

**APPLICABILITY OF TOTAL QUALITY  
MANAGEMENT SYSTEM IN METAL QUARRY  
INDUSTRY IN SRI LANKA**

B.A.R.D. Balasooriya

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Degree of Master of Science in Project Management

Department of Building Economic

University of Moratuwa

Sri Lanka

April 2016

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Dissertation submitted in partial fulfillment of the requirements for the degree Master  
of Science in Project Management

Department of Building Economic

University of Moratuwa

Sri Lanka

April 2016

## DECLARATION

### Student Declaration

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## **ABSTRACT**

Total Quality Management (TQM) is a very important and significant management practice which used in the world industries. TQM is used for the total operation process of the organization and it talks about the all aspect which engages with the final outcome. Mining is the most historical engineering practice in this world and the world largest mining companies use the TQM in their companies to improve the quality of their product and services.

Usage of TQM in metal quarry industry at Kaluthara district in Sri Lanka is addressed in this report. Questionnaire survey was done to collect the data from mining engineers. The total sample was interviewed. This research used a quantitative analysis, RII method and the graphical illustrations to present the results. The results show a huge gap in use of TQM at metal mining. Lack of TQM knowledge and the lethargic attitude on TQM practices of the management are the main problems that have been identified.

Organizing the Lecture series, training programs, video training programs are recommended to address the knowledge and attitude problems. Development of TQM as a culture than a practice would be more effective in quality management in metal quarry industry at Kaluthara district.



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Key words: TQM, Knowledge



## **DEDICATION**

This report is dedicated to my loving parents who got every possible effort to make me an educated and useful person to the world.



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## **ACKNOWLEDGEMENT**

First of all, I would like to express my deepest appreciation to Department of building economic, University of Moratuwa, Sri Lanka, which started a very useful course of M.Sc. in project management to fulfill the increasing requirement of project managers. I believe that, this course covered all aspect of project management.

I would like to give a special gratitude to my project supervisor Ch. QS. L.D.I.P. Seneviratne who guides me in the total process of the research project by giving good guidance and coordinating the report writing.

Finally, I am using this opportunity to express my gratitude to everyone who supported me throughout this M.Sc. program. I am thankful to them, who spend their valuable time to make this project a success.



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## LIST OF ABBREVIATIONS

Abbreviation	Description
ABC	Aggregate Base Cores
AIV	Aggregate Impact Value
AML	Artisanal Mining License
B.C.E	Before the Common Era
CQI	Continuous Quality Improvement
EL	Exploration license
GSMB	Geological Survey and Mines Bureau
ICMM	International Council on Mining and Metal
IML	Industrial Mining License
ISO	International Standard of Organization
JIT	Just In Time
LAAV	Los Angeles Abrasion Value
LPSD	Leading Practice Sustainable Development
OSHAS	Occupational Health & Safety Advisory Services
PDCA	Plan – Do – Check –Act
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
QMS	Quality Management System
RII	Relative Importance Index
SPC	Statistical Process Controlled



TQM

Total Quality Management



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## CHAPTER 01

### INTRODUCTION

#### 1.1 Background

Having a proper road sector is an important factor of a country and it is a reflection of the development of a country. During last one decade Sri Lankan road sector achieved a marvelous accomplishment through the road projects introduced by the government.

Various materials are required for road construction. Aggregate Base Cores (ABC), Concrete Aggregate, Asphalt aggregate, rubbles and Soil are the main materials required for road construction. These materials are processed through quarrying and crushing of metal and this process belongs to mining industry. Therefore metal mining is the heart of the supply chain of road construction. Even though the Project managers are keen about the material quality, they are not much concerned about the quality management of their mining site because mining sites exist in remote areas separately from the main project. Therefore this research addressed about the Total Quality Management (TQM) in mining site subjected to road projects.

The mining sector is made up of organizations whose primary activity is the extraction of naturally occurring mineral solids or natural resources. Examples of these types of minerals are coal, ores and precious stones. The mining industry also broadly covers quarrying and well operations. The sector comprises two basic activities: mine operations and mining support activities.

The history of mining is fascinating. It parallels the history of civilization, with many important cultural eras associated with and identified by various minerals or their derivatives: the Stone Age (prior to 4000 B.C.E.), the Bronze Age (4000 to 5000 B.C.E.), the Iron Age (1500 B.C.E. to 1780 B.C.E), the Steel Age (1780 to 1945), and the Nuclear Age (1945 to the present). (Unknown, Introduction to Mining)

During the last two centuries, there has been great progress in mining technology in many different areas. Such progress is often made in an evolutionary rather than a revolutionary manner. Yet every once in a while, a revolutionary discovery comes

along and changes the process of mining profoundly. During the nineteenth century, the invention of dynamite was the most important advance. In the twentieth century, the invention of continuous mining equipment, which extracts the softer minerals like coal without the use of explosives, was perhaps the most notable of these accomplishments. (Unknown, Industrial revolution 2010)

In 2010, the nominal value of world mineral production was nearly four times higher than it had been in 2002. A recent assessment of global trade data indicates that in 2010 there were 40 countries that could be defined as relying on non-fuel minerals for over 25% of their merchandise exports (OPM, 2011a). Of these, 75% are low and middle income countries. This number represents a considerable rise over time: in 1996 there were only 29 mineral reliant economies and, as recently as 2005, there were 33. Dramatic changes in this indicator have occurred since 2005 when commodity prices started to rise rapidly. In the years to 2010 eight additional countries have entered the ranks of mineral reliant countries including Bolivia, Burkina Faso, Georgia, Ghana, Guyana, Lao PDR, Montenegro and Somalia. (ICMM, October 2012, Mining's contribution to sustainable development)

With this huge economic growth of the mining industry it tends to the new management practices to enhance the quality and the profit of the industries. Total Quality management, Lean management, Just in Time (JIT) was applied to the mining sector by large mining companies in the world.

Quality is a major factor in the business quality revolution that has proven itself to be one of the 20<sup>th</sup> centuries' most powerful creation of the sales and revenue growth, genuinely good new jobs, soundly based and sustainable business expansion. (Barric G. Dale, T. Van, J. Van, Managing Quality, 5<sup>th</sup> edition)

TQM is a total organizational approach for meeting customer needs and expectations that involves all managers and employees in using quantitative methods to improve continuously the organization's processes, products and services (Milakovich, 1990).

Total Quality management is a culture mainly in manufacturing industry rather than a practice. It is an approach to improving the competitiveness, effectiveness and flexibility of an organization for the benefit of all stakeholders. It is a way of

planning, organizing and understanding each activity, and of removing all the wasted effort and energy that is routinely spent in organizations. It ensures the leaders adopt a strategic overview of quality and focus on prevention not detection of problems (Thomas C. Powell, Jan 1995). This research wish to satisfy the objectives related to Total Quality Management in Mining industry in Sri Lanka.

All mining activities in Sri Lanka are carried out under the regulations imposed by Geological Survey and Mines Bureau (GSMB), according to the Mines & Minerals Act No.33 of 1992. GSMB has the fully ownership to Issuing licence, Renewals and cancellation of mining license. GSMB issue three types of license, i: e, Exploration, Mining, Trading and Transport under the Mines & Minerals Act No.33 of 1992.

An Exploration license (EL) grants the license-holder the exclusive right to explore for all mineral categories authorized by the license. Artisanal Mining License (AML) Grants the license-holder the exclusive right to mine, process and trade in all minerals specified in the license within an area not exceeding ten hectares or to a depth not exceeding twenty five meters. Industrial (IML) Grants exclusive right to explore for mine, process and trade in all minerals mined within the area specified in such license. There are three categories of Industrial Mining Licenses categorized by considering the possible environmental pollution.

With the boom of the Construction industry, metal quarry industry acquired a significant demand for material supply and more newcomers entered to the metal quarry industry by considering the large revenue of it. Therefore it is no longer a typical mining site and quarry industry needs new managing techniques and concept for its survival and goes for huge revenues.

## **1.2 Aim of the Research**

Research aim to identify the application of total quality management in metal quarry industry in Sri Lanka and importance of TQM applications in metal quarry industry.

In order to achieve this aim following objectives have been set.

### 1.3 Objectives

- Identify the TQM principles which can be used in the metal mining industry.
- Establish the knowledge level and attitude on quality management practices of the Mining Engineers in the metal quarry industry in Sri Lanka.
- Identify the current quality management practices used and TQM applications and methods which can be used to overcome the management difficulties.
- Make recommendations to come out with solutions to the problems identified, by using TQM principles.

### 1.4 Methodology

In order to achieve the above objectives following methodology was used.

- A literature survey was done to establish the TQM which can be used in metal quarry industry worldwide and in Sri Lanka. The literature survey was done through using text books, mining journals articles, World Wide Web and mining videos.
- The main tool used for the research was the questionnaire survey since it is the best way to get the opinion of mining engineers who are giving the leadership to mining industry. They were used for the questionnaire survey because they were the most educated party in the metal quarry industry. Further the act no: 33 of 1992 require the mining engineer to be graduated and passed out from a recognized university, because they formed the future direction of the mining industry in Sri Lanka.
- The questionnaire helped to establish current TQM practices, knowledge level, people attitudes and difficulties about the subject.
- In the design of the questioner survey, a pilot survey was done among six mining experts. It helped to identify the most critical areas in mining operations.

### 1.5 Scope and Limitation

- Research was carried out only for Industrial Mining License (IML) – ‘A’ grade metal quarries.

- Research was carried out only for the quarries at the Kaluthara area because highest number of IML – ‘A’ grade quarries in Sri Lanka, exist in the Kaluthara district.
- Research was limited to the main quarry operations in the development, exploration and the reclamation phases.

The overall sequence of activities in metal quarry projects can be grouped into five stages, they are; Prospecting, Exploration, Development, Exploitation and reclamation (guide LPSD, 2011). This research was focused on the Exploitation, Processing and Marketing in an IML-‘A’ categorized quarries. The Prospecting and Development sequences were omitted from this research study since they had been completed already in currently operating mines in kaluthara district.



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## 1.6 Chapter Breakdown

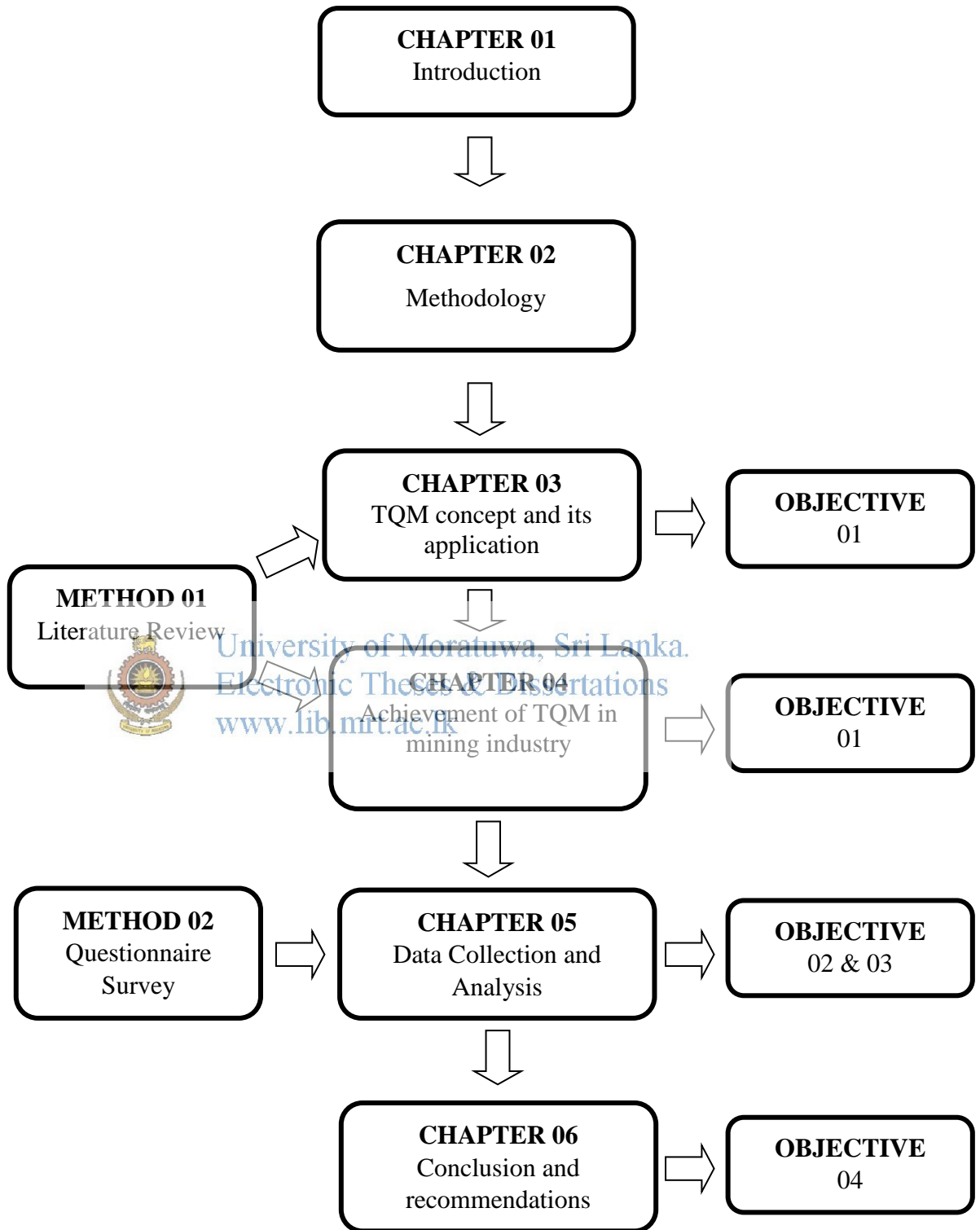


Figure 1.1: The illustration of chapter breakdown



## **1.7 Chapter Summery**

Introduction about the Mining, Total Quality Management and Sri Lanka mining act are represented in this chapter. Research was carryout under the scope and limitation given in heading 1.5, chapter-01 due to time restrictions.

