please specify).....

30. Employee involvement is critical to successful TQM implementation ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

31. Training and development of staff is integral to effective TQM implementation ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

32. Do you heard about quality audit ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

33. Do you believe that quality audit improve the performance of RHD ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

Part- 6 : Others

34. Which of the following approach RHD is taken during construction works ?

- ☐ Quality control
- ☐ Quality assurance
- ☐ Other (Please specify).....

35. What approach RHD follows in decision making ?

- ☐ Top Down
- ☐ Bottom up
- ☐ Employee himself
- ☐ Others (Please specify).....

36. Is there any contractor's quality approach ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

37. Is there any time based management system in RHD ?

- ☐ Yes
- ☐ No
- ☐ Can't say (undecided)

38. Obstacles in the implementation of TQM program (not limited to one answer)

- ☐ Rigid attitude of RHD Engineers towards quality
- ☐ Lack of education and training to drive the improvement process
- ☐ Too much document commitment/ understanding
- ☐ Lack of employees commitment/understanding
- ☐ Lack of expertise/resources in TQM

Thank you for your valuable time and sincere effort.

Appendix- B

Title : TQM in Roads and Highways Department, Evaluate an approach how it improves the performance of supply chain to its organization.

35 responses

Publish analytics

Name :

31 responses

Faeg Ahammad

Utpal Samanta

Mohammed Shamim Al Mamun

ZulfiquarAhmed

Md. Jahidur Rahman Milu

Suman Singha

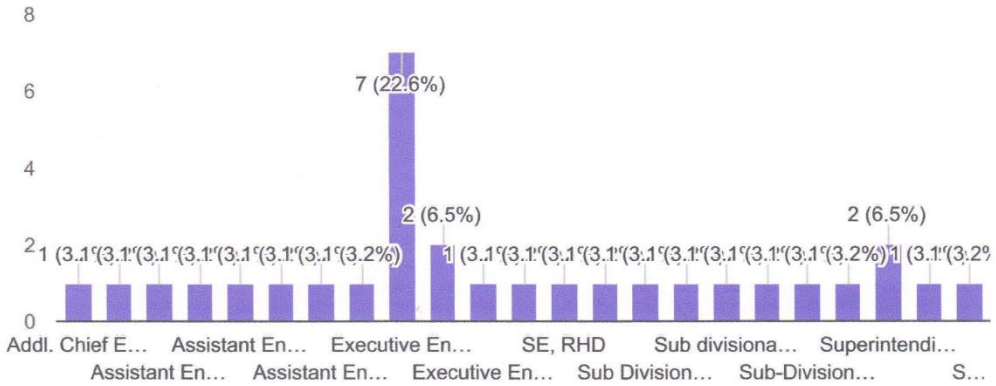
Syed Halimur Rahman

Bikash Chandra Das

Md. Masum Sarower

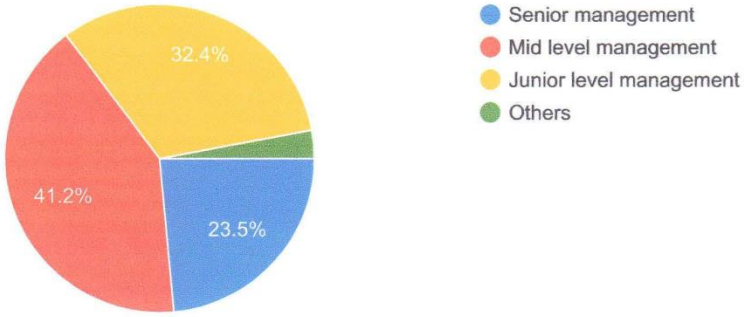
Job Title :

31 responses



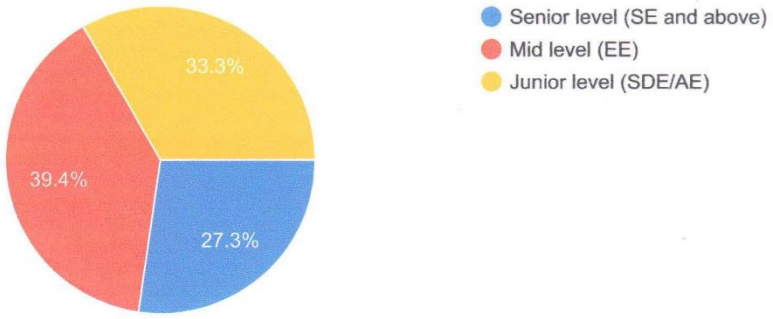
Job Role :

