The causes and effects of project delays in the coal mining industry in South Africa

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Research Report submitted by

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Abstract

This research is addressing the causes and effects of project delays in the coal mining industry in South Africa. A literature review was conducted and it was found that the causes of delays are extensively researched in the construction industry with only limited reference to delays in the mining industry which are mainly risk based. The effects of delays are predominantly listed as timing and cost effects. The research tool used to obtain sample data was a questionnaire which was mailed to perspective respondents. The questions were close- ended and subdivided into relevant areas which covered biographical details, causes of delays and the effects of delays. The study found that the causes found in the mining industry are similar to those found in the construction industry. Similarly the effects of delays were found to mainly be cost and time related. These causes and effect are listed and ranked based on their frequency of occurrence. The study concluded with recommendations on the need to measure delays as well as the prevention of the reoccurrence in other coal mining projects which should reduce the negative effects. Recommendations on potential future research were also made.

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Abbreviations

BECSA	BHP Billiton Energy Coal South Africa
UMIACS	University of Maryland Institute for Advanced Computer Studies
SACMA	South African Collieries Managers Association
SAMREC	South African Mining Mineral Resource Committee
DMR	Department of Mineral Resources

Chapter 1: Orientation

1.1 Introduction

The following research aims to establish whether delays are experienced in the coal mining industry in South Africa. Coal mining projects are based on the establishment of infrastructure that supports mining and the workings that are developed as the ground is moved. Globally the research into the causes of project delays is focused on the construction industry. The effects of delays are only linked in some cases of research. The literature available from the construction industry is relevant to mining as the process of planning and execution of a project in mining is basically the same as any construction process. Further a mine project inevitably contains an element of construction. This may include a processing plant, offices, workshops, stores, training facilities, an explosives magazine, fuel bays, wash bays and medical facilities. Usually the mining of a reserve will commence prior to the completion of the processing plant (Bissiri and Dunbar, 2001). The general idea is to ensure that the mineral is available to run through the plant when commissioning takes place.

As concluded by Williams (2003), the delays can be as a result of the contractor or the client or both, which can result in claims. Literature prior to 2000 focused on the delays from a single perspective. Post 2000 researchers started to determine the causes of delay based on the view of the owner, contractor and consultant. The list of delays has become comprehensive in the construction industry.

Sweis, Sweis, Hammad and Shboul (2008) used the terminology of the Drewin's Open Conversion System (DOCS) to classify the causes of delay into three major categories; input factors, internal environment and exogenous factors. They concluded that in the major causes of delays related to the input factors category, mainly related to labor and the internal environment which was related to the contractor. The exogenous factors had a minor impact to the delays of the projects.

Alwi and Hampson (2003) showed that the ranking of delays, in Indonesia, plays an important part in the effect of certain delays on a type of construction. By ranking delays in projects the major causes can be determined and if their effect is significant the project managers can ensure that these are a priority to mitigate. Subsequently other authors have ranked delays in this manner.

Delays can be classified according into critical and noncritical, excusable and non-excusable, compensable or non-compensable, and concurrent and non- concurrent (Kao and Yang, 2009).This classification assists in the resolution of disputes where projects have experienced delays. The cost impact and the time overruns are important to quantify as there should be a difference depending on whether the delays are in the critical path or not. If the delay is experienced on a critical task the result will be a time delay (Trauner, 2009).

The research on the effects of delays is usually combined with that of the delays themselves. Rarely are potential effects listed and discussed. The majority of authors conclude that the effects of delays are the increased timing of project delivery and the negative cost associated with delays. Once a project has commenced tracking the progress of the project through Key Performance Indicators (KPIs) used in reports to stakeholders ensure that the project team can react to changes and minimize delays (Noort and Adams, 2006). By investigating some of the detailed analysis done in the construction industry the specifics of the causes of delays and effects thereof are portrayed which can assist in determining and even linking some of these issues in the coal mining industry.

In Africa the focus on delays in research has been modest. Mining projects research has usually focused on the risks associated with these projects and not on the specific delays caused by factors during the projects. Literature on delays in mining projects have been incorporated in articles based on broader mining projects and this study will attempt to focus on the particular delays faced by project managers in the coal mining industry in South Africa as well as the effects these delays can have on the related project.

1.2 Definitions

1.2.1 *Project management*

A project is defined (Gido and Clements, 1999: 2) as:

"….an endeavor to accomplish a specific objective through a unique set of inter-related tasks and the effective utilization of resources."

These tasks need to take place in a ordered sequence to ensure that the final product is achieved with the resources allocated to the specific project.

1.2.2 *Project delays*

Strumpf (2000: 32) defined delay as:

"……. an act or event that extends the time required to perform tasks under a contract."

Therefore the delay caused in a project is a negative factor in achieving the project deliverables.

1.2.3 *Greenfield and Brownfield mining projects*

The Oxford Dictionary, (2005) provides definitions of a Greenfield and a Brownfield. Based on these definitions a Greenfield mining project is the development of mining into an area in which no mining infrastructure exists. The Brownfield mining project is the development of mining infrastructure in an area which the expansion of current mining and its related infrastructure will take place.

1.3 Problem Statement

Coal fields in South Africa are concentrated in the northern areas, which include the North Free State province, North Eastern Cape province, North Kwazulu Natal province, North Limpopo province and a major portion of the Mpumalanga province as shown in Annexure 3. Most of the economically active mines are in the Mpumalanga province. Establishing a mine or extending the operational capabilities requires that a strict project management process be followed. The issues that arise from this process are related to the inability of the project managers to execute the project management plan. The process of exploiting coal is directed by some form of project management.

As for any project, a mining project needs to follow a structured approach to ensure that the project ends in a success. The project life cycle, as shown in Annexure D, has four basic phases which are; identify the need, develop a proposed solution, perform the project and terminate the project. The effort required in each phase increases to a peak and then tapers off as the project is completed (Gido and Clement, 1999). This effort, however, does not govern success as the first phase needs to be completed in full and successfully to enable the project team and organizations management to decide if they can move forward with the project's purpose. The literature does not give an indication of whether there are delays in projects in the coal mining industry in South Africa or for that matter in which phase of the project life cycle the majority of these delays take place.

On planning to mine a mineral resource, in this case coal, some fundamental questions need to be answered with regard to the coal i.e. the coal quantity and quality and the depth of the coal seams. The determination of reserve information is acknowledged as part of the project process and that delays can be caused through poor information or running too many iterations as determined by Noort and Adams (2006). The type of delays that may be caused in the South African coal mining industry if the reserve information is flawed needs to be determined. The effects of these delays on a project in the industry should give an indication of the severity of these delays. It may be that these delays could cause project failure as proper prior planning was inadequate (Noort and Adams, 2006).