Research would be helpful to conduct smooth operations and quality works through quality improvements in metal quarry industry.



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## CHAPTER 02

### METHODOLOGY

#### 2.0 Introduction

Method used to achieve the objectives is comprehensively described in this methodology chapter.

#### 2.1 Literature Survey

Basic information and knowledge on TQM was gathered through the literature survey. The literature was based on world mining industry, quality management practices, TQM practices, and the supply chain management used in the metal quarry industry. Mining magazines, management magazines and books, articles, World Wide Web and videos were used during the literature survey.

##### 2.1.1 Research Gap

Literature survey findings and my work experience in the mining industry enabled to establish the research gap. The non-application of TQM principles in the open cut metal mining industry was thus established.



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#### 2.2 Pilot Survey

A pilot survey was done in order to design the questioner survey. Six (06) expert mining engineers were selected for the pilot survey as the target group to get inputs for the designing of the questioner. The composition of the pilot survey participants are displayed in table 2.1.

Table 2.1 composition of the pilot survey

Experience level	Number of persons
More than 10.1 years	3
8.0 to 10 years	3

Six mining engineers were interviewed during the pilot survey. Further it also helped to design the questioner to identify quality management problems in the metal mining process.

It was established that there was a knowledge gap in application of TQM in metal mining. The target group identified the following critical areas such as time management, safety management, environment pollution mitigation, record maintenance, machine breakdown management, material quality management and resources management in order to implement TQM in open cut metal mining industry in Sri Lanka.

### 2.3 Questionnaire Survey

Questionnaire was prepared to cover the above areas that were identified at the pilot survey. Some direct questions as well as the indirect questions were included in the questionnaire. Mining Engineers were used to administer the questionnaire survey since mining Engineers are the most educated and the managerial level people in the metal quarry industry.

### 2.4 Sample Population

Details of the IML-'A' grade quarries at Kaluthara district was taken from the regional mining engineer GSMB, Kaluthara. According to his records there were fourteen IML-A grade quarries were actively operated in the Kaluthara district during the research period. All fourteen mining engineers attached to these quarries were used for the questionnaire survey. Therefore total sample was covered.

Collected data was analyzed by using statistical and graphical methods. Problems were identified at the analysis, and the methods to overcome the problems were discussed in the recommendation chapter. The graphical representation of research methodology figure 2.1 had been given below.

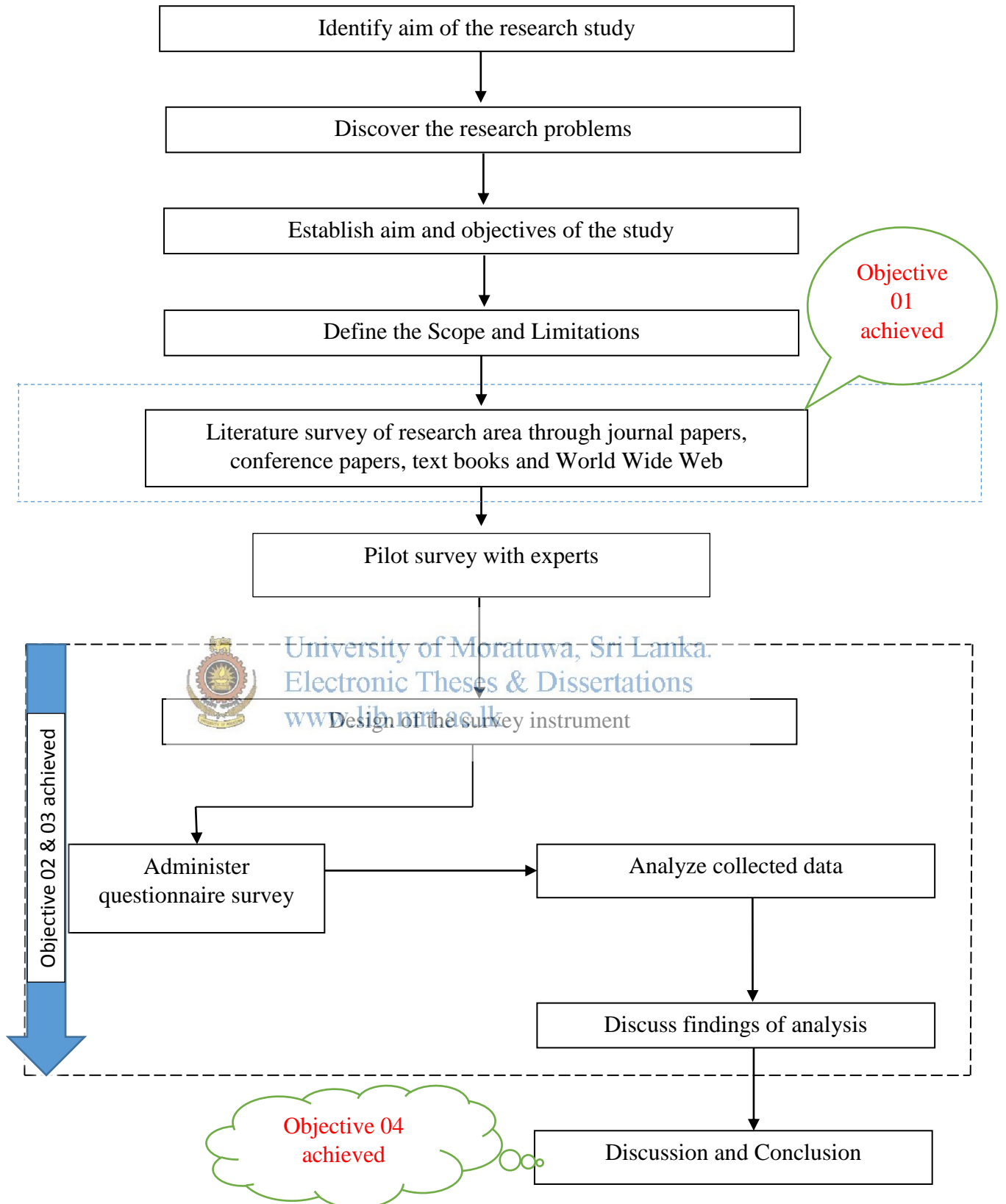


Figure 2.1: Research Methodology

## CHAPTER 03

### LITERATURE SURVEY

#### 3.0 Introduction

This chapter is talk about the TQM philosophy and its applications. It was too difficult to found literatures which written in TQM in mining industry. Therefore literature of TQM and the literature of mining are separately analyzed.

#### 3.1 Philosophy of Total Quality Management

Total Quality Management is a broad, companywide management approach to achieve long-term success with a solid focus on customer satisfaction. Quality could not be assured by just a small group of quality professionals. It depends on the active involvement and participation of all the members in an organization from management to ordinary employee to improve processes, products, services and working culture of the organization. (Philosophy of TQM and teachers, 2012)

TQM is a better application for the customer focused organizations that, involve every employee in endless quality improvement of all aspect of the organization. TQM uses strategy, data, and effective communication to integrate the quality principles into the organization culture and activities. Quality is an agreed and fully understood requirement meeting the customer needs and wants (R. D. Turney, ICHEME Symposium). Under the TQM concept, there is neither low quality product or service nor any high quality product or service. The product or service either satisfies what the customer wants or it does not (Anita Johari, Khin Than Myint, 2012).

Total Quality Management is a set of practices and it is an incorporated management philosophy. Continuous improvement of product and service, involvement of employee and teamwork enhancement, team base problem solving, work for the customer satisfaction, reducing reworks, constant measurement of results, lesson learning and proper documentations are the set of practices in total quality management.

Quality management is a common principle of leadership with values of systematic and continuous long-term work according to good business practices, improved level of materials, services and processes within organization and customer needs now and in future. Total Quality Management combines all basic leading and management techniques, development procedures and technical tools to discipline continuous way of working. (Borgman & Packalen, 2002 cited Marco Manu 2011).

TQM can be applied to any Government organization, servicing, non-profit organization, manufacturing, military and all other organizations in this world. “TQM generates improved products and services, reduced cost, more satisfied customers and employees, improved bottom line financial performance” (Walton, 1986)

TQM is seen a management system consisting of core values, methodologies and tools with the aim to increase external and internal customers satisfaction with reduced resources (Hellson and Kelejsjo, 2000 cited Maria Fedrikson, 2004)

Quality management is a culture rather than a practice. Managers should always be keen on quality management practices and should not lose their attention on quality management. Ground level workers do not give much attention on continuous quality improvement and conducting continuous quality operation if managers do not show their higher interest to quality products. Therefore endless attention of the managers on total quality management is the key to conduct quality culture in an organization.

“Total Quality Management (TQM) is a continuous set of mind set that keeps on improvement processes for individuals, groups and whole organizations by understanding and discovering better process”(Poonsook Janpan, 2005 cited Mart Loughlin 2008)

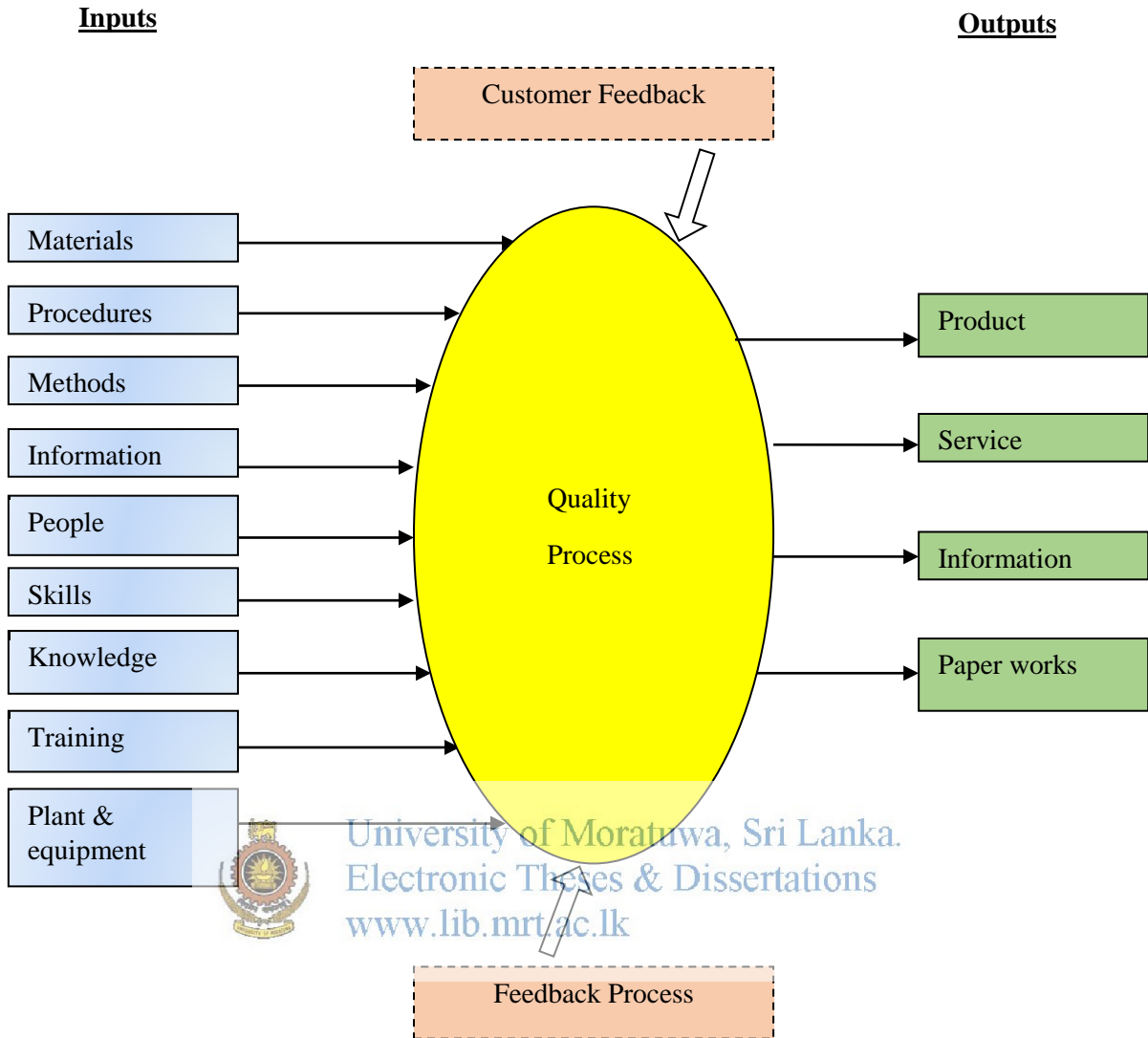


Figure: 3.1: Quality process

Source: Quality excellence; Department of trade and Industry

[www.dti.gov.uk/quality/tqm](http://www.dti.gov.uk/quality/tqm)

### 3.2 History of Total Quality Management

According to the journal from quality to excellence, Department of trade and industry UK, Japanese were the pioneers of adopting the philosophy of Total Quality Management (TQM) in Japan and then introducing it to the rest of the world. The first quality control cycle was designed in Japan on 1960 and it used simple statistical methods to approach quality improvements. Japanese companies could flourish

through TQM gaining cultural and financial benefits for their organization. Later on, the Total Quality Management which is a quality oriented management approach was developed.