34 responses



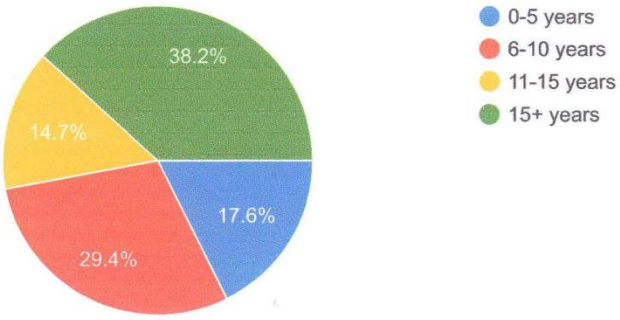
Present position

33 responses



Overall experience

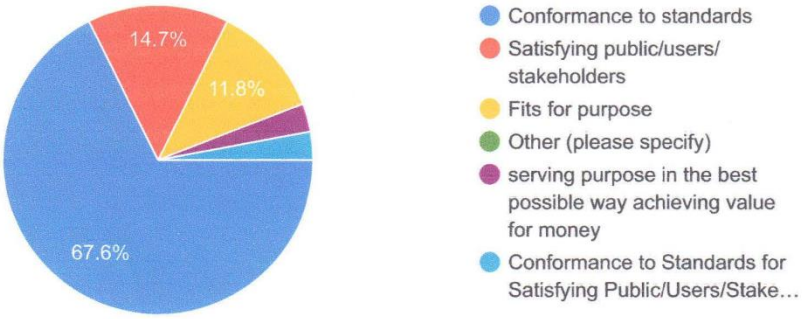
34 responses



Part-2: Concern about TQM

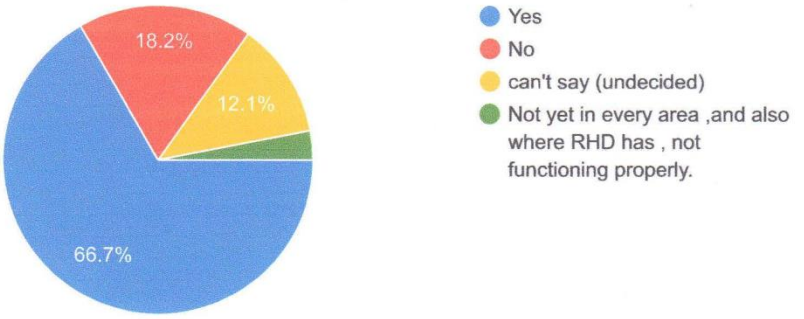
In your opinion, which words best define quality ?

34 responses



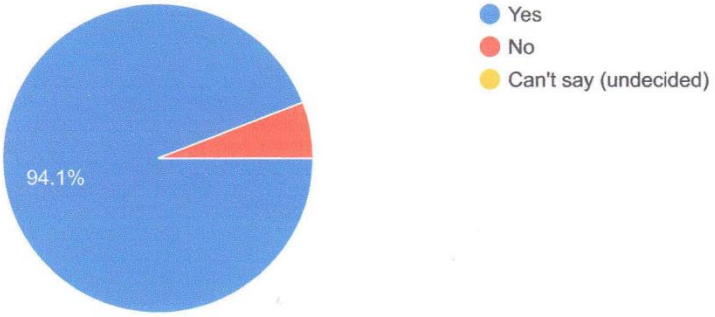
Has RHD a formal quality management tools ?

33 responses



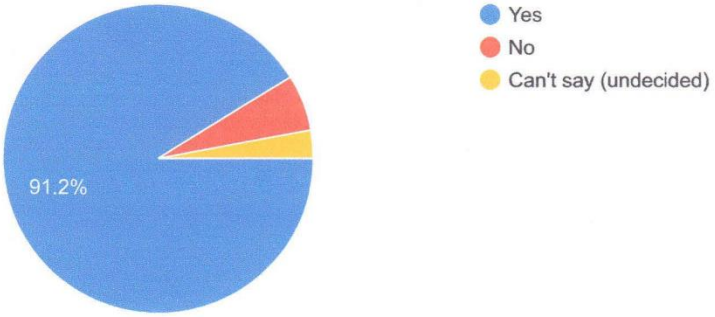
Do you understand word TQM ?