The construction industry has been exhaustively studied in the area of delays in projects internationally. A list of possible delays has evolved over the past 10 years that covers all major delays in this industry. The most extensive list is that of Yang, Yang and Kao (2009) which listed eighty possible delays. In the coal mining industry a new mine project (Greenfield project) or an expansion project (Brownfield Project) may have several of these listed delays. This may be partially due to the construction portion that is experienced in all mining projects and the generic type of delays listed such as “delays in site preparation”. It will be important to test this list of delays with role players in the South African coal mining industry so that the relevance between the two industries can be tested. The trend in investigating the delays in the construction industry has been to obtain the view of the project owner or sponsor, the consultants and the contractors. It would be relevant to determine which contractors and consultants are used in the South African coal mining industry projects and what their experiences are in delays at various points in the project life cycle. The delays analyzed in construction projects in Africa are limited. From the literature available the authors have referenced articles from construction delay research. From these articles it can be argued that there are strong indications to suggest that a similar situation applies across the African continent.

The delay analysis in South Africa seems to be written as part of literature related to other subjects in project management e.g. project maturity. The fact that delays take place is mentioned, but no full analysis has been done on delays specifically not in coal mining. South Africa has pertinent issues that can affect any project particularly when it comes to labor related issues.

The effects of delays on projects have not enjoyed much attention in previous research as stated by Sambasivan and Soon (2006). The authors conclude that the delays effect completion time and cost mostly. In the South African coal mining industry it may be relevant to delve deeper into the effects in terms of the costs and time delays. How the effects are currently mitigated in the industry? Is it effective? There are methods of analyzing the effects of delays on projects such as the critical path method as researched by Trauner (2009) which assists to determine the effect of delays on the schedule, which in turn will assist in determining if the claimant of a delay has a case or not. A model has been constructed by Bissiri and Dunbar (2001) to determine the effect of delays on the NPV of a mining project. Effects that are related to coal mining may include the delivery of coal to the export or local market, the employment of local labour that can create frustration for the local communities and the inability to start the exploitation of the mineral due to pending government authorizations. These are some of the issues that could be facing the South African coal mining industry.

Talent management is identified Toor and Ogunlana (2008) as an area of concern for industries in developing countries due to the growth of industries such as construction. The issue is that the market gets drained of skilled personnel and cannot feed the industry with qualified personnel quickly enough to support the growth. How does the coal mining industry in South Africa ensure that they retain talent and assist in grooming talent for the future?

Another area that can be investigated is that of mine closure, which is considered a crucial activity for a mining group as suggested by Ray (2009). As mines are expanded there are areas that are shut down due to the completion of mining activities. These areas are closed and rehabilitated in a structured project management manner. The delays in this type of mining project can result in community frustrations as well as frustrations from government and have a cost implication on the mining organization that could be, not only short term, but long term as well.

The purpose of this study is therefore to identify the factors causing delays in projects in the coal mining industry in South Africa and determining what the specific effects will be caused by such delays.

The following research questions are to be addressed:

a) What are the delays that are experienced in a coal mining project in South Africa?
b) What are the effects of delays on coal mining projects in South Africa?

The following research sub- questions are to be addressed:

a) Are delays experienced in coal mining projects in South Africa?

    a. How are these delays measured?

b) In what areas or phases of the project process are delays experienced?

c) What are the delays that are experienced?

d) Are the delays experienced similar to the construction industry?

e) What are the delays that are common to coal mining in South Africa?

f) Are consultants and contractors used in coal mining projects in South Africa?

g) What are the effects of delays in the various areas or phases of the project process?

    a. How are these effects determined?

1.4 Objectives of research

The objectives of the study are:

a) To determine what delays are encountered in projects in the South African Coal Mining Industry (SACMI).

b) To determine if delays are encountered at all phases of the project life cycle or whether they are only encountered at certain phases.

c) To determine if coal mining project delays are similar to the construction industry delays and if they are similar.

d) To determine if consultants and contractors are used in the SACMI.

e) To determine what the effects of delays are in the SACMI and whether they are quantified.

f) To determine if the effects of delays are classified into cost, people, environment, corporate image and safety.

1.5 Hypotheses

To answer the research questions it will be necessary to collect data from various coal mining organizations in South Africa i.e. a representative sample. The answer to these questions will be determined by quantitative means. The reason for using this method is that the study generalizes to a population based on a representative sample, whereas a qualitative study is context specific (Kruger, 2009). Further, the method that was used in the previous studies done in construction delays has been quantitative. The data collected is factual based on a measuring method chosen by the mining operations, consultants and contractors. This type of data enables a statistical analysis.

Hypothesis testing is a statistical approach to making inferences about the population from sample statistics. Thus by using a sample of data the aim is to determine if a particular proposition concerning the population is likely to hold or not (Diamantopoulos and Schlegelmilch, 2006). Further, the hypotheses in this research are based on the null hypotheses type. This type of hypothesis always includes a statement of inequality.

The following hypotheses were tested:

H_o1: There are no delays in coal mining projects in South Africa.

H_11: There are delays in coal mining projects in South Africa.

H_o2: The delays experienced in projects in the coal mining industry in South Africa are not measured effectively.

H_12: The delays experienced in projects in the coal mining industry in South Africa are measured effectively.

H_o3: The effects of delays in projects in the coal mining industry in South Africa are not measured effectively.

$H_1$3: The effects of delays in projects in the coal mining industry in South Africa are measured effectively.

H_o4: The majority of delays are not experienced during the planning phase of the project process

$H_1$4: The majority of delays are experienced during the planning phase of the project process.

H_o5: The majority of delays are not experienced during the execution phase of the project process.

$H_1$5: The majority of delays are experienced during the execution phase of the project process.

1.6 Delimitations of the study

The nature of the research has inherent limitations. Limitations were more specifically linked to biases in terms of the subjectivity of the questionnaires and non representativeness of the elements of the sample population. This study does not asses the success of the projects referred to or the maturity of the project management system of the organization.

1.7 Chapters Outline

Chapter 2: Theory and Practice of the Causes and Effects of Delays

A comprehensive review of literature available on the causes and effects of delays is reviewed. Through the understanding of the previous research done the current understanding of the subject can be analyzed. The review starts with an international perspective and is funneled down to an African perspective and finally a South African perspective of research done in the subject of causes and effects of delays in project management in relevant industries. These industries are mining, construction and information management. This chapter outlines the various aspects of delays, how delays are caused and how they affect the project.