The evolution of TQM happened in few stages easily identified as Inspection, Quality Control (QC), Quality Assurance (QA) and now Total Quality Management (Mark Loughlin, 2008).

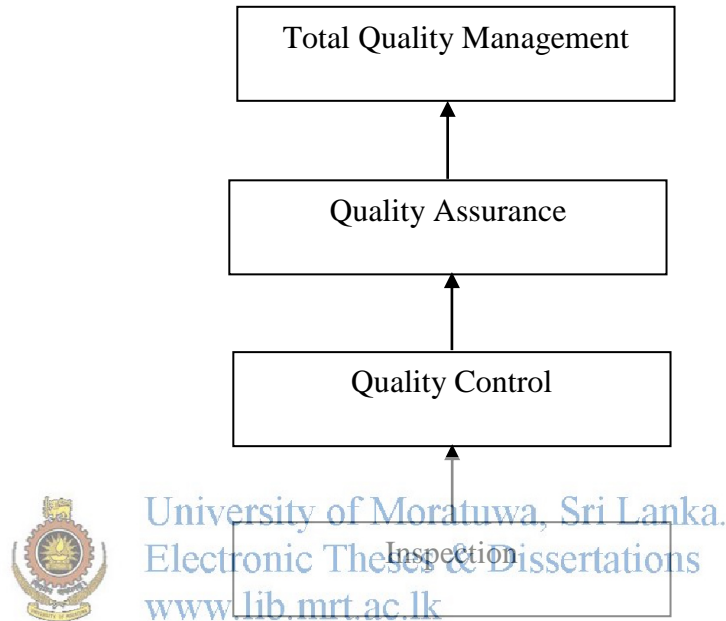


Figure 3.2: Evolution of TQM

Source: Discuss the key element of TQM within the context of emerging business environment. (Mark Loughlin, 2008)

W. Edward Deming was the person who introduced Statistical Process Controlled (SPC) system and problem solving technique to Japanese organizations for effective communication in quality management. Deming introduced fourteen important points which communicate to managers to increase quality in an organization.

M. Juran who started an institute on 1979 with the idea of helping organizations to improve their total quality was another famous individual. Juran believed quality as “fit for use”. According to him, any product should be 100% defect free if it is to be used.



People began to rely on Japanese product and services by considering their quality output. There was a competitive advantage to Japanese business over other nations with their ability to produce high quality product with fewer defects. Japanese companies earned huge revenue relies on their quality product. In 1980 decade, American organizations started to move into this new theory by following Japanese foot steps to make zero defects product and services.

The Ford company which manufactured motor vehicles was the first American organization who transformed itself into a quality oriented organization in America with the help of Edward Deming. Then, Ford could become the number one American quality oriented automotive company and its substantial sales growth was significantly increased in 1980 even though the sales of rest of American automotive companies were experiencing a turned down. (TLFebook, Quality management system, chapter 14, p268).

Early stage TQM applied only for the manufacturing industry and it was believed that TQM may not be fit for the service sector. But later on that belief became a buzz word because service sector also acquired a high improvement by applying TQM (Prof. Alessandro Brun, 2011).

When Total quality management seem to be a profitable manner in business world some organization started to award quality certification like International Standard of Organization (ISO) 9000, ISO 9001 to emphasize the fitness of the product.

Government made quality award to promote the quality practices. The Malcolm Baldrige national quality award from the United States, the European quality award, Deming prize from Japan, the Canadian quality award and the Australian quality award are the some of them. The criteria of most of these award programs encouraged strategic initiatives in the approach and deployment of quality practices. But as with most successful quality initiatives, the award programs underwent continuous improvements in design and administration (Robert J. Vokurka, Gary L. Stading and Jason Brazeal, 2000)

### 3.3 System of Standard for Quality

ISO 9000 family addresses various aspect of quality management and represents the management systems standards and series of particular standards. International organization of Standardization is federations which engage with 132 of national standards bodies. ISO 9000 series Quality Management System (QMS) apply to the process which provides the final outcome. It does not directly apply to the product or service. Quality product or service is bloomed by a quality process. QMS covers all aspect of TQM process. ISO 9001:2008 Sets out the requirements of quality management system, ISO 9000:2005 covers the basic concepts and language, ISO 9004:2009 focuses on how to make a quality management system more efficient and effective, ISO 19011:2011 set out guidance on internal and external audits of quality management system ([www.iso.org](http://www.iso.org)).

To get an ISO certification, particular organization must fulfill all the standard criteria stated in ISO standard and pass the audit conducted by an ISO auditor. Nowadays ISO reputation is a must to keep their good will among the business world. Stakeholders are much willing to attract the quality reputation.



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### 3.4 Principles of Total Quality Management

There are basically nine key principles that can be found in TQM literature. It shows the way of immersing with TQM and distribution of intelligence from top to bottom. Total employee involvement, continuous quality improvement, continuous training, teamwork, empowerment, top-management commitment and support, Democratic management style, customer satisfaction, culture change are the nine key principles of Total Quality Management.

#### 3.4.1 Total employee involvement

All employees in the organization directly involved with the quality process. Top management implements the process to be followed by the employee from top to bottom. Everybody is responsible for the task that they are allocated. All the departments bond with the organization quality process. As an example, materials are requested by the stores then purchasing department purchase. Here stores peoples are

responsible to requesting required exact material and purchasers are responsible to purchasing correct materials at the correct time. Purchasing is no longer purchasing cheaper materials at the TQM application, because it is necessary to purchase required quality material on time.

TQM is an ongoing process. Once started it cannot be stopped. Nobody can be isolated by it and nobody can let go the process. If the chain is broken at one place total process would collapse. Therefore total employee involvement is a must in TQM process.

### 3.4.2 Continuous quality improvement

Continuous Quality Improvement (CQI) is a team approach to improve day-to-day operations. CQI is done by using FOCUS-PDCA method. First start with FOCUS steps. Those are,

F - Finding a process to improve

O - Organize to improve a process

C - Clarify what is known

U - Understand variations

S - Select a process improvement

After the FOCUS steps then move on to the PDCA.

P- Plan (create time line, resource planning, activity planning, dates and personal training)

D – Do (plan implementation and data collection)

C – Check (results analyzing)

A – Act (act on what was learned and determination of next steps)

Quality is a never ending process. Due to huge business competition, organizations are keen on continuous quality improvement. Quality improvement is done by research, experiment and survey to compete with similar product and services. Organizations should approach quality improvement in long-term perception. Quality improvement is not a task that has an end, as it is not static. The emphasis is on

seeking improvement opportunities, not just holding the status qua. The focus is on planning, prevention, and anticipation (Dale, 1992).

In order “ to maintain a wave of interest in quality, it is necessary to develop generations of managers who are dedicated to the pursuit of never ending improvement in meeting external and internal customer needs ( Oakland, p.296, 1989; cited in Alexanderos G. Psychogios, 2007)

TQM should be implemented into a company as a ‘Kaizen’ initiative, Kaizen is a strategy developed by the Japanese meaning ‘continuous improvement’. So with TQM, it should be at the core of an organization and employed every working day, to achieve the best quality attainable (Mark Loughlin, 2008)

### **3.4.3 Continuous training**

Continuous training is a very important concept in total quality management. Training should be given individually as well as team wise and department wise. Employees can be empowered by a proper training to a continuous quality improvement. Training need to be a continuous process because technology is changing, management and quality requirements are also changing with time. Therefore training seems to be a never ending process it should be done from time to time to fit the final outcome.

“Continuous training contributes to the establishment of a common language throughout the business (Dale, 1999).

“quality training must be continuous to meet not only changes in technology, but also changes involving the environment in which an organization operates, its structure, and perhaps most important of all the people who work there” (Oakland, p. 263, (1989), cited Alexanderos G. Psychogios, 2007 ).

Training is very important for employees to be productive. Supervisors are responsible for implementing TQM in their departments and to spread the philosophy of TQM among employees operate (Prajogo et. al., 2004, cited Ioan Milosan, 2014)

#### **3.4.4 Team work**

Within the context of TQM, team work is an important outcome and a condition for continuous improvement (coyle-shapiro, 1997). Teams are more powerful than individuals. Team building is a complex process and it has its own theories. Teams are more effective at the performing stage. When it applies to the TQM process team work is a more successful since it comes with total employee involvement. Therefore cross functional team work through the department makes mutual trust among the group while driving the organization to a one language.

TQM teams can be divided into three types such as Quality improvement team, Problem solving team and work teams. Quality improvement teams are temporary created groups which are building to analyze the problems that appear in a process or an organization. Problem solving teams are used to solve certain problems and to do root cause analysis. Work teams are the groups which are built of skill workers who share the same duties and responsibilities (Ioan Milosan, 2014).

It is important to understand at this time that although teams come in various forms, they need to enhance the cross-functional, objective, factual implementation of strategy. The quality units or teams usually occur in three forms: Quality circle teams, problem-solving project teams, and Quality improvement teams (Kairong Liang & Qi Zhang, 2010)

To be successful in business, teamwork is an essential element of TQM, where the team can find solutions faster to the problems in the organization. Teams can provide improvement of processes and activities (Ioan Milosan, European scientific journal February 2014).

### 3.4.5 Empowerment of the employee

Employee empowerment is another important part of the TQM. Empowerment is done through the identification of skills, strengths and weaknesses of the employee. Empowerment is a process which emphasizes the responsibility of the job and practicing people work without direct orders from the top management or the middle management for their day to day works. After a proper training and guidance empowered employee can conduct their daily routines qualitatively through a good understanding of responsibilities.

TQM offers ways in which empowerment of employees can support an organization's efforts not only in quality improvement, but in empowerment as well (Wilkinson, 1998). Empowerment approach places the responsibility for an organization's processes in the hand of those who know these processes best, and help them to participate directly in the organization mission or purpose. In particular, the plan-do-study-act cycle lies at the heart of the improvement process and represents the key to employee empowerment in that process (Alexander G. Psychogios, 2007)



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### 3.4.6 Top management commitment and support

Top managers have to take charge personally, lead the process, provide direction, exercise forceful leadership, including deadline with those employees who block improvement and maintain the impetus (Dale, 1999). Companies with high top management commitment have the ability to produce high quality product in contrast with firms with low top management support (Ahir and O'Shaughnessy, 1998). Senior managers need to define the quality objectives of the organization to provide direction and clarity and to communicate these continually within the organization (Torrington and Hall, 1998; cited G. Psychogios, 2007)

### 3.4.7 Democratic management style

Democratic leadership is behavior that influences people in a manner consistent with and / or conducive to basic democratic principles and processes, such as self-determination. Inclusiveness, equal participation, and deliberation (Dahl, 1989; Fishkin, 1991; cited John Gastil, 1994)

Authority and the leadership is the main function defined in democratic management. Delivering the responsibility among the group members and delivering the leadership are the basic concepts in democratic management. Leadership should not be confused with the occupant of a formally established position in a hierarchical structure (Fisher 1986, cited in Ostroff & Kozlowski 1993). Democratic management is a method of leadership which behaves only as a leader but it is not a given position.

Leaders should help members to develop technical and emotional maturity and should avoid a know-it-all attitude. Leaders should foster the emancipation of consciousness and pursue the ideal of making members into leaders. Problems must be analyzed by the group, and therefore information must be shared. Disagreement has to be dealt with in an open and constructive way. ( Weibler, Jurgen, 2011)

### 3.4.8 Customer satisfaction

TQM means satisfying customers first time, every time. It means enabling your employees to solve problems and eliminate waste (Dr. H. Nagaprasad and B. Yogesha, 2009). Customer is the person who consumes the product or service. The satisfaction level of the customer is intangible and it is depend on the knowledge of the consumer, previous experience of the consumer on same type of product or service. Therefore it is a too difficult task to satisfying each and every customer. Giving a fully confident and standard outcome is the proper way to achieve the customer satisfaction.