34 responses



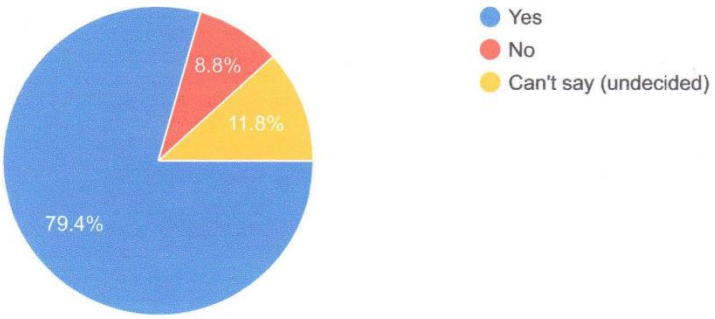
Do you know quality accountability ?

34 responses



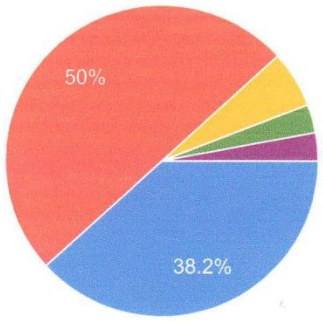
Do you have idea about long-term quality outcome ?

34 responses



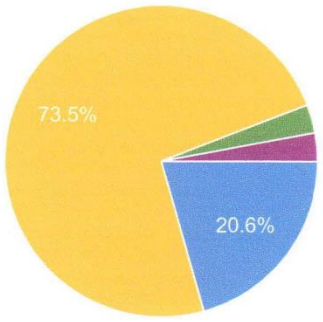
Do you think that TQM will (or does) work in RHD ?

34 responses



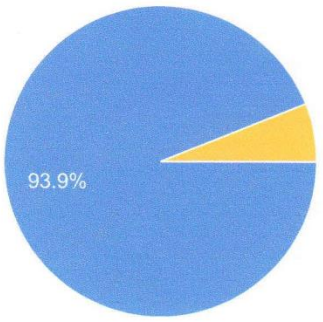
What is the purpose of TQM in RHD to improve ?

34 responses



Would a TQM program be beneficial to your organization ?

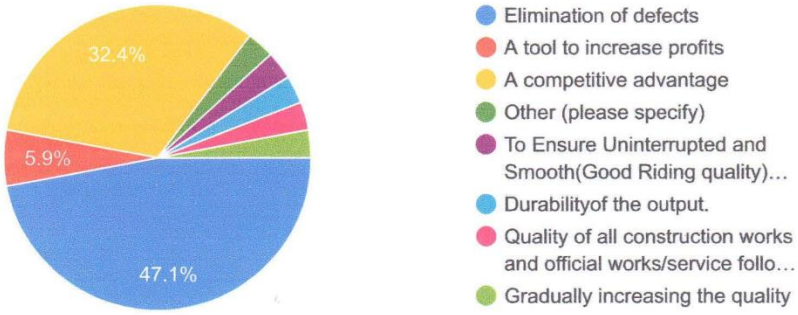
33 responses



Part-3: Quality perspective organizational improvement

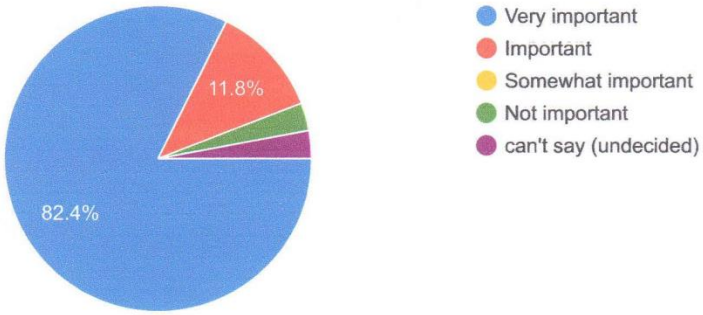
What is RHD perception of quality ?