Chapter 3: Methodology

This study is a quantitative study and the method followed is explained to obtain representative results within the population in Chapter 5. Questionnaires were developed to enable the collection of relevant data. The questionnaire is a Likert type questionnaire to focus the responses to delay related issues found in literature and thereby determine the causes and effects of delays in projects in the coal mining industry. Only the coal mining industry was targeted for this study based on coal mining organizations, contractors used by them and the consultant firms that assist in the process of planning and executing a coal mining project.

Chapter 4: Research Results

The results from the questionnaires are analyzed through basic statistical methods which is the representation of frequency distributions. The return on completed questionnaires is 70% which is a representative analysis. This chapter is based on the basic findings of the research results without any statistical testing.

Chapter 5: Synthesis and analysis of results

The software, Minitab, was used to statistically analyze the data. Hypothesis testing was done to answer the various research questions posed. The results from the quantitative study are analyzed and presented based on the hypothesis testing. The ranking of various causes and effects of delays in projects in coal mining is done in this chapter.

Chapter 6: Discussion, Conclusions and Recommendations

This chapter is the discussion of the results obtained in chapter 5. The connection between the findings from this study and previous studies shows relevance to prior work as well as pose new questions for further research. The results also culminate into recommendations for mining organizations to recognize the potential for delays in mining projects and the effects thereof.

Chapter 2: Theory and practice of the causes and effects of delays in coal mining projects

2.1 Introduction

This chapter explores the causes and effects of delays in projects based on a comprehensive review of literature available. Through the understanding of the previous research projects done the current understanding of the subject can be analyzed. The review will start with the international perspective and funneled down to an African perspective and finally a South African perspective of research done in the subject of causes and effects of delays in project management in relevant industries. These industries will be mining, construction and information management. This chapter will outline the various aspects of delays, how delays are caused and how they affect the project.

2.2 Defining the project management process

A project is defined (Gido and Clements, 1999: 2) as:

> *"….an endeavor to accomplish a specific objective through a unique set of inter-related tasks and the effective utilization of resources."*

The project life cycle, as shown in Annexure B, has four basic phases which are; identify the need, develop a proposed solution, perform the project and terminate the project. The effort required in each phase increases to a peak and then tapers off as the project is completed (Gido and Clement, 1999). The project life cycle phases are more formalized in project management terms by Meredith and Mantel (2006) as:

a) Conception

b) Selection

c) Planning, scheduling, monitoring and control

d) Evaluation and termination

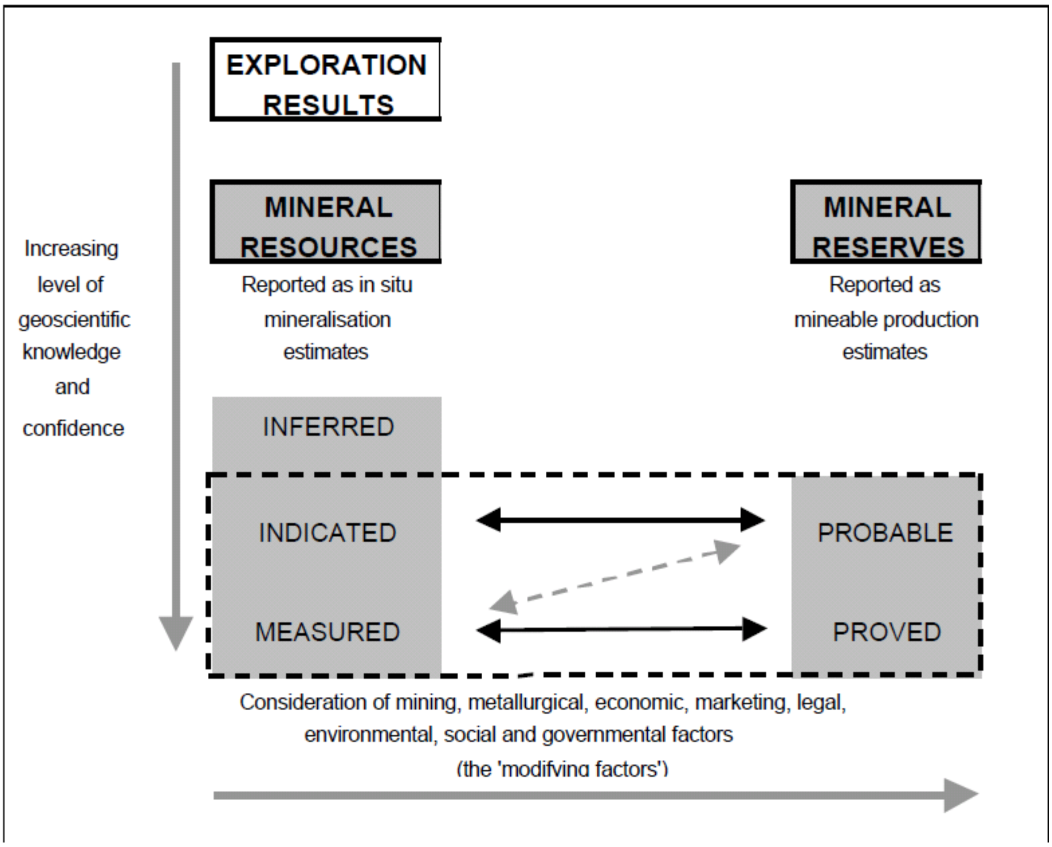
Project management in mining is broken down into five phases; scoping studies, prefeasibility, definitive feasibility studies, design and construction and operations (Noort and Adams, 2006). The mining project phases can be linked to both the life cycle phases by Gido and Clement (1999) as well as those by Meredith and Mantel (2006). It is feasible that mining organizations may use variations of the defined life cycle in their business.

2.3 Coal deposits in South Africa

Coal fields in South Africa are concentrated in the northern areas, which include the North Free State province, North Eastern Cape province, North Kwazulu Natal province, North Limpopo province and a major portion of the Mpumalanga province as shown in Annexure A. Most of the economically active mines are in the Mpumalanga province. According to Bian, Inyang, Daniels, Otto and Struthers (2010) 81.9% of all the coal extracted in the world occurred in USA, Russia, India, China, Australia and South Africa during 2006. In 2008 South Africa had an estimated 30 billion tonnes of proved, recoverable coal reserves, which is the tonnage that can be mined under the current economic conditions and technology (World energy council, 2010). From a study done by Jeffrey (2005) it is clear that the remaining reserves are of a poorer quality and will require a change in exploitation technology to benefit from this coal through use and sales.