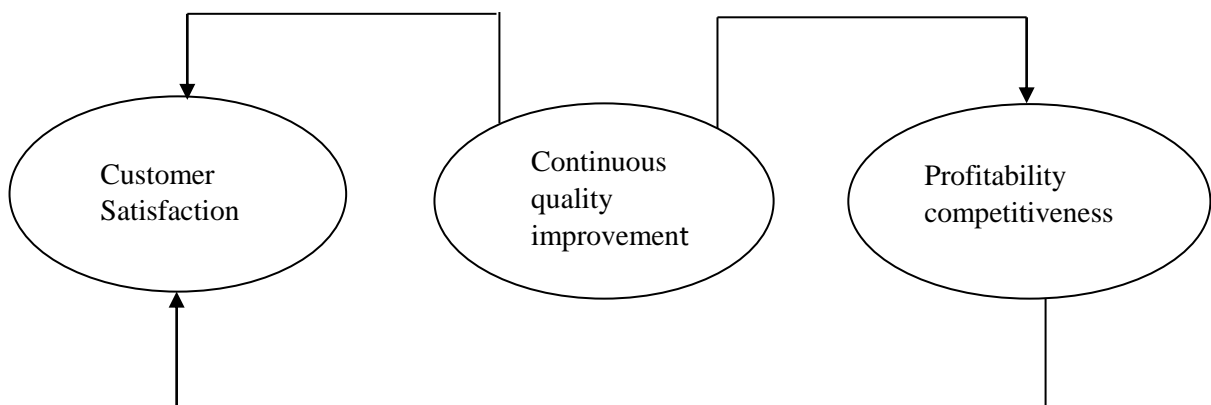


Figure 3.3: Quality function in business activity (Savolainon 1997:46)

Source: Quality and customer satisfaction perspective in organization by gap and total quality improvement method, by Marco Manu



Present situation is not like the past business. Many rival actions can be seen between organizations that provide similar kind or product or services. To compete with competitors' business entities must maintain high quality culture of customer satisfaction.

### 3.4.9 Culture change

Quality culture improves the trust among employee of the organization and the stakeholders involve with its business. Employees no longer waiting for the autocratic information flow as earlier stages but work according to the responsibility they empowered with. TQM is a culture rather than a practice and always try to getting it right first time. Quality culture bind with all TQM principles applied. "The culture in any organization is formed by the beliefs, behaviors, norms, dominant values, rules and the climate. There is widespread recognition that major change initiatives will not be successful without a culture of good teamwork and cooperation at all levels in an organization (unknown, from quality to excellence: Department of trade and industry).



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Two components are identified in TQM culture says "what" and the "how". Things belongs to "what" are identify via the text books and theories belong to TQM but 'how' are identify through the management experiences and lesson learnt.

### 3.5 Elements of Total Quality Management

Element of TQM are the driving forces and techniques which used to streamline the TQM process and its concepts. TQM elements are applied to look after the process but not the product. Because, when the process is look after the product will looks after itself. Participative management, vision and values, developing plan, communication and rewards and acknowledgement are the basic elements of TQM process. (Ioan Milosan, 2014)

#### 3.5.1 Participative Management

Participative management is the integration of employee involvement, training, leadership and the empowerment of quality process. Trust is the base of the



participative management and the trust help the full participation of all employees. It tolerates all workers empowerment which lead to involvement and engagement. “Participative management is a type of management which employees at all levels are encouraged to contribute ideas toward identifying and setting organizational goals, problem solving and other decisions that may directly affect them. This is also called consultative management”. (www.managementstudyguide.com)

### 3.5.2 Vision and Values

Vision and values is the important guide which gives the quality direction to the organization. Vision statement is a most important element in TQM because it set agendas for all other processes which used to manage systems. Proper vision can lead an organization toward success as well as the improper vision can ruin the organization. Vision is some kind of dream and it should be cleared, simple and understandable to every level of employee.

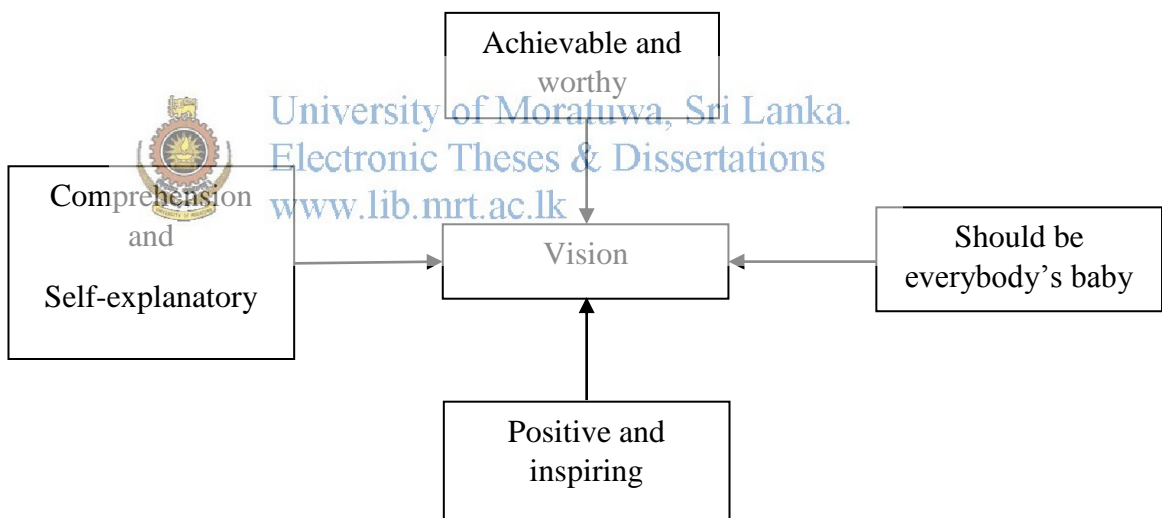


Figure 3.4: Description of the vision statement

Source: Total Quality Management, by L. Suganthi and Anand A. Samuel

### 3.5.3 Quality Planning

Quality plan is another important element and it says the path to achieve the organization vision. Goal setting, physical and financial resources identification, training schedules and all quality activities are included in this action plan. Goals

should be clear and measurable. Quality plan should be consist with organization vision and values.

### **3.5.4 Communication**

Communication is the other significant element of TQM. Two way communications between top-management, employees, customers, suppliers and stakeholders is an essential part in communication chain. Communication can be done by feedback slips, feedback round tables, interviews in both formal and informal ways. Feedback helps to identify the problems involved in the process and new ideas to enhance the current system and results it zero defect.

Superiors should create and maintain channels of communication through which to receive and transmit information about TQM processes. Sharing of accurate information is vital. For a credible communication is absolutely necessary that the message be clear that the interpretation of receptor to be in the sense in which the broadcaster has intentionally (Ioan Milosan, 2014).



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### **3.5.5 Rewarding and acknowledgement**

Employees can be motivated to continue TQM process without high supervision by giving Rewards, compensation and acknowledgement for the quality achievement.

## CHAPTER 04

### MINING INDUSTRY

#### 4.0 Introduction

Chapter four talk about the literature, subjected to mining industry and the mining supply chain. Metal quarrying is directly subjected with the supply chain of the construction industry in Sri Lanka. Therefore this chapter based on the basic philosophies in supply chain at mining industry.

#### 4.1 World Mining Industry

Mining industry is the industry which can influence every trade in the world. All industries are depending on the materials which are extracted from the earth. “Minerals and metals are key to all services and infrastructure that are used by contemporary society: including shelter, food and water supply, sewage treatment, energy supply, for a vast range of needs including heat and light, transportation, construction, manufacturing, education, health, communication, entertainment, the arts, tourism, and the vast range of Associated consumer goods and services” (ICMM, Mining contribution to sustainable development October 2012).

Metallic minerals, nonmetallic minerals and fossil fuels are explored from the earth and these are needed for each and every trades and it is a continuous chain. Metallic ores consist with ferrous metals, base metals, precious metals and radioactive minerals. Iron, titanium, tungsten, manganese are the example for ferrous metals and copper, zinc, lead are the example for base metals. Precious metals are gold, silver and platinum. Uranium, thorium, radium are the example for radioactive minerals. Phosphate, potash, halite, sand, gravel, metal, lime stones are not associated with metallic substances and those are non-fuel minerals called nonmetallic minerals and also called industrial minerals. Organic mineral substances such as coal, natural gas, coal bed, petroleum are utilized as fossil fuels.

With the technology development of the mining industry large number of companies' moves on to mining industry by considering the large revenue generated from it. Huge mining machineries are introduced to the mining operations which had helped to product improvement. "In recent years huge investments have taken place in Latin America, Africa and parts of Asia and these are Likely to escalate in the next ten years."(International Council on Mining and Metal, October2012)

BHP Billiton is the world largest mining company measured by revenue. BHP Billiton operates wide verities of mining operations in 25 countries employing approximately 41,000 employees (Boyi Xie, mining overview March 2012). Vale, Rio Tinto, China Schenhua, Xstrata, Anjalo Amarican, Freeport McMoRan, Barric Gold, India Potashcorp are the most popular and other largest mining companies in revenue.

Mining can be divided into two basic type called underground mining and opencast mining. Opencast mining methods are used to extract the minerals which are close to the earth surface. But there are some mineral ores exist deeper from earth surface and underground mining methods are used to access to deepest ore bodies.



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Invention of tungsten carbide and the industrial explosives accelerated the mining activity cycles and it increased the production. New technologies like Core drilling, seismic wave analysis, satellite images and Arial photography have come to the mining discussion and it is now used for investigating to identify new resources. Some companies improved the mining machinery performance and introduce new technologies and new machineries to the mining industry and increased their revenue parallel to the mining boom.

#### **4.2 Stages of the Mining**

Life of a modern mine can be divided into five stages based on its overall activities. Prospecting, exploration, development, exploitation and reclamation are the stages of

a mine (Guide LPSD, 2011). These stages cover all the activities of a mine from its start to end.

Prospecting in the searching stage of ore deposits and other valuable minerals which exist on the surface or beneath the surface. Direct geological methods and indirect (geophysical and geochemical) methods are used to search the mineral deposits. Exploration is the second stage which accurately determines the size and the value of the mineral deposit. “The line of the demarcation between prospecting and exploration is not sharp; in fact a distinction may not be possible in some cases” (unknown, introduction to mining).

If the mineral ore exploration phase proves that there is a large enough mineral ore deposit, of sufficient grade, then the project proponent may begin to plan for the development of the mine (unknown, guide book for evaluating mining projects EIAs). Development stage is the phase which starts the physical operations to access to the ore deposit. Getting license approvals, land acquisitions, finance arrangements, access road preparations, water and power supply arrangements are done at the development stage.

Ore excavation starts at the exploitation stage and once it is started continues the production of a mine (unknown, Exploration and mining guide for aboriginal communities).

Final stage is the reclamation and it is run parallel to the exploitation. Mine re-encountering, vegetation are done at the reclamation phase. Reclamation is done to bring the environment again into the vegetated stage and to minimize the environment pollution.

### 4.3 Mining Supply Chain

Supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer (Christopher

1992, cited John T. Mentzer 2001). That mean supply chain consists of multiple firms both supply and distribute to the ultimate customer.

Supply chain is a set of firms that pass materials forward. Normally, several independent firms are involved in manufacturing a product and placing it in the hand of the end user in a supply chain. Raw material and component producers, product assemblers, wholesalers, retailer merchants and transportation companies are all members of a supply chain (La londe and Masters 1994, cited in Journal of business Logistics 2001).

IBM chief supply chain officer study has conducted a survey through 400 mining supply chain leaders around the world in 2009. Here they had identified five most important issues and drivers which are affecting on mining supply chain. Those points represent by the IBM are cost containment, supply chain visibility, customer demand, risk management and globalization.

#### 4.3.1 Cost containment

Cost containment activities will focus on more than just reducing expenditures it is concurrently build more value into the supply chain and facilitate companies to be more flexible and agile in operations.

#### 4.3.2 Supply chain visibility

Supply chain visibility is the ability to see through the information and collaboration, supply chain activity need to react both internally as well as the external suppliers and customers (Guy Isherwood, Commodities Now). Visibility is a top challenge in mining supply chain. Higher visibility of a supply chain leads to make sound business decisions, generate very precise forecast, and achieve efficient operations, good responding to supplier, market and to customer.

### **4.3.3 Customer demand**

Customer demand is fluctuating according to the reasons affecting the mining industry such as Supplier cost, material availability, weather, politics, and finance. Therefore customer demand plan and forecasting program can be improved to value provided to the customer.

### **4.3.4 Risk management**

Risk management is a most important in mining supply chain. Risk run through the all aspect of economy, employee, credit sales, price, substitute and many other. These all are interconnected. Communication development and risk management planning is deployed to the mining supply chain to minimize the risk associated from pit to port.

### **4.3.5 Globalization**

Globalization talks about the availability of qualitative materials at low cost. World industries are no longer depends only on domestic suppliers and go for the low cost supplier considering the cost containment. Mining also embraced in low cost countries. Successful metal and mining companies are able to enhance their ability to meet customer requirements by extending capabilities across global service centers to meet local demand” (IBM, the smarter supply chain of the future).

## CHAPTER 5

### ANALYSIS

#### 5.0 Introduction

Data gathered through the questionnaire survey is analyzed in this chapter. This chapter presents the analysis on the knowledge level of the occupiers and the current practices of time management, resources management, records and maintenance handling, environment and safety concerns, material quality management and the breakdown repair management. Data was quantitatively analyzed by using the graphical representations to aid a clear final outcome.