34 responses



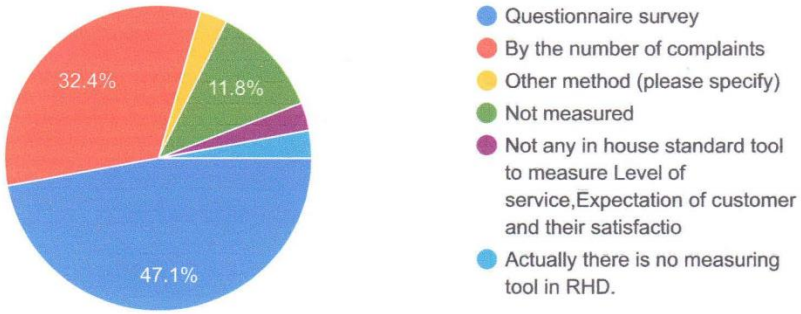
How would you rate the importance of product/service quality ?

34 responses



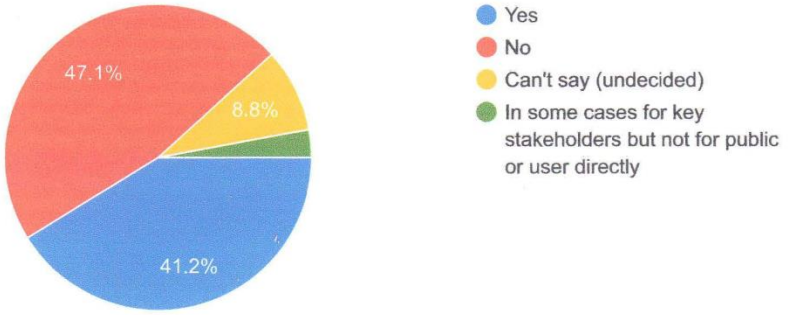
How do you measure public/users/stakeholders satisfaction ?

34 responses

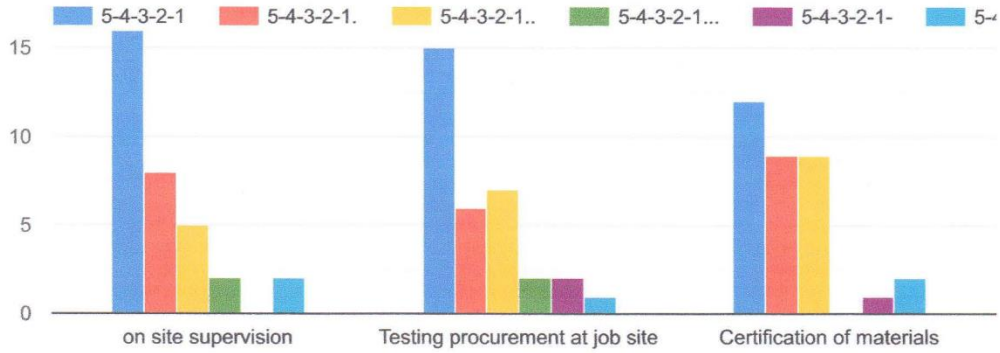


Do you have a system for gathering public/users/stakeholders suggestions ?

34 responses

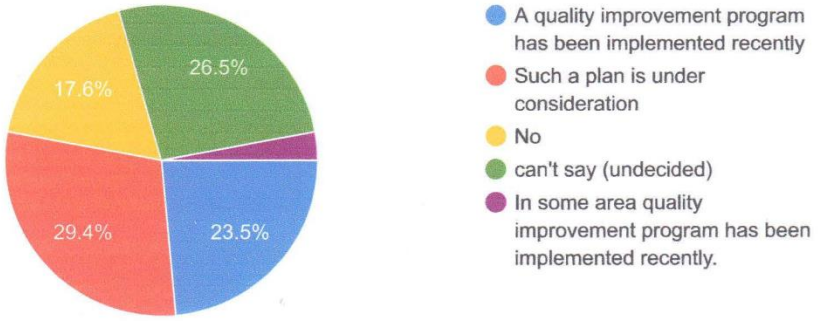


Please rate the potential for improvement within the following processes: (Scale 1 to 5, 1:Low 5:High)