As the base for coal mining projects the mineral to be exploited needs to be examined. The South African Mining Mineral Resource Committee (SAMREC), have set out the minimum standards for the reporting of exploration results of any mineral. SAMREC modeled its code based on the code prepared by Joint Ore Reserves Committee of The Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia (JORC) (SAMREC, 2000).

Figure 2.1 Mineral resource and reserve (SAMREC, 2000)



Source: SAMREC,(2000)

The definition of a Mineral Resource and a Mineral Reserve are:

(i) **According to SAMREC (2004: 16):**

"A 'Mineral Resource' is a concentration [or occurrence] of material of economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable and realistic prospects for eventual economic extraction. The location, quantity, grade, continuity and other geological characteristics of a Mineral Resource are known, estimated from specific geological evidence and knowledge, or interpreted from a well constrained and portrayed geological model. Mineral Resources are subdivided, in order of increasing confidence."

(ii) **Furthermore, SAMREC (2004: 16) defines a mineral reserve as:**

"……..the economically mineable material derived from a Measured and/or Indicated Mineral Resource. It is inclusive of diluting materials and allows for losses that may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified. Mineral Reserves are sub-divided in order of increasing confidence into Probable Mineral Reserves and Proved Mineral Reserves."

The determination of a mining resource and reserve is important as it is usually the first step in any Greenfield and even Brownfield mining project. The SAMREC code advises the use of a checklist, which is attached as an Annexure in that document, for the evaluation of a project (SAMREC, 2004). The reporting of the mineral deposit results are divided into three main elements with the listed criteria as sub points:

a) Reporting of exploration results
    i. Mineral rights and land Ownership
    ii. Exploration work done by other parties
    iii. Geology
    iv. Data compositing (aggregation) methods
    v. Relationship between mineralization widths and intercept lengths
    vi. Diagrams
    vii. Balanced Reporting
    viii. Other substantive exploration data
    ix. Historical information of interest about the mine
    x. Historic verification of the performance parameters
    xi. Further work

b) Reporting of mineral resources
    i. Database integrity
    ii. Geological interpretation

iii. Estimation and modeling techniques
iv. Cut-off grades or parameters
v. Mining factors or assumptions
vi. Metallurgical factors or assumptions
vii. Tonnage factors (in situ bulk densities)
viii. Classification
ix. Audits or Reviews
x. Historical information of interest about the mine
xi. Historic verification of the performance parameters
xii. Others

c) Reporting of mineral reserves

i. Mineral Resource estimates for conversion to Mineral Reserves
ii. Plant and equipment
iii. Cut-off grades or parameters
iv. Mining factors or assumptions
v. Directors' forecast
vi. Volume and capacity estimates for processing
vii. Mass balance plan and description
viii. Metallurgical factors or assumptions
ix. Environmental descriptions of anticipated liabilities
x. Plant and equipment
xi. Cost, revenue factors and funding
xii. Historical information of interest about the mine
xiii. Historic verification of the performance parameters
xiv. Market assessment
xv. Other modifying factors
xvi. Comparative values
xvii. Classification
xviii. Audits or reviews

The elements in C should make up the basic information required for a mine project as part of the feasibility requirements.

2.4 Coal mining in South Africa

Reporting on the status of coal in 2008, DMR (2010: v) reported that:

> *"……….. the country's saleable coal production was 252.2 Mt, of which 2.2 kt was anthracite and 250 Mt was bituminous coal. Local sales mass amounted to 197.0 Mt generating a revenue of R30.1 billion while export sales mass amounted to 57.9 Mt and revenue from export sales were R42,4 billion."*

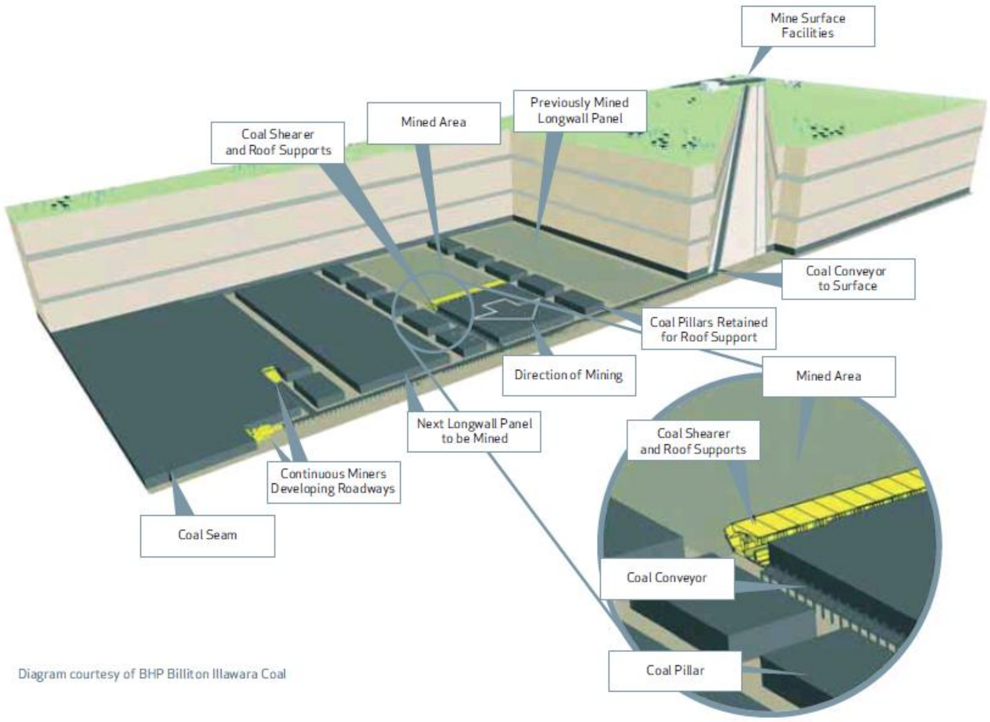
Table 2.0: Coal mining saleable production in South Africa. (DMR, 2010)

Saleable Production	
Year	**Metric Tons (Mt)**
2000	224.9
2001	223.4
2002	220.2
2003	237.8
2004	243.3
2005	244.9
2006	244.8
2007	247.6
2008	252.2
2009	250.6

Source: DMR (2010)