There were fourteen Industrial Mining License (IML) – “A” grade quarries actively in operation in the Kaluthara district and the survey was done with all the fourteen mining engineers at the metal quarries in the Kaluthara district. Therefore this survey covered the total sample population.

#### 5.1 Knowledge Level



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Before applying a management practice to the work place the people who are involved in the operation should be aware of the management practice what he or she going to implement. Therefore, awareness of the TQM was checked. Only Forty three percent of managers were aware of TQM but the other Fifty Seven percent of managers did not know about the Total Quality Management. Even though Fifty Seven percent of engineering graduate managers had not known TQM, Twenty eight percent of them know some other management practices like 5S system, Lean Management, Just in Time, Six sigma. Most important thing is Twenty Nine percent of engineering graduate managers did not know any special management practice. 5S was the most common quality practice where as Sixty four percent of respondents aware of. Forty three percent of respondents were knowledgeable about more than one management practice and Seventy one percent of respondents were aware even one quality management practice.




Mining Engineers are the Managers in quarry industry and they are the key persons at site. They are the people who provide guidance to the followers. But Fifty Seven percent of quarry managers were not aware of TQM and Twenty Nine percent was not aware of any management practice. This seems to be a critical problem in the quarrying projects.

According to the above results forty three presents of respondents said that they aware of TQM. Therefore next question was “how much they know the subject?” RII index was used to identify the level of the awareness TQM.

For the RII index, weight from one to five had been used. Following table illustrate the weight system used to find RII.

Table 5.1: Weight are given system for the RII index and its interpretation

Knowledge level	Given weight	Demonstration of the knowledge level
 Excellent	5	<ul style="list-style-type: none"> <li>• Management practice can be explained.</li> <li>• Particular system can be demonstrated to the other.</li> <li>• It can implement to the site alone.</li> <li>• Can be performed while motivating others.</li> <li>• Result oriented.</li> </ul>
Very good	4	<ul style="list-style-type: none"> <li>• Management practice can be explained</li> <li>• Particular system can be demonstrate to the other</li> <li>• It can implement to the site with the help of another professional.</li> <li>• Can be performed.</li> </ul>
Good	3	<ul style="list-style-type: none"> <li>• Management practice can be explained.</li> <li>• Particular system can be demonstrate to</li> </ul>

		<p>the other.</p> <ul style="list-style-type: none"> <li>• Not confident to implement it to the site along.</li> </ul>
Medium	2	<ul style="list-style-type: none"> <li>• Management practice can be explained</li> </ul>
Bad	1	<ul style="list-style-type: none"> <li>• Not confident for the above</li> </ul>

$$RII = \frac{\sum f x}{\sum n}$$

$$RII_{(TQM)} = \frac{2 \times 2 + 3 \times 3 + 4 \times 1}{6}$$

$$RII_{(TQM)} = 2.83$$

According to the RII index received for the TQM, it says the people who aware of TQM (forty three present from the total sample) have a good knowledge.  $RII_{(TQM)}$  exists between two and three, and it is closer to number three. Therefore we can say that they have a good knowledge in TQM.

Five –S was the most known quality practice. According to the data sixty four present of people aware of five –S. knowledge level of these sixty four present was checked by using RII.

$$RII = \frac{\sum f x}{\sum n}$$

$$RII_{(5S)} = \frac{3 \times 3 + 4 \times 3 + 5 \times 3}{9}$$

$$RII_{(5S)} = 4$$

According to the RII index received for the five-S, it say the people who aware of five – S (sixty four present from the total sample) are having a very good knowledge

in five - S. RII (5S) is given the answer four. Therefore we can say that they have a very good knowledge in five- S.

## 5.2 Use of Quality Management Practices

Uses of a special quality management practices were checked and it was found that only fourteen Percent of quarry projects were using quality management practices but the other Eighty six Percent of quarry projects were not using any special management practice. OHSAS and the ISO2008 were the practices used by the above fourteen Percent.

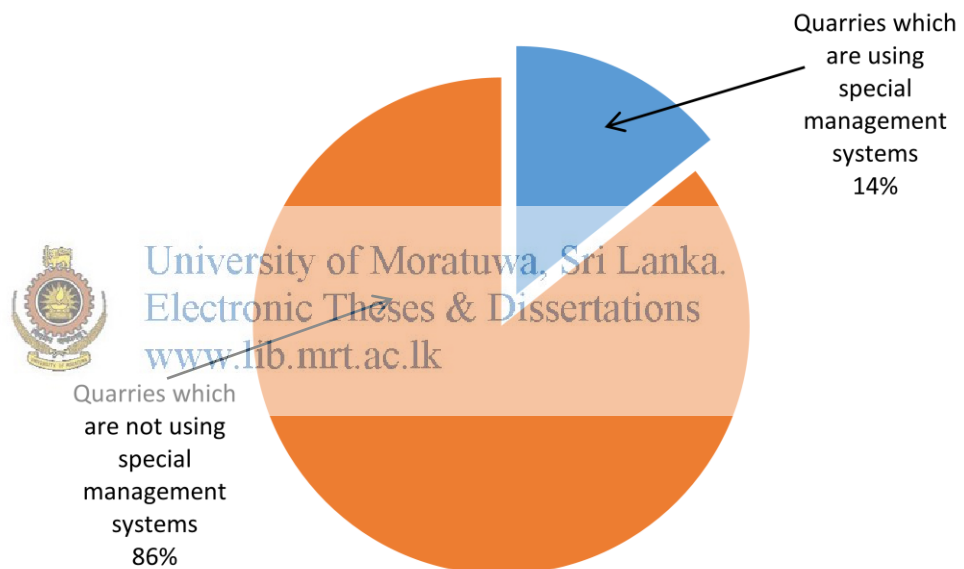


Figure5.1: Use of special management practices

When compared to the awareness of any quality management practice and the physical applications of the theories it showed a total different type of relationship. Even though the awareness of any quality management practice of the quarry managers was Seventy One percent, only Fourteen percent of places used quality management practices. Really this is a practical problem that can be seen in Sri Lankan quarry industry.

Managers should have a clear idea on how to apply theories into practice and they must have an attitude to use the quality practices to the process. It can be attributed to lack of commitment to implementing of quality management practices in the work place.

### 5.3 Operation Time

Time of quarry operations in Sri Lanka is restricted by the license authority which is Geological Survey and Mines Bureau (GSMB). The operation time is limited from 6:00 hrs. to 18:00 hrs. Blasting activities can be done only from 10:00hrs to 16:00 hrs. During the day. After 16:00hrs blasting is restricted by GSMB. These time conditions are imposed due to safety, environment and social reasons.

Large sounds and dust are emitted when quarry operations are carried out. If these operations are carried out at night it is disturbing the people who living the surrounding. Therefore it is very important to follow the time conditions given by the license authority.

Research shows that, seventy nine percent of quarry projects were adhere to strict time restriction imposed by GSMB but rest of the twenty one percent violated it.

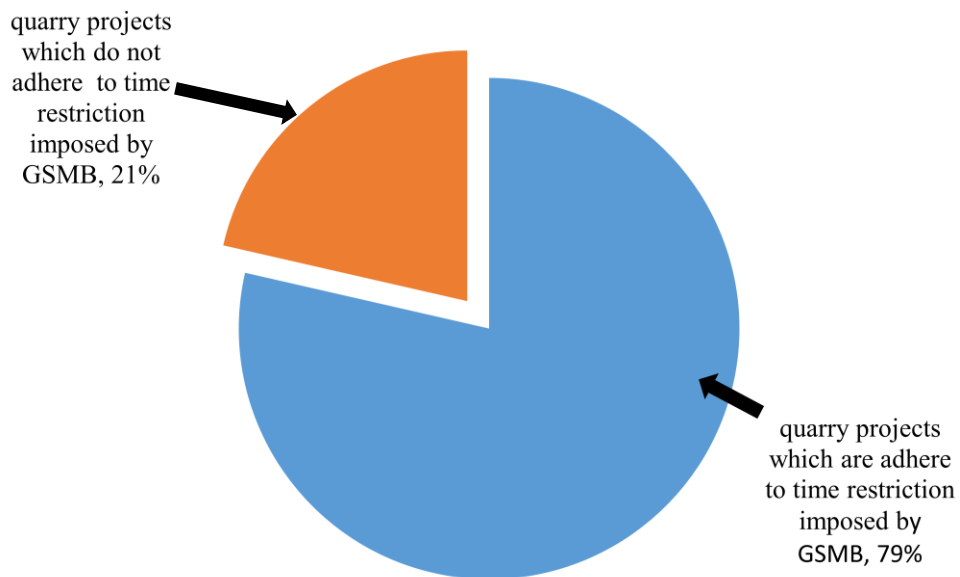


Figure 5.2: Project respond for time restriction imposed by the GSMB

It was found that Twenty One percent violated the GSMB approved time period which is a huge amount. Therefore, reasons for violation were checked and it was found that Sixty percent violators do the violation purposely to fulfill the monthly targets. From the violators, Twenty percent of quarries did not bother about the time regulations and other Twenty percent violate the regulations due to other reasons which are not applicable to day to day operations. Such reasons include an unexpected weather condition or breakdowns at the quarry (Figure 5.3). But Hundred percent of respondents were well aware of license conditions and they had enough workforce. It was also noted that no one reported that they violate the time regulation due to management pressure.

It was shown a contradiction because Sixty percent out of Twenty One percent of time restriction violators were said that, they have enough workforces for their operation. But they again say that they violate regulations to reach the monthly targets. The above data describes an unidentified management problem in resource allocations. If resources are allocated correctly, there is no need to violate the regulations.

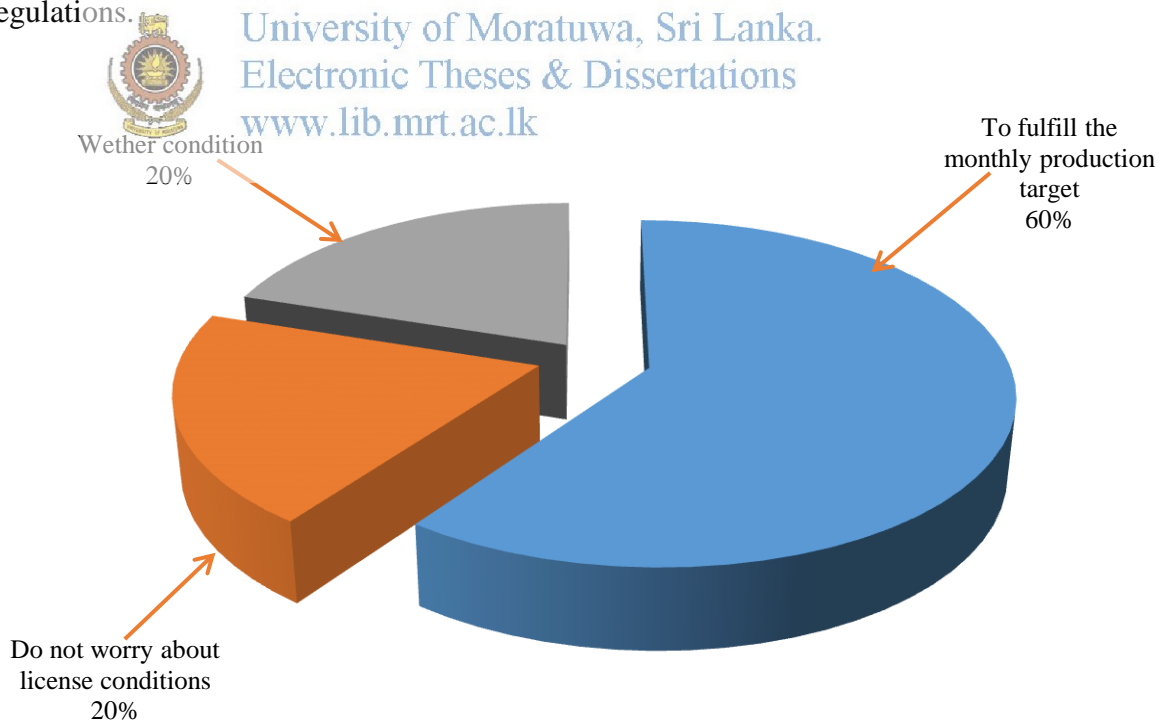


Figure 5.3: Reasons for time regulation violation

## 5.4 Communication

Communication between the workers and the middle management is a very important factor in mining industry. This communication help to improve work quality, safety, welfare of people and reduce the breakdown times, cost and time consumption of works. Toolbox meetings are the most widely used communication tool in the world mining industry to communicate for the day to day activities. It is held prior to the each and every shift as a discussion between workers and the operation management team. Management had given the work instructions to execute activities for the particular shift.

But the findings show that in the Kaluthara district a very poor communication between management and the workers. This was because, only Fourteen percent of quarry projects hold daily tool box meetings but the other Eighty Six percent did not practice it.