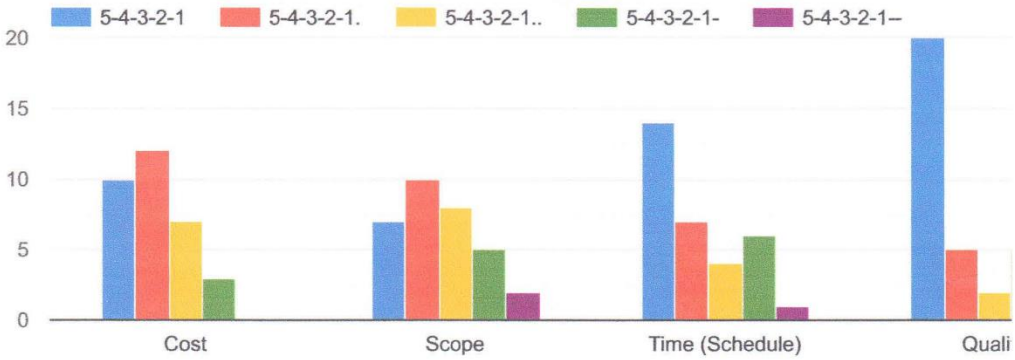


Does RHD have a quality improvement program ?

34 responses



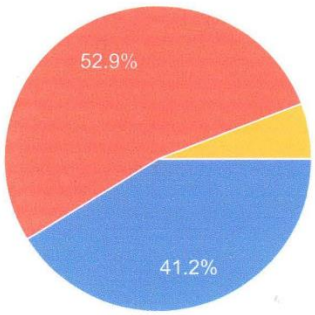
Which one would you prefer in order of importance ?(Scale 1 to 5, 1:Low 5:High)



Part-4: Data acquisition of TQM

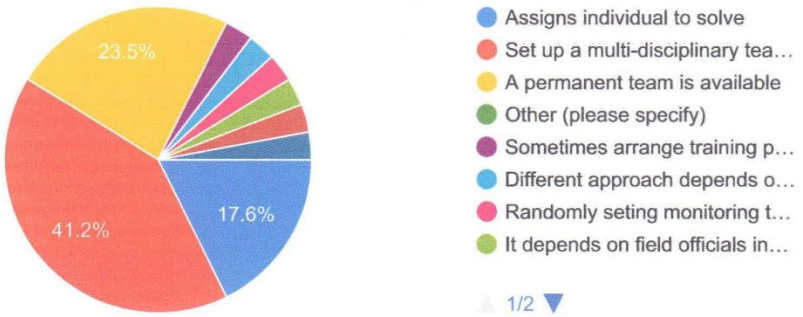
Do you collect data to measure the performance of RHD ?

34 responses



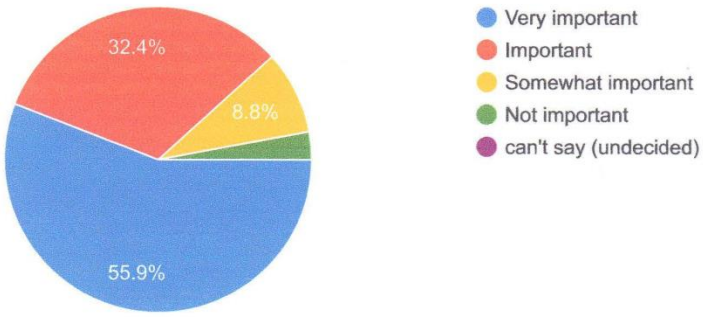
How does your organization solves quality related problem ?

34 responses



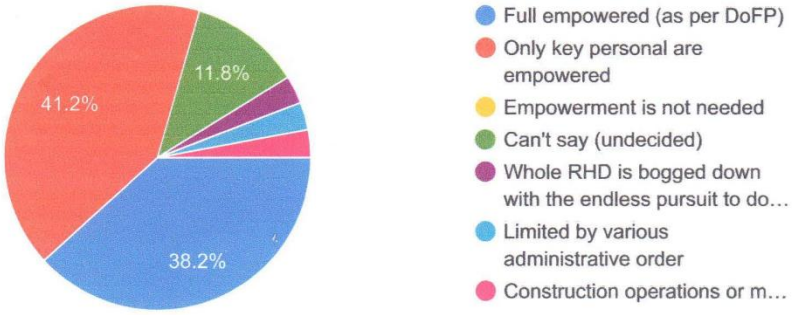
How would you rate public/users/stakeholders satisfactions ?