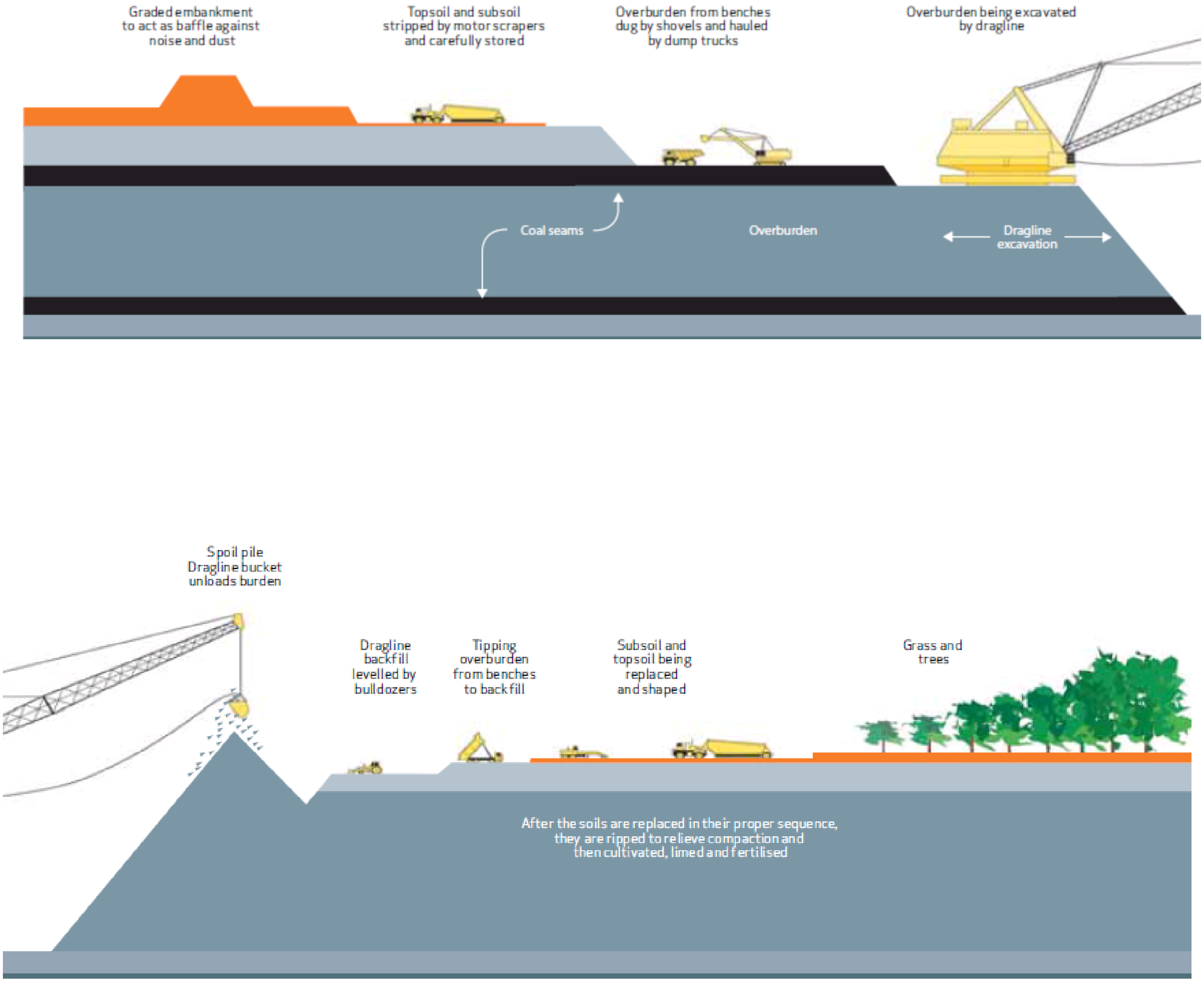
Table 2.0 shows the saleable production from 2000 to 2009 which has increased over this period. Coal is mined by either surface mining or underground mining. Underground production accounts for about 60% of the world's coal production (World coal institute, 2005). Figure 2.2 shows a cross section through a typical underground coal mine. The mine will typically consist of underground workings, access to the workings from surface via a vertical or incline shaft, an office complex for administrative personnel, workshops, stores, ventilation fans and in some cases living quarters. The coal is removed from the workings by means of a conveyor system which can be linked to a stock area or to a processing plant. The surface mining operations are shown in Figure 2.3. The type of coal deposit suitable for mining by surface mining means is usually large horizontal coal reserves consisting of one or more coal seams. The waste burden covering the seams can be thick or thin (SACMA, 2005). The cross section through the surface mining process shows the mining and rehabilitation process of the surface mining operation. The basic infrastructure at a surface coal mining operation consists of an office complex for administrative personnel, workshops, stores, ventilation fans and in some cases living quarters. The coal is usually transported by truck to a point from which coal conveyor belts transport the commodity further to a coal processing plant or stock area.

Figure 2.2 Underground coal mining operations (SACMA, 2005)



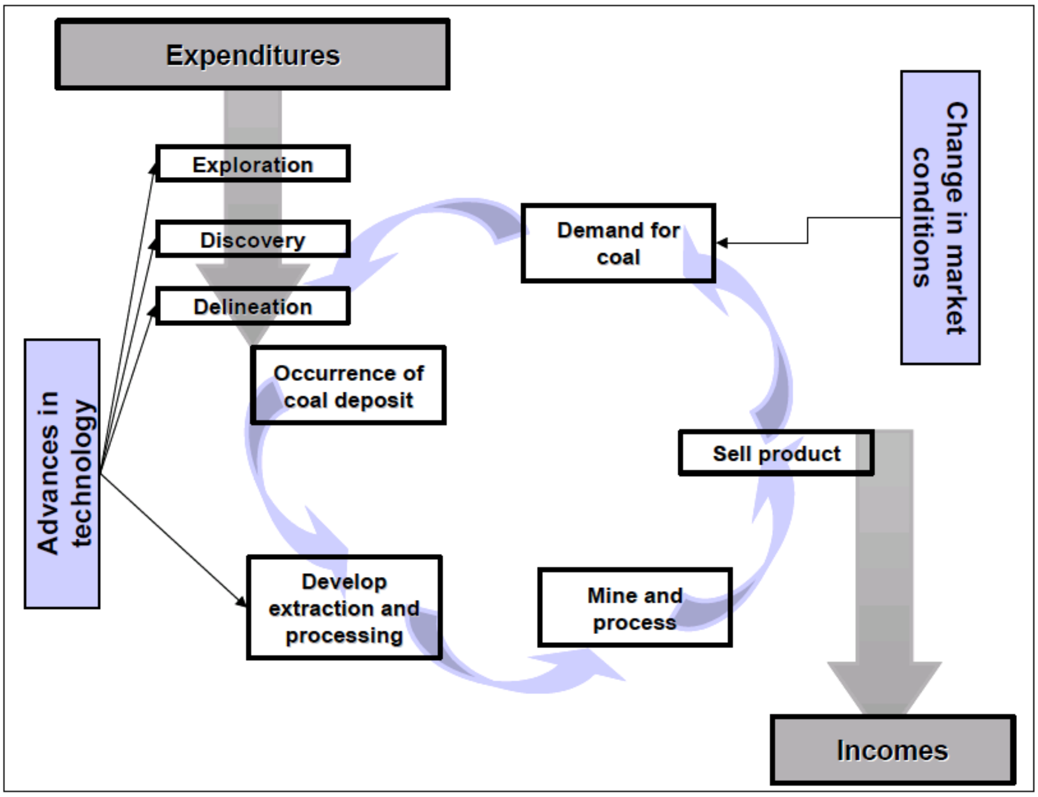
Source: SACMA,(2005)