Above Fourteen percent of projects deliver messages directly to employees through the daily toolbox meetings and they believed it help to emphasize people on the safety of works, daily program, targets. It was found that, Eighty Two percent out of rest of Eighty Six percent passed their management messages to the workers mainly via special meetings other Eighteen percent used to pass the management messages and decisions personally.

Telling something personally is an informal practice and time wasting. It lead to differences of opinion on the same message and it is not transparent.

Maintaining a signboard is another good quality practice to convey messages to the employees further. But only Thirty Three percent of quarry project was maintain a signboard to display notices.

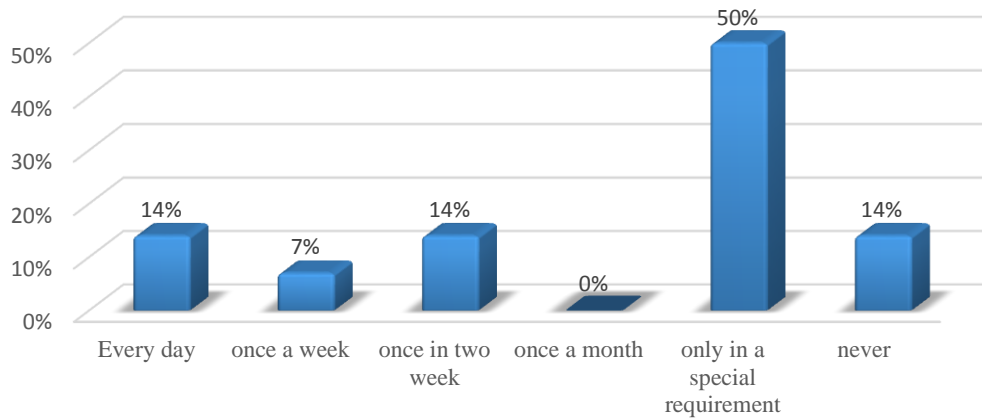


Figure 5.4: Periodical meeting arrangement

Figure 5.4 represent the periodical meeting arrangement of quarry projects at Kaluthara district for communication between middle management and the employees. According to that, Sixty four percent of quarries do not make face to face meeting with their employees even at least once a month. Fifty percent of them hold meetings only when there was a special requirement. It was found that, Fourteen percent out of total sample never held meeting and they used to tell the message to one by one. Only Twenty One percent of middle managers meet their employees face to face at least once a week. Rests of Seventy Nine percent of workers perform their works without guidance and project management updates. These figures indicate a huge communication gap between the management and the employees.

### 5.5 Resources Allocation

Resources allocation is a major and an important function in project management. Resources should be allocated according to the production requirement of the quarry project and it must be tally with the target and the budget.

Resources allocation of the quarry project at kaluthara district was checked and results are illustrated below.

Table 5.2: Test results for the resources allocation

Resources allocation questions asked	Yes percentage
Do you fulfill monthly target regularly?	71%
Do you have enough staff for your quarry operation?	93%
Do you have enough machinery for your quarry operations?	86%
Are you doing any assessment or calculation before resource allocation?	64%
Are there any standard procedures to allocate new resource to quarry?	21%

According to the results, Ninety Three percent out of the total sample equipped with human resource and the Eighty Six percent of projects were equipped with required machineries.

Further, seven present acknowledge that they lack human resources and fourteen present suffered due to lack of machinery. These projects would have financial problems and management decision making problems.

According to the given answers the Sixty four percent of mining engineers had done calculations according to the production forecast before requesting new resources but Seventy Nine percent of projects did not have any standard procedure to resource allocation. It had been done according to the financial strength of the company and the view of the top management. Engineer's calculations were not much supported to the final decision of the management. Some mining engineers said "we do not do calculation because management does only what they want to do". Therefore mining engineers had lot of grievances about resources allocation because of the absence of a standard resource allocation procedure.



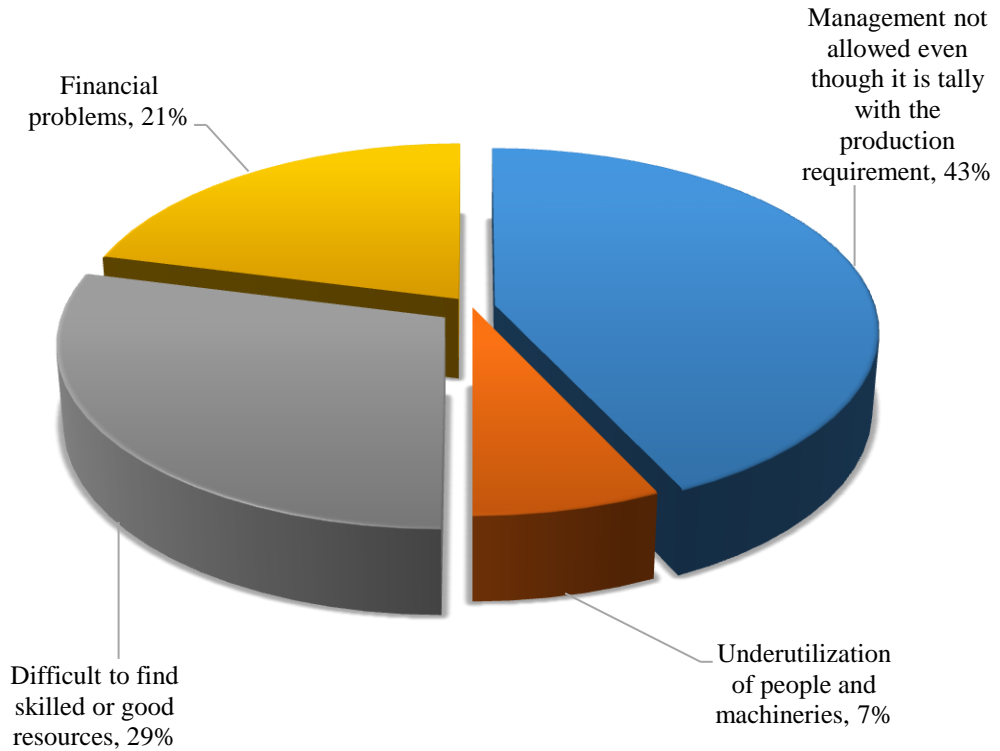


Figure 5.5: Problem involve with resource allocation

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According to the research, Twenty Nine percent of respondents said that, it was too difficult to find trained and skilled resources surround area of the quarries. This is a general problem that can be seen in Sri Lanka. Rather than finding skilled resources, train the current and unskilled resources can be easy. Therefore, it is better to arrange training programs for the employees.

### 5.6 Record Keeping

Record keeping is a very important character in project management and total quality practices. Record keeping of Kaluthara quarry projects was at a satisfactory level when compared to their operational practices.

Table 5.3: Test results for the record keeping

Test results and record keeping questions	Yes percentage
Do you keep personal record files of your workforce?	71%
Do you keep running chart of machineries and vehicles in your site?	100%
Do you keep maintenance record of machineries?	100%
Do you keep Drilling record in your files?	100%
Do you keep Blasting Records in your files?	100%
Do you calculate the drilling and blasting requirement according to the project requirement?	79%
Do you consider about the monthly production requirement when you ordering the explosives?	100%
Do you maintain monthly production records?	93%
Do you maintain a proper accident record book in your site?	50%

### 5.6.1 Machinery records

According to the above results, respondents are keen about the vehicle and machinery running records and maintenance record. It helps to predict the upcoming losses which would happen by machine breakdowns and the bad machine conditions. Recording of drilling and blasting is Hundred percent and mining engineers were fully concerned about this operation records.

### **5.6.2 Production records**

It was found that, Seven percent of quarry projects do not maintain monthly production records. Even though Seven percent is a small amount by a number, when one considers the importance of the monthly production records Seven percent forms a considerable amount. The production records are needed for financial position and the production output of the quarry and thus need to be in an inventory. If the producers do not know how much they produce and amount of the material at site it is a total breakdown of the supply chain. Anybody can misuse production for their private purposes when there are no production records. This is happening due to lack of management practices.

### **5.6.3 Drilling and blasting records**

Planning of drilling and blasting activity according to the project requirement is a very important part of quarrying, but Twenty One percent of quarry projects were not planning their drilling and blasting activities according to the project requirements. This type of negligence leads to over production or lesser production at the quarries. If there is an overproduction it waste time and money and if it is a lesser production it is wasting time of the project. Therefore this kind of professional negligence must be minimized.

### **5.6.4 Personal records**

Further it shows that the priority to be given to the personal record of employee was less in Kaluthara district quarry projects. Because Twenty Nine percent of quarry projects did not maintain employee personal files. Maintaining employee personal files are very important because all the details pertaining to a particular employee can be known in his or her personal file. Document relating to his or her promotion, demotion, inquiries, and warning must be maintained through the personal record files. This is a good practice in human resource management, but the important of the personal record was not identified well by the respondents.

### 5.6.5 Accident records

Accident record book is another very important record in quality management. Accident record book contain all the details of site accidents with the description of the incident that lead to the accident. Therefore it helps to minimize the similar kind of future accidents. But only Fifty percent of quarry projects maintained accident record book and the other Fifty percent of quarries did not do any recording. It is a problem which, without a proper accident records how they going to evaluate the site safety and awareness of the employee about site accidents would become a problem.

### 5.7 Safety

Safety is a huge subject which is applicable to every activity in the metal quarrying. Major activities and the requirements subjected to the safety of metal quarrying were investigated because safety is bond with the total quality management process and results are as follows.



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#### 5.7.1 Personal protective equipment (PPE)

When we talk about the safety, first thing come to our mind is Personal Protective Equipment (PPE). PPE provide the basic protection to individuals. Safety helmet, eye protectors, ear guards, dust masks, hand gloves, safety shoes, safety boots and the safety belts are PPEs which is required at the quarry operations. The company should provide PPEs for workers to make a safe environment. When TQM is applied the safety should be Hundred percent. But the survey results indicated major safety problems in the Kaluthara quarry projects.

Following chart describes the percentages of PPE provide to the employee by the employer.

Table 5.4: Percentages of PPE providing

Personal protective equipment (PPE)	Percentage provided
Safety helmet	86%
Safety boots	57%
Safety shoes	79%
Ear guards	64%
Dust Mask	79%
Eye protector	50%
Safety Belts	50%

According to the above results it is clear that quarry managers had given the priority to provide safety helmets, safety shoes and dust mask only. But the priority of the other required PPE are less when compared to the safety helmets. It was found that Fourteen percent of quarries did not supply even a safety helmet. Table 5.4 is a good picture to identify the lack of personal safety concern on the employee of the employer. Because, if TQM is to be applied to the quarry projects at least most important PPEs should be provided Hundred percent to the work force.



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The next step was finding whether the workers wear the provided PPEs regularly or not. It was found that sixty four present of quarry employees wear the PPEs regularly. However Thirty Six percent of them do not wear the provided PPEs. If the employee does not wear the provided PPEs, management should take action to make them do it because wearing PPE is a culture rather than a law. But the problem was management of above Thirty Six percent of quarries had not taken any action to the people to understand the important of the PPEs.

### 5.7.2 Safety awareness programs

Arranging safety awareness program with a participation of a good safety professional is a very good practice to keep employee vigilance about safety. According to the survey results Forty Three percent of quarries had conducted safety

awareness programs with the participation of a safety professional. Other Fifty Seven percent of quarries had not ever conducted a safety awareness program at site. Further it was checked the effectiveness of the conducting programs. Then it was found that only Fourteen percent of projects conducted for safety awareness program once a month but other Twenty Nine percent of quarries arrange safety awareness program only in a special requirement. Once a month is an effective period. But only in a special requirement mean it happens once in a blue moon. During this period lot of differences can happen at site staff and they work blindly without proper guidance for safety. Therefore it is clear only Fourteen percent of quarry projects conduct safety awareness programs effectively. Providing PPE and the wearing PPE is also at Hundred percent at this Fourteen percent of the quarries.

#### **5.7.2.1 Fire fighting**

Firefighting is another very important aspect in safety. Installing fire extinguisher at pre-identified areas is a requirement for safety. Only installing is not enough, people should train how to act at a fire and workers must be knowledgeable to use the fire extinguishers. But it is sad to find out that, Thirty Six percent of quarry project are running without having at least one fire extinguisher device. It was found that Seventy One percent quarry has never arranged a fire fighting program to educate their workers and they do not know how to act and what to do in a fire situation. Fire extinguishers are installed in Sixty four percent of quarries, but the most important thing is even though fire extinguishers are available at site people in Fifty Six percent of quarries does not know how to operate it because management has not arrange any firefighting program to train people for firefighting. Therefore it is very clear only Twenty Nine percent of quarries equipped with firefighting effectively.

### **5.8 Environment**

Metal quarry industry is always struggle with the natural environment. All mines disturb the natural environment. Therefore it is very important to organize quarry

operations minimizing the environment damages. Quarry projects should have a pre-planned environment rehabilitation plan. The disturbances to the environment by the quarry, there should be a method to minimize the damage and rehabilitate the surrounding. But according to the findings Fifty percent of quarry projects do have a proper pre-planned environment rehabilitation plan. These quarry projects do the rehabilitation parallel to the operation but other Fifty percent of quarries do not have that kind of proper rehabilitation practice.