34 responses



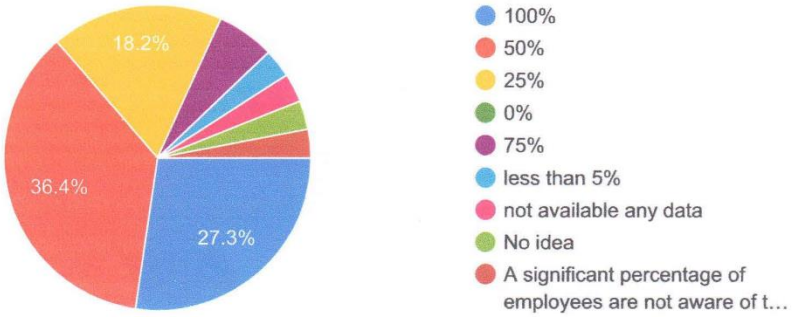
Are employees empowered to make significant changes to construction operations or methodology ?

34 responses



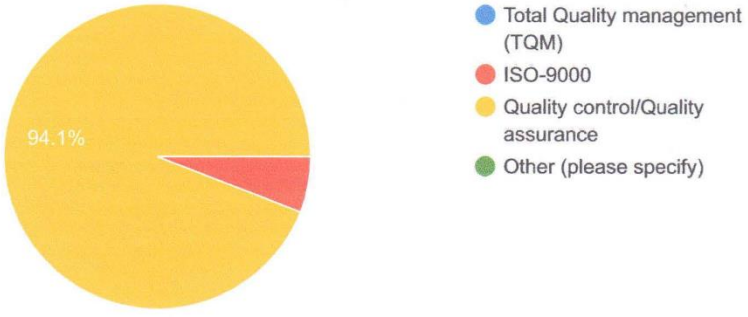
Percentage of employees who are aware of the importance of quality ?

33 responses



What type of quality improvement program do you have ?

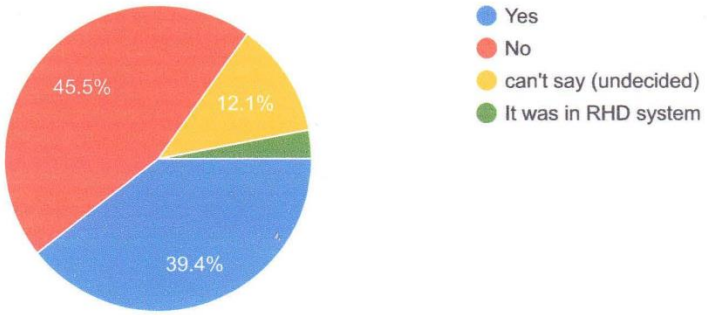
34 responses



Part-5: Improvement strategy regarding quality

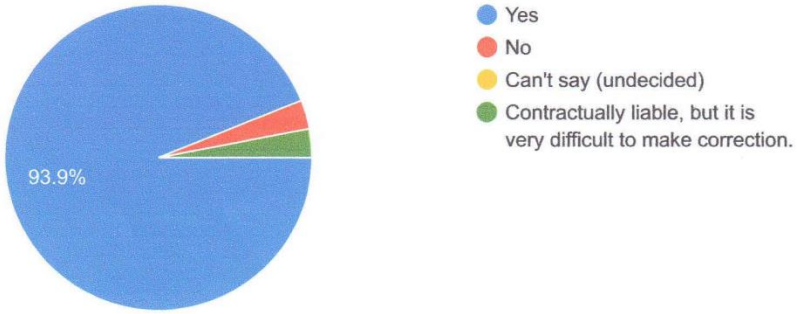
Are RHD rated contractor/supplier ?

33 responses



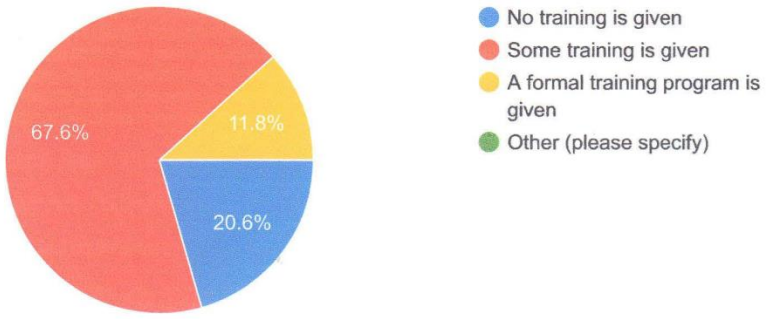
If defects in work/service are identified then contractors are contractually liable for correct this ?