Figure 2.3 Surface coal mining operations (SACMA, 2005)



Source: SACMA, (2005)

Figure 2.4 Coal supply process (SACMA, 2005)



Source: SACMA, (2005)

Figure 2.4 depicts a basic coal supply process which is initiated by the change in market conditions. This has an effect on the market demand for coal which initiates exploration of coal. Next the coal is extracted and processed based on technology developed through advances in technology. The final step is the sale of the product according to customer's specifications.

2.5 Defining delays and their effects

Strumpf (2000: 32) defined delay as:

> "……. an act or event that extends the time required to perform tasks under a contract."

According to Trauner (2009) there are a number of definitions for delays which can describe a delay to an activity or work schedule. These definitions are; to make something happen later than expected; to cause something to be performed later than planned or to not act timely. The common factor to delays is the time aspect. Williams (2003) generalizes the delays experienced in projects as time delays. He further states that the delays on the critical path activities will result in a delay to the total project and if the delay is not on the critical path, but the float is exhausted it will have a delay on the total project.

The delays can be categorized as explained by Trauner (2009):

a) Critical and noncritical delays: critical delays are those that affect the project completion date or milestone dates and those that don't affect these two dates are considered noncritical.

b) Excusable and non-excusable: excusable delays are those that have taken place due to unforeseeable events beyond the control of the project executor. These events are typically:

    i. Labor strikes
    ii. Fires
    iii. Floods
    iv. Acts of God
    v. Owner- directed changes
    vi. Errors and omissions in plans and specifications
    vii. Changing site conditions or concealed conditions
    viii. Severe weather
    ix. Intervention by outside agencies such as government authorities
    x. Lack of action by government authorities

The non- excusable delays are events in the control of the project executor.

    i. Late performance by sub contractors
    ii. Supplier's untimely performance

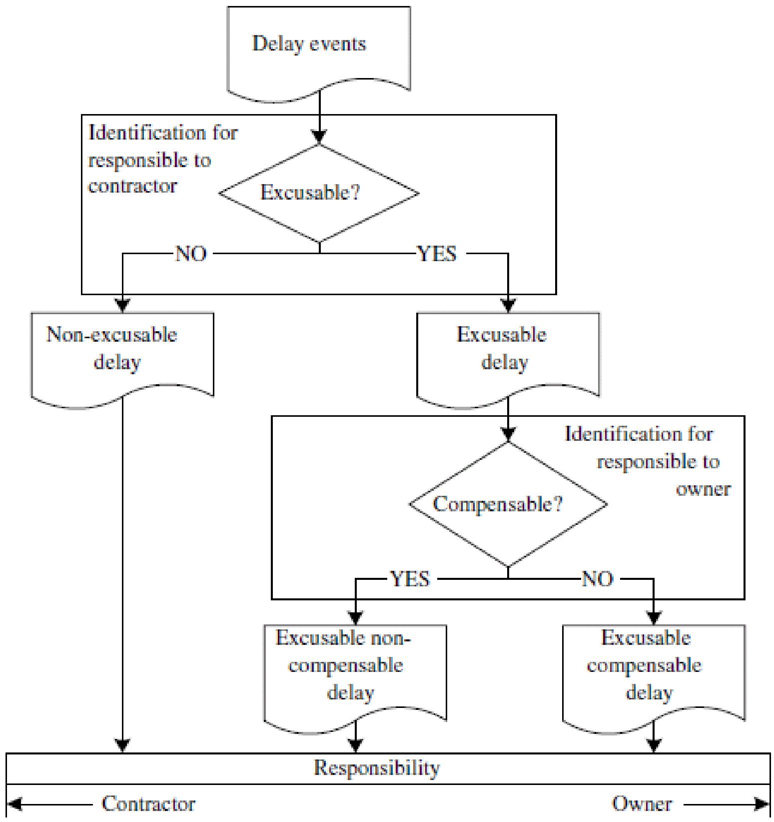
iii. Faulty workmanship by contractors and subcontractors

iv. Labor strike that has taken place due to the unwillingness of the contractor or labor representatives to negotiate

c) Compensable or non-compensable: a compensable delay is one that entitles the project executor to time extensions or additional compensation. Non- compensable means that the project executor is not entitled to time extension or other compensation even if the delay is excusable.

d) Concurrent and non- concurrent: delays occurring on separate paths that can cause a delay to the critical path are concurrent delays.

Figure 2.5 Delay classification process (Kao and Yang, 2009)



Scource: Kao and Yang, (2009)

Figure 2.5 is a flow diagram developed by Kao and Yang, (2009) depicting the flow of delay events to a point where the responsibility can be assigned to either the owner or the contractor based on the excusable or non excusable delay classification of the delay.

Delays can be costly and can result in disputes and claims which in a bigger context can impede development in the construction industry (Odeh and Battaineh, 2002). This statement is can be relevant to other industries such as the coal mining industry depending on how significant the delays in the coal mining projects are.

2.6 A global perspective to project management causes and effects of delays

The research on the causes of project delays is dominant in literature. The effects of delays are only linked in some cases. The majority of literature focuses on the delays in projects in the construction industry. Owners, contractors and consultants in many projects dislike the experience of extensive delays which have a negative impact on the initial cost and time estimates (Odeh and Battaineh, 2002). These authors grouped their delay factors based on the client, contractor, consultants, material, labor and equipment, external factors, contract and contractual relationships. Their research was based on the perspective of the contractors and consultants. The agreed significant factors of delay were; inadequate contractor experience, owner interference, financing of work, delays caused by subcontractors, slow decision making by owners, improper planning and labor productivity. Four recommendations were proposed to reduce the costly delays experienced:

a) Enforce liquidated damage clauses and propose incentives for early completion of projects.

b) Proper training and classification of labor (craftsmen)

c) Approach contract award procedure from a capabilities perspective and not a lowest cost perspective.

d) Establish new approaches to contracts such as the design- build and construction management type contracts which limit owner interference.