Soil erosion is the worst problem in metal quarry operation. Preparation of sedimentation tanks, silt trap grounding, Tufting, Planting, drainage networking are the action to be taken to minimize the soil erosion. It was found that Fourteen percent of quarries at Kaluthara district have not taken any action to prevent the environment by soil erosion. Even though the other Eighty Six percent of quarries has taken the actions to minimize the soil erosion, all of them believe that the actions they have taken are not enough to control the hazards. Management says that “They should consider more about the production rather than environment planning.”

The overall mean of the survey answer is Kaluthara metal quarry conductors are not conducting the metal quarries in an environmental friendly manner.



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## 5.9 Material Quality

Material quality is a very important matter in TQM. In the metal quarry industry material quality directly talk about the rock features. There are some common test like Aggregate Impact Value (AIV), Los Angeles Abrasion Value (LAAB), Sieve Analysis, Tri-Axial test are used to evaluate the material quality. Use of quality material leads the quality of the end product.

At the survey, Seventy Nine percent of quarry projects claim that they are conducting material testing to evaluate the material quality. But, further investigation shows that the material testing procedure did not operate effectively. There was no quarry, which conducts testing at least once a week. Testing was conducted only as a special

requirement and that amount was Sixty five percent According to this results. It is very clear that, Kaluthara quarry projects do not consider about the material quality.

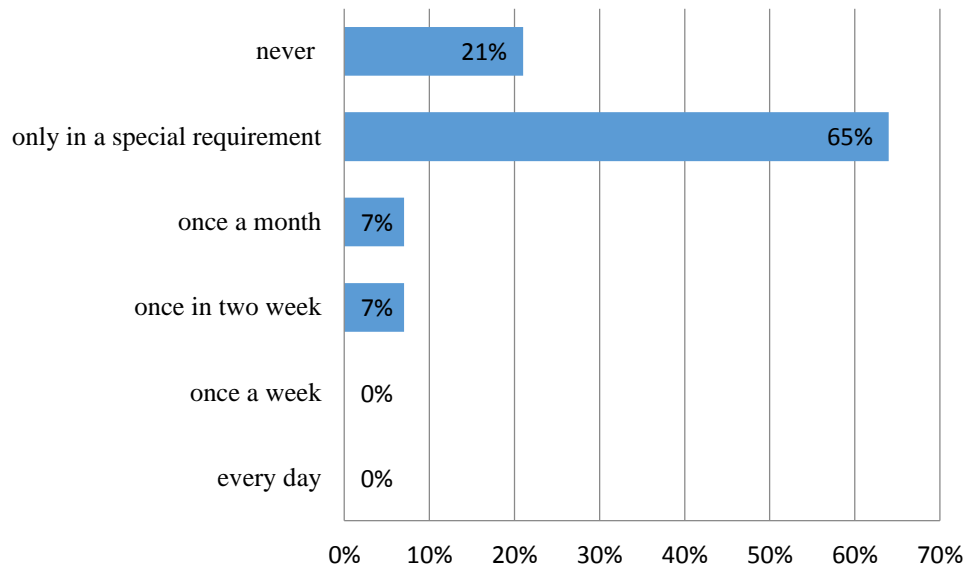


Figure 5.6: Periodical material testing analysis

Without a continuous assessment it can never assure about the material quality of the product. This result clearly indicates that nobody bothers about the quality of their material and they conduct testing for special cases only. Therefore it is totally out of the TQM philosophy.

It is very important to maintain a file which contains material testing results. Then the managers can confidently talk about their product while delivering the testing results. According to the above condition there is no proof to the managers about their product quality. Even though Sixty four percent of respondents say that they are “maintaining a material quality record file”, the figure 5.6 shows that the period between two tests, it takes more than one week. Therefore these records are useless. This can be seen as a lack of attitude of the managers on material quality.



## 5.10 Breakdowns and Repair

Down time minimizing is another very important practice in TQM. It is very important to have a backup mechanical team and equipment at site to act quickly against the machine breakdowns to minimize the down times.

Site work shop is a common item in quarry projects at Kaluthara district because Seventy One percent of quarries do have a site workshop and other Twenty Nine percent of quarries do not maintain a site workshop because their site situated within 70km radius from their company workshop and if there's a breakdown, they directly call to workshop for repair and wait until repairing team come from workshop even though it is a very small running repair. As a total Sixty four percent of quarries at Kaluthara district have both company main workshop and site workshop for machine repairs.

Company main workshop repairs problems which cannot be fixed at the run time. Site workshop is needed to fix the machine problems which occur at run time. To fix runtime errors, site workshop is needed to be equipped with required tools and knowledgeable workforce. It was found that a contradiction of site workshop arrangement because Thirty percent of quarries which have site workshops did not have enough tools for running repairs and Sixty percent of quarries did not have enough technical workforces for the particular job. Other problem was; Forty Three percent of quarries which have tools for repair suffering without enough technical workforces. For an effective outcome both tools and workforce must be there to attend at the same time. Otherwise it is a waste of time and money. Management must address this problem immediately without idling people and machineries.

When quarry site does not have technicians it should be hired for outside or has to wait until the arrival of their own company technical team from the main workshop. Managers of Ninety Three percent of quarries said that always they have to wait more than a day until the arrival of the technical team even for a small repair.

Other main problem is the stock failures of the items which need for running repairs. All quarries (Hundred percent) suffer with this problem but nobody act to keep machine parts at their stocks because they think it as an unnecessary cost. It is very important to recognize the commonly wearing parts and keep those parts in stock. Then it can be replaced as soon as a breakdown takes place to minimize the downtime. But this practice is not applied in Kaluthara quarries. They used to order spare parts at the breakdown point itself and thus wait keeping the machine and human resources idling. Figure: 06 shows the maximum period of wait time until purchasing of machine parts.

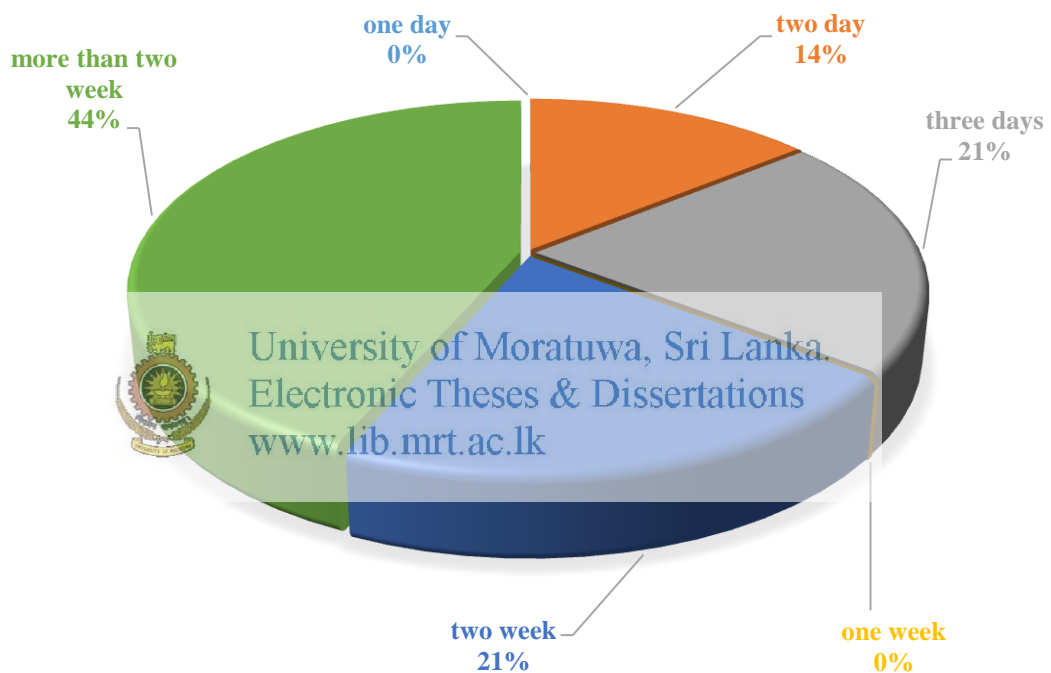


Figure 5.7: Maximum period of wait for machine parts

Figure 5.7 clearly represent that Eighty Six percent of quarries have wait for machine parts for more than three days. After purchasing it should be repaired and it also takes at least one day to complete repair and testing. Altogether it is at least four or five days. During this period company pays the idling labor and also for the machineries. This can be minimized by implementing proper system to pre-identify the upcoming breakdowns and implementing proper procurement system at the quarries.

### **5.11 Summery**

This chapter analyzes total operational process of development, exploitation and reclamation phases in the metal quarrying related to TQM. According to the TQM final outcome should be a satisfied customer. As an example: following the time restrictions imposed by the GSMB will indirectly affect to the customer satisfaction. GSMB has the authority to suspend the mining license if the license holder violates the license conditions. If license suspended or cancelled by the authority, license holder will not be able to do the mining operation further and he will fail to supply the customer demand. Then customer would be naturally dissatisfied.

Another example is: If a person died due to safety violation, quarry operations could be delayed until settle the reasons that lead to the accident identified and addressed. This delay can make a bad impress on customers about on time delivery.

Therefore all above areas can be identified as the areas which directly and indirectly deal with TQM in the metal quarry industry. Recommendations to minimize the problems identified in this chapter are discussed under chapter six.



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## CHAPTER 06

### RECOMMENDATIONS AND CONCLUSION

#### 6.1 Introduction

This chapter concluded the analytical findings and provides TQM solutions to overcome the problems thus comprised of four objectives. First objective was identifying the TQM principles which can be used in development, exploitation and reclamation phases in metal mining industry. It was fulfilled in the chapters three and four.

Second objective was to Identifying the knowledge level and attitude on quality management practices of the Mining Engineers in metal quarry industry in Sri Lanka and the third objective of Identifying the current quality management practices used and TQM applications and methods which can be used to overcome the management difficulties in metal quarry industry was achieved at the data analysis in chapter five.

Chapter six addresses the final objective of making recommendation to come out with the solutions to the problems identified by using TQM principles.



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#### 6.2 Recommendations for problems identified by using the TQM approach

Details of the data analysis, findings, TQM solutions and recommendations to overcome the quality management problems in metal quarries at Kaluthara district are addressed under the following headings.

##### 6.2.1 Knowledge attitude

Research data indicate a huge knowledge gap at the top personals in Kaluthara metal quarry industry. It was found that Fifty Seven percent of them are not aware of TQM and Twenty Nine percent of mining Engineers are not aware of any quality management practice.

If management does not know about TQM, they are not in a position to implement TQM at site. They will not be able to teach TQM to the followers. Knowledge is the base of everything. It is clear that, why the management lacks in the application of TQM.

This problem can be overcome by teaching TQM to the management as well as to the bottom level workers of the site. Training sessions, Seminars, videos, are the best way to educate people on TQM. Companies should understand the importance of knowledge because knowledge is an asset. Providing knowledge to employee is not an additional cost. Therefore, conducting of TQM training programs to the management is proposed.

Research findings clearly indicate that, lack of attitude on implementing quality management practices. According to the analysis, Eighty Six percent of quarries do not conduct quality management practice even though they are educated about quality practices.

This problem can be minimized via leadership training programs, team working skill development programs, out bound training programs and positive thinking seminars since this kind of programs help to drive employee empowerment.



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TQM principles used for above mentioned solutions are Total employee involvement, continuous training, team working and empowerment.

### **6.2.2 Resource allocation**

Resources allocation failure was found during the investigation. The quarry managers say that they are violating time conditions which are given under mining license to achieve the monthly targets. But they say they have enough resources to work with. Here it is clear, management does not have a clear resources planning program to meet their demand.

The problem should be identified first. Problem is they are violating the time period given in the license. Then management should find that, why it is happening. It happens to full fill the monthly target. To solve that, Managers should identify the

project demand during different periods. The working time cannot be extended since it is restricted by law. Therefore resources should be allocated to satisfy the demand within the period.

Following the local government rules and regulation is an important part in TQM. Time regulation violation could be suspending or cancelling the mining license. If the mining license is suspended or cancelled by the license authority total process could collapse as well as loose the customer due to dis-satisfaction and non-continuous supply. Therefore, managers should do the resources allocation correctly.

Managers highlighted that, finding trained and skilled human resources is very difficult in the surrounding areas. This is a general problem in Sri Lankan contest. Therefore it is proposed that training programs to train existing human resources and new comers rather than concentrating to find trained resources.

According to the research findings some quarries does not have enough tools for repairs. Some quarries do not have enough technical workforce for repairs. Some quarries have enough tools for repair but they don't have enough technical workforce. Some quarries do have enough technical work force but without adequate tools. This is due to bad planning. According to the TQM, tools and work force must tally with the requirement for an effective outcome. Therefore project managers should identify the machine and the human resources and tally these two together.

TQM principles used for the solutions are top management commitment and support, continuous training and culture change.

### **6.2.3 Communication**

Analysis indicates a huge communication gap between the management and the work force. Managers and workers do not meet face to face with each other to share their ideas regularly. Distance between management and the employees are high and this problem should be addressed.

TQM solutions to minimize the communication gap are given below. Total employee involvement, team working, top management commitment and support and culture change are proposed as the solutions.