33 responses



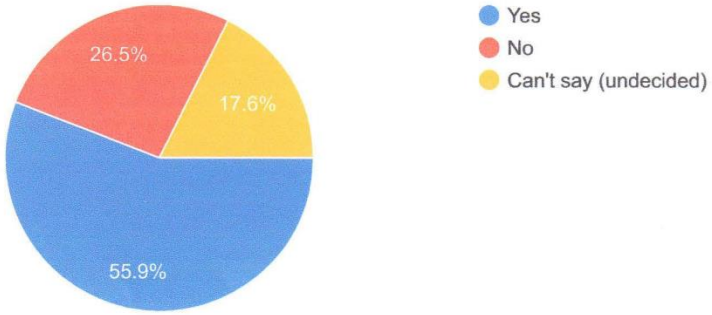
Is formal training in TQM or other quality improvement philosophies given to employees ?

34 responses



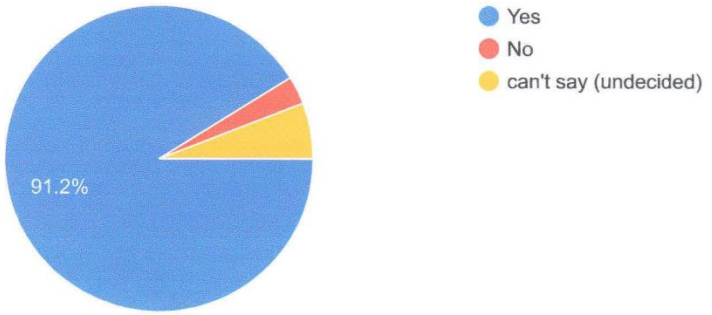
Employee involvement critical to successful TQM implementation ?

34 responses



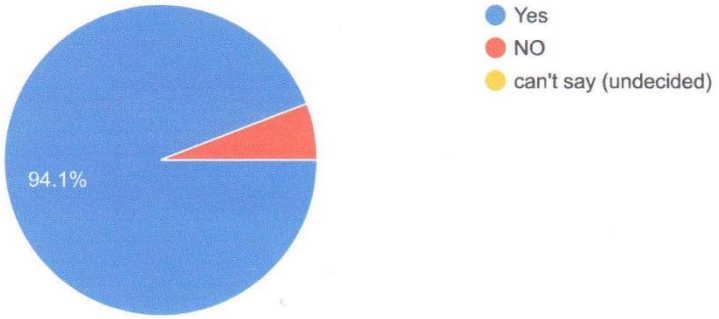
Training and development of staff is integral to effective TQM implementation ?

34 responses



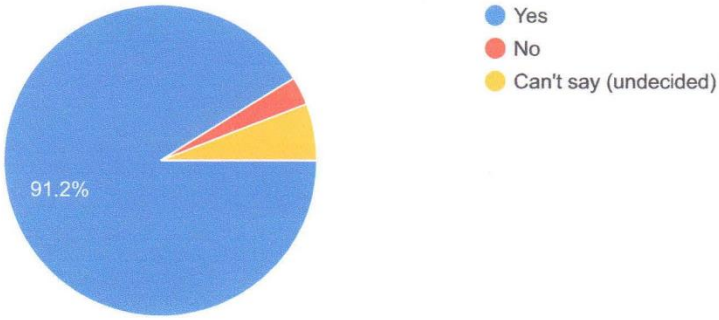
Do you heard about quality audit ?

34 responses



Do you believe that quality audit improve the performance of RHD ?