This research may have been reinforced by the inclusion of the owners or sponsors in the survey of the construction industry.

As further enforcement to the Jordanian construction industry, Sweis, Sweis, Hammad and Shboul (2008) listed the three most critical delay causes as shown in Table 2.1 as viewed by consultants, contractors and owners in residential construction projects.

Table 2.1: Critical Delay Causes for Consultants, Contractors and Owners

Critical Delay Causes	Consultants	Contractors	Owners
1	Poor planning and scheduling of the project by the contractor	Financial difficulties faced by the contractor	Poor planning and scheduling of the project by the contractor
2	Financial difficulties faced by the contractor	Too many change orders from owner	Financial difficulties faced by the contractor
3	Too many change orders from owner	Shortage of manpower (skilled, semi-skilled, unskilled labor)	Incompetent technical staff assigned to the project

Source: Sweis, *et al.* (2008)

These authors also used the terminology of the Drewin's Open Conversion System (DOCS) to classify the causes of delay into three major categories; input factors, internal environment and exogenous factors. They concluded that in the major causes of delays related to the input factors category, mainly related to labor and the internal environment which was related to the contractor. The exogenous factors had a minor impact to the delays of the projects. The authors suggest further research in other developing countries using the same methodology, however, in the same industry. The effects of the delays were not analyzed in this study which would add a dimension of value to the delays.

Williams (2003), researched the delays caused by the extension of time and found that delays can be as a result of the contractor or the client or both, which can result in claims. The three main claims noted are; the loss of productivity claims, cardinal changes claims and project float claims. By analyzing the delays using the critical path the claims can be validated. It is important to track the project to enable the delay analysis to be done effectively. The result of this analysis should also enable the transfer of knowledge with regard to the lessons learned from the projects.

Ruuska, Ahola, Artto, Locatelli and Mancini (2010) discuss the role of governance in three nuclear power plant projects. In addition, the major delays caused were by quality control issues due to the inadequate quality systems of the concrete supplier. The case called for an arbitration procedure due to the delays. The transfer of knowledge based on the safety culture did not take place sufficiently and the concrete supplier developed safety practices in an unsystematic way (Ruuska, Ahola, Artto, Locatelli and Mancini, 2010). These two issues are partially related. If the safety culture is not transferred by the owner company to the companies contracted to the project the quality control practices will also be affected. An example may be the establishments of an electrical switch panel for high voltage electricity that is not the required specifications e.g. a poor locking mechanism. This may result in a major safety incident such as a fatality. Mining companies such as BHP Billiton shut down operations immediately to determine the cause an asses changes to avoid future reoccurrences. Another pertinent issue highlighted by Ruuska, Ahola, Artto, Locatelli and Mancini (2010) is that of cloaboration between project role players. They admit that the collaboration between the role players in the project researched was good, however, this is not noted as a cause of delay in other literature. It may be that collaboration is a perception not tested as yet.

Ahsan and Gunawan (2010) have, as part of their analysis of cost and schedule performance, considered the delays in international development (ID) projects in Asian countries. The delays causes were:

a) Lengthy procedure for contract evaluation and award

b) Procurement delay
c) Civil works and land acquisition delay
d) Consultant recruitment delay
e) Natural calamities
f) Government procedural delay
g) Local politics and economic problem
h) Loan approval and disbursement delay
i) Project staff hiring delay
j) New scope addition
k) Frequent change in project staff (manager, director)

The delays are ranked as listed. The authors also mentioned that cultural issues of the host countries in with the projects are performed can be considered in terms of the impact on the project performance. The countries to which these results pertain are Bangladesh, China, India and Thailand. They also related the causes listed to the effects of time and cost overruns. The cost impact and the time overruns are important to quantify as there should be a difference depending on whether the delays are in the critical path or not. If the delay is experienced on a critical task the result will be a time delay (Trauner, 2009).

Assaf and Al-Hejji (2006) investigated the causes of delays based on the perception of owners, contractors and consultants in the construction industry in Saudi Arabia. They listed 73 possible causes. They ranked the frequency of delay causes and then ranked the importance of delay causes. The importance was calculated by finding the product of the frequency and the severity of the delay causes. Their top ten importances of delay causes are shown as ranked in Table 2.2 and the top ten delays according to frequency is tabled in Table 2.3. They concluded that the correlation between the importance ranking of the owners and consultants was high at 0.72 and between owners and contractors was 0.57. The authors recommend more specific research targeted at the parties and resources in a project and finding their effects on the time overruns of a specific project.

Table 2.2: Importance of delay causes

Ranking. No.	Owners	Contractors	Consultants
1	Shortage of labors	Delay in progress payments by owner	Type of project bidding and award
2	Unqualified work force	Late in reviewing and approving design documents by owner	Shortage of labors
3	Ineffective planning and scheduling of project by contractor	Change orders by owner during construction	Delay in progress payments by owner
4	Low productivity level of labors	Delays in producing design documents	Ineffective planning and scheduling of project by contractor
5	Hot weather effect on construction activities	Late in reviewing and approving design documents by consultant	Change orders by owner during construction
6	Conflicts encountered with subcontractors _ schedule in project execution	Difficulties in financing project by contractor	Low productivity level of labors
7	Poor site management and supervision by contractor	Mistakes and discrepancies in design documents	Difficulties in financing project by contractor
8	Inadequate contractor’s experience	Late procurement of materials	Poor site management and supervision by contractor
9	Effects of subsurface conditions (soil, existing of utilities, high water table, etc)	Inflexibility (rigidity) of consultant	Poor qualification of the contractor’s technical staff

10	Change orders by owner during construction	Slowness in decision making process by owner	Delay in material delivery

Source: Assaf and Al-Hejji (2006)

Table 2.3: Frequency of delay causes

S. no.	Owners	Contractors	Consultants
1	Type of project bidding and award	Delay in progress payments by owner	Type of project bidding and award
2	Shortage of labors	Suspension of work by owner	Change orders by owner during construction
3	Ineffective planning and scheduling of project by contractor	Late in reviewing and approving design documents by owner	Shortage of labors
4	Low productivity level of labors	Change orders by owner during construction	Ineffective planning and scheduling of project by contractor
5	Unqualified work force	Late procurement of materials	Delay in progress payments by owner
6	Change orders by owner during construction	Mistakes and discrepancies in design documents	Low productivity level of labors
7	Hot weather effect on construction activities	Delays in producing design documents	Unavailability of incentives for contractor to finish ahead of schedule
8	Type of construction contract (turnkey, construction only)	Difficulties in financing project by contractor	Ineffective delay penalties
9	Poor site management and supervision by contractor	Late in reviewing and approving design documents by consultant	Hot weather effect on construction activities
10	Conflicts encountered with subcontractors _ schedule in project execution	Slowness in decision-making process by owner	Poor qualification of the contractors technical staff

Source: Assaf and Al-Hejji (2006)

Similarly, in the Malaysian construction industry the causes and effects of delays were researched (Sambasivan and Wen Soon, 2007). The causes of delays were reported per client, consultant and contractor. The top five causes are listed in Table 2.4.