#### **6.2.3.1 Toolbox meeting**

A daily toolbox meeting is a very important practice to minimize the communication gap between these two parties. Day to day operations, safety arrangements, welfare and the all other important discussions can be done at the daily toolbox meetings. It is a good platform for two way communication from top to bottom and bottom to top. Therefore daily toolbox meetings are proposed for the metal quarry projects at Kaluthara district to improve communication.

#### **6.2.3.2 Sign boards**

Even though the sign boards are effective in communication it is poorly used by the quarry projects. Therefore sign boards and the notice board technique must be improved and promoted for effective communication. Reading the notice board displays by workers must be made a common practice.

Passing messages via rumors is a bad habit and it must be stopped because, it is not recommend in TQM. It is very important to held special meetings at least once a month to discuss about the next month program, current achievements, safety arrangement, management changes to maintain the working spirit. Participation for the meeting is very important and management should be keen on it and they should use tactics to make participate employees in the meetings.

#### **6.2.4 Safety and professional negligence**

TQM solutions for the management problems embossed under safety and professional negligence are based on the TQM principles of total employee

involvement, continuous training, top management commitment and support, democratic management style and culture change.

#### **6.2.4.1 PPE culture**

Lot of safety and professional negligence evidence was found at Kaluthara quarry projects. Companies should provide correct PPE to their employees. But, it is clear that only Fourteen percent of quarry projects are provided with Hundred percent of required PPEs to their employees. Rest of quarries provides only few items and some do not provide. Providing a safe environment to work is a responsibility of the manager. But managers have neglected the first rule of site safety. Therefore it is proposed to provide all required PPEs to the workers to minimize the future accidents. Further it was found that, even though PPEs provided employees reluctant to wear it. Managers should promote the culture to wear PPE at work place.

#### **6.2.4.2 Firefighting programs**



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It was found the lack of knowledge in firefighting. It is proposed to conduct firefighting programs as well as the safety programs with a participation of safety professionals to train employees. Firefighting equipment's must be placed at the pre-identified accessible areas and signboards should be displayed. Even though fire extinguishers are available at site if people don't know how to operate it, it is useless. Therefore training is very critical.

#### **6.2.4.3 Accident record book**

It was found that Fifty percent of quarry projects did not maintain an accident record book. This is not just a book. This is a log book. Reason for the accident, nature of the accident, damage from the accident, precaution to overcome similar accidents and all other details are included in accident record book and it help to minimize the



future accidents. Therefore, maintaining an accident book is proposed to the all quarry projects at Kaluthara district.

#### **6.2.4.4 Inventory maintenance**

Planning and scheduling problems can be seen in metal quarry projects at Kaluthara district. Management should pay their attention on stock management too. Inventory maintenance is directly linked with the cash flow. Research study indicate Seven percent of projects do not know their monthly production and sales amount. This is a critical professional negligence and this issue is directly compromising the financial stability of the project. Therefore managers must have short term as well as the long term plans for the project success.

### **6.3 Recommendations**

According to the research findings it is pretty clear that, metal quarry projects at Kaluthara district were not using TQM directly or indirectly. Main problem was the lack of knowledge on TQM and the attitude on implementing quality practices. To implement something, implementer should be well aware of it. But the problem is the lack of knowledge on TQM among mining Engineers.

By implementing the proposals which were discussed under chapter six, it will be able to enhance the attitude towards TQM by the quarry project managers. The findings and recommendations which were based on Kaluthara district; can be generalized and applied in the other mining district too in Sri Lanka.

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**INTERVIEW GUIDELINE OF TOTAL QUALITY MANAGEMENT IN  
QUARRY INDUSTRY**

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**Instruction**

- Please answer to all the questions given below under Part-1, Part-2, Part-3 which is not optional.
- The answers you given are fully confidential and will not represent single ID
- The answers you given are fully confidential and will not present to a third-party

**PART 1**

Name of the Organization/Project (Optional):  
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Name of the Respondent (Optional):  
.....

Designation of the Respondent:  
.....

Years of Experience:  
.....

**PART 2**

**GENERAL INFORMATION**

**2.1. Please give general information of the site based on the guide given below.**

- a) Date of Commencement .....
- b) Location of the site (Village, Grama Niladari Division, Pradeshiya Shaba and District)

.....  
 c) Objective of the project

.....  
 d) Production categories of the quarry

.....  
 e) Total number of employees at the quarry

**2.2. Please give brief introduction of the Exploitation / Quarrying stage based on the guide given below.**

a) License category of the quarry

1.) IML-A       2.) IML-B       3.) IML-C

b) Total area of the land .....hectare

c) Permitted area for the quarrying activities by hectare

1.) 01 Hec     2.) 02 Hec     3.) Less than one   
 2.) 4.) More than Two

d) Total estimated rock volume of this permitted area.....

e) Applied mining method.....

f) Permitted blasting parameters Spacing     Burden

g) Number of employees.....

h) Permitted quantity, present demand and supply of each category.

Production category	Present Demand	Currently achieving Qty (Present Supply)

**PART 3**

**3.0 IDENTIFICATION OF KNOWLEDGE OF THE MANAGEMENT PRACTICES WHICH ARE COMMONLY USED**

3.1. What is the general management practices you aware of?

- a) Total Quality Management
- b) Lean Management
- c) Five- "S" system
- d) Just In Time ( JIT )
- e) Six Sigma
- f) Other (Mention what it is).....
- g) Nothing

3.2. Do you use any special management practice in your quarry?

Yes / NO

"If yes answer to question 3.3"

3.3. What is the management practices currently use in your site?

- a) Total Quality Management
- b) Lean Management
- c) Five- "S" system
- d) Just In Time ( JIT )
- e) Six Sigma
- f) Other (Mention what it is).....
- g) Nothing

3.4.. Knowlegdge level of respondent

	1	2	3	4	5
Total Quality Management					
Lean Management					
Five -" S" System					
Just in Time					
Six-Sigma					

Rating system

Knowledge level	Given weight	Demonstration of the knowledge level
Excellent	5	<ul style="list-style-type: none"> <li>• Management practice can be explained.</li> <li>• Particular system can be demonstrated to the other.</li> <li>• It can implement to the site alone.</li> <li>• Can be performed while motivating others.</li> <li>• Result oriented.</li> </ul>
Very good	4	<ul style="list-style-type: none"> <li>• Management practice can be explained</li> <li>• Particular system can be demonstrate to the other</li> <li>• It can implement to the site with the help of another professional.</li> <li>• Can be performed.</li> </ul>
Good	3	<ul style="list-style-type: none"> <li>• Management practice can be explained.</li> <li>• Particular system can be demonstrated to the other.</li> <li>• Not confident to implement it to the site along.</li> </ul>
Medium	2	<ul style="list-style-type: none"> <li>• Management practice can be explained</li> </ul>
Bad	1	<ul style="list-style-type: none"> <li>• Not confident for the above</li> </ul>

**4.0 TIME MANAGEMENT**

4.1. What is the approved time give by license authority to operate your quarry?  
 .....

4.2. What is the approved time period given by license authority to conduct blasting activities in your quarry?.....



4.3. What is the actual time your quarry operations generally started?  
 .....

4.4. What is the actual time period blasting activity carry on?  
 .....

4.5. Do your site adhere to strict time condition given by GSMB ? Yes / No

If "NOT"

4.5.1 Why you do so?

- a) To fulfill the monthly production target
- b) Given workforce is not enough to fill the target within given period?
- c) Management force you to do so
- d) You are not aware of license condition
- e) You do not worry about license conditions
- f) Any other .....

**5.0 HUMAN AND MACHINE RESOURCES MANAGEMENT**

5.1. Do you conduct toolbox meeting in your site, YES/NO

5.1.1. If "YES", how often you conduct tool box meetings?

- a. Every day
- b. once a week
- c. once in two week
- d. once a month
- e. only in a special requirement

5.1.2. What are the things you discuss at toolbox meetings?

- a. Day to day operations
- b. Safety
- c. Breakdowns
- d. welfare

5.2. What are the communication techniques you use to pass the management decisions to workers?

- a. Special meetings
- b. general toolbox meeting
- c. Signboard notices
- d. tell it to one by one
- f. any other method .....

5.3. Do you fulfill monthly production targets regularly? YES / NO

5.4. Do you have enough staff for your quarry operation? YES / NOT

5.5. Do you have enough machinery for your quarry operations? YES/ NO

5.6. Who do the resource allocation for the quarry operation?

- a. Owner  b. Manager  c. Mining Engineer   
d. Supervisor/Forman  e. Other.....

5.7. Are you doing any assessment or calculation before resource allocation?  
YES/NO

5.8. Are there any standard procedure to allocate new resource to quarry? YES/NO

5.8.1. What are they?  
.....

5.9. What are the difficulties face when you request resources for quarry?

- a. Management not allowed even though it is tally with the production requirement   
b. Underutilization of people and machineries   
c. Difficult to find skilled or good resources   
d. Any other .....

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6.0 RECORDS AND MAINTENANCE HANDLING  
6.1. Do you keep personal record files of your workers? YES / NO

6.2. Do you keep running chart of machineries and vehicles in your site? YES / NO

6.3. Do you keep maintenance record of machineries? YES / NO

6.4. Do you keep Drilling record in your files? YES / NO

6.5. Do you keep Blasting Records in your files? YES / No

6.6. Do you calculate the drilling and blasting requirement according to the project requirement? YES/NO

6.7. Do you consider about the monthly production requirement when you ordering the explosives? YES / NO

6.8. Do you maintain monthly production records? YES / NO

6.9. Do you maintain a proper accident record book in your site? YES / NO

## 7.0 ENVIRONMENT AND SAFETY CONCERNS

7.1. What are the safety equipment's you have provided to your quarry workers?

- a. Safety helmets  b. Safety boots  c. Safety shoes   
d. ear guards  e. Dust Mask  f. eye protector   
g. Safety Belts

7.2. Are workers wear the provided PPEs regularly? YES/NO

7.2.1. If "NOT", Do you have any standard methods or rule to direct workers to follow wearing PPEs? YES / NO

7.2.1.1. If "YES" what are they?  
.....

7.3. Do you have ever conduct any safety awareness program in your quarry site with a participation of a safety professional? YES / NO

7.4. How often you conduct awareness program in your quarry?

- a. Every day  b. once a week  c. once in two week   
d. once a month  e. only in a special requirement

7.5. Have you installed fire extinguishers in your site? YES / NO

7.6. Have you ever arrange firefighting training program in your site? YES / NO

7.7. What are the precautions taken to minimize the soil erosion?

- a. Sedimentation tanks  b. Silt trap  c. Drainage network   
d. Planting  e. Other .....

7.8. Do you believe that, the precautions you have taken are enough? YES / NO

7.8.1. If "NOT" tell why is that?.....

7.9. Do you have a pre-planned proper environment rehabilitation plan in your site? YES/NO

7.10. Do you conduct rehabilitation parallel to the quarry operations? YES/NO

7.11. Do you maintain a proper drainage system to flow down the rain water? YES/NO

## 8.0 MATERIAL QUALITY MANAGEMENT

8.1. Do you maintain quality standard of your end product? YES / NO

8.2. Do you conduct material testing to maintain product quality? YES / NO

8.2.1 If “ YES” What are the testing you conduct?

- a. LAAV       b. AIV       c. Tri axial test   
d. Sieve analysis       e. Other .....

8.3. How often you conduct material testing?

- a. Every day       b. once a week   
c. once in two week       d. once a month   
e. only in a special requirement       e. never do

8.4. Do you maintain a material testing record file in your site? YES / NO

8.5. What will you do to the removing top soil layer?

- a. Use for site road preparation       b. it is piling in a separate place   
c. some amount add with quarry product       d. use for rehabilitation   
e. out sales       f. Pile close to the drilling surface   
g. any other

8.6. Are there any Scrap production in your site? YES / NO

8.7. What are the actions taken to remove the scrap product from the site?

- a. mix with end product      b. Do not use for any thing  
c. do out sales      d. Other.....

## 9.0 BREAKDOWN AND REPAIRING MANAGEMENT

9.1. Do your company have a main workshop? YES / NO

9.2. Do your company have a site workshop in your site? YES/ NO

If “YES”

9.2.1. Do you have enough tools for running repairs? YES/ NO

9.2.2. Do you have enough technical work forces for repairs? YES/ NO

If “NOT”

9.2.3. What will you do when a breakdown took place?

a. Weight for mechanical team come from main workshop

b. Hire a mechanic from outside temporally

9.3. What is the general procurement practice when a break down took place?

a. Keeping general all running spare parts in your stock

b. Buying required parts only at the break downs.

c. Keep some and buy some

9.4. Have you ever face for an operation delay due to stocks failure? YES/ NO

If "YES"

9.4.1. How often you face for this matter?

a. always  b. Sometimes  c. rarely

9.5. What is the maximum period you have wait for parts?

a. one day  b. two day  c. Three days

d. one week  e. two week

f. more than two week



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9.6. What is the maximum period you have wait for the arrival of main workshop mechanical team/hired person from outside?

a. one day  b. two day  c. Three days

d. one week  e. two week

f. more than two week