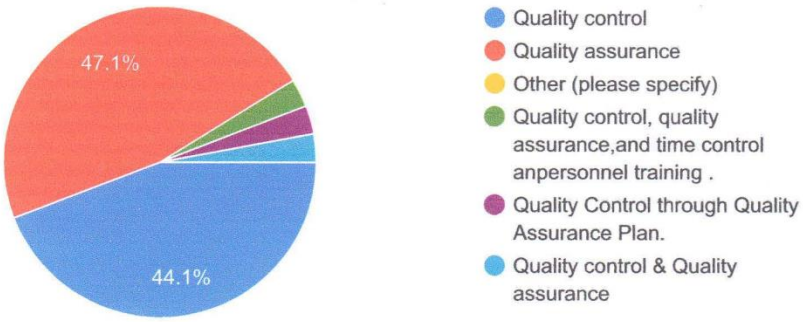
34 responses



Part-6: Others

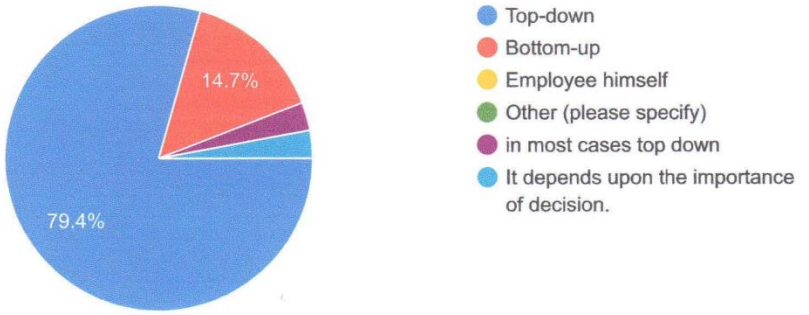
Which of the following approach RHD is taken during construction works ?

34 responses



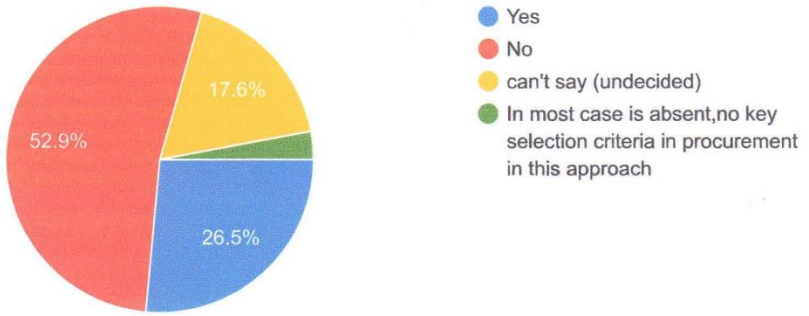
What approach RHD follows in decision making ?

34 responses



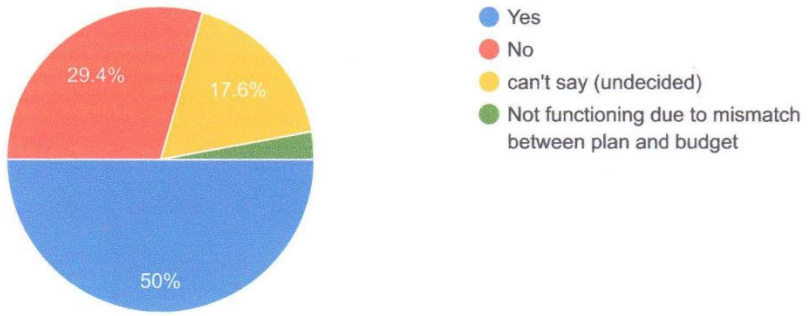
Is there any contractor's quality approach ?

34 responses



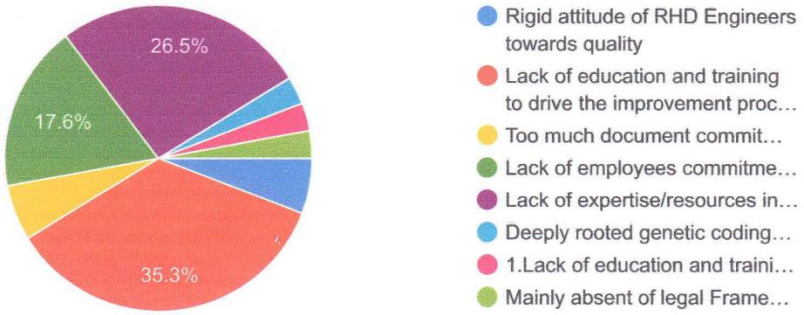
Is there any time based management system in RHD ?

34 responses



Obstacles in the implementation of TQM program (not limited to one answer)

34 responses



Thank you for your valuable time and sincere effort.