Table 2.4: Causes of dela*y*

Cause ranking	Client	Consultant	Contractor
1	Contractor's improper planning	Contractor's improper planning	Contractors poor site management
2	Contractor's site management	Contractor's site management	Inadequate client's finance and payments of completed
3	Inadequate contractor experience	Shortage in material	Subcontractors
4	Labor supply problems	Inadequate contractor experience	Inadequate contractor experience
5	Subcontractor problems	Inadequate client's finance and payments of completed	Equipment availability and failures

Source: Sambasivan and Wen Soon (2007)

Interestingly, the results from the effects of delays in this study were exactly the same for the clients, consultants and contractors. Time overrun, cost overrun, disputes, arbitration and litigation are the main effects of delays. This type of analysis, basing the research on the three main role players in a project should give a balanced perspective on the causes and effects of delays in coal mining. Sambasivan and Wen Soon (2007) suggest that similar studies should be done in other parts of the world which may have unique causes and effects of delays. Similar to this study, it may be advantageous to investigate industries closely related to construction such as the petroleum and mining industries.

Kao and Yang (2009) classified delays as Excusable (ED) and non- excusable (NE) where NE delays are controllable by the contractor and ED are typically unforeseen events and those not attributable to the contractor. The NE and ED's can be further broken down into excusable- compensable (EC) or excusable- non- compensable (EN), where EC are caused by actions by the owner and EN are out of the control of both the contractors and the owners. The final conclusions were in the selection of a delay analysis program which depends on the available resources, time and the accessibility to project control documentation (Kao and Yang, 2009). As noted earlier in this document, the effect of delays on the critical path is what will delay the entire project. It is imperative for companies to record and analyze the delays to determine if they are on the critical path and whether the contractor or consultant has the right to claim delay compensation or not. If recording and analysis takes place in a proficient manner the effects such as disputes can be reduced.

A list of eighty causes of delays has been classified into the stages of the Build- Operate-Transfer (BOT) method. This method includes: feasibility study and preliminary plan, announcement and submission of application, evaluation and selection, negotiation and signing of concession agreement, design, construction, operation and transfer (Yang, Yang and Kao, 2010). The list of possible delays is comprehensive and will be used as the base for determining the delays in mining projects. The conclusion made was that the most significant phase which would delay the project is at the 'Negotiation and signing of concession agreement' phase. The causes that would impact this phase are:" *'improper contract planning', 'debt problem' and 'uncertainty on political issues and government – finished items'*" (Yang, Yang and Kao, 2010: 578). In a mining project some of the mining organizations will negotiate a "turn-key" type project in which the consultants and contractors will be tasked to deliver a ready to operate system to the mining organization. This may be done through a mining contractor or a project management company. The question would be, if the mining organization has a project management system in place, how do the contractors, consultants and project managers fit in and how do they avoid delays that can affect the critical path? Yang, Yang and Kao, (2010) also suggested that the questionnaire be sent overseas to expand the research outside of Taiwan.

To demonstrate the similarity in project issues an article by Cerpa and Verner (2009) was studied who assessed the reasons for project failures in software projects. The main factors causing the failures are:

a) Delivery date impacted the development process

b) Project under-estimated

c) Risks were not re-assessed, controlled, or managed through the project

d) Staff were not rewarded for working long hours

e) Delivery decision made without adequate requirements information

f) Staff had an unpleasant experience working on the project

g) Customers/Users not involved in making schedule estimates

h) Risk not incorporated into the project plan

i) Change control not monitored, nor dealt with effectively

j) Customer/Users had unrealistic expectations

k) Process did not have reviews at the end of each phase

l) Development Methodology was inappropriate for the project

m) Aggressive schedule affected team motivation

n) Scope changed during the project

o) Schedule had a negative effect on team member’s life

p) Project had inadequate staff to meet the schedule

q) Staff added late to meet an aggressive schedule

r) Customers/Users did not make adequate time available for requirements gathering.

As mining operations are run using computer software and hardware to regulate, assess and improve productivity part of the mining projects will include these listed potential risks which can cause delays.

A comprehensive list of delays across varying countries was developed by Toor and Ogunlana (2008) which further showed the difference in construction delays prior to the year 2000 and post 2000. Their study identified additional factors that cause delays in developing countries. These factors include: lack of finance, technically incompetent and less experienced local companies, an underdeveloped business environment, complexities in legal and regulatory systems, and distinct socio- cultural issues (Toor and Ogunlana, 2008). They concluded that factors causing delays in construction across developing countries in the world are mostly identical. The final recommendation made by Toor and Ogunlana (2008) is that talent management and the development of professionals is needed in growing construction industries.

From the comparison made by Toor and Ogunlana (2008) some of the points listed above by Cerpa and Verner (2009) can be linked to the delays found in construction delays. Point's b, e, g, h, k and l can be linked to deficiencies in planning and scheduling which was found to be a cause of delay in projects in Nigeria, Thailand, Indonesia, Saudi Arabia, Malaysia, Ghana, Vietman and the UAE. The control and dealing with change to a project as shown in point i and n is also identified as causes of delays in the UK, Thailand, Nigeria, Indonesia, Hong Kong and Saudi Arabia. The adequacy of staff to meet the schedule in point p has also been identified by Toor and Ogunlana (2008) in Thailand, Indonesia, Saudi Arabia, Malaysia and the UAE. There is a clear link between the construction project's delays and the software project failures. In mining projects software plays an important role as computer software and hardware must be installed in mining operations to enable the transfer of information which enables effective mining. An interesting observation from the work presented by Cerpa and Verner, (2009) is that they have incorporated the pressure of maintaining the schedule performance of the project to how it affects the morale of the project team. These factors were lack of rewards for working long hours, unpleasant experiences, an aggressive project schedule and a schedule that had a negative effect on their personal lives. These factors can probably influence people on any project and should be tested to elaborate on the people factors as mentioned in other literature.

Alwi and Hampson (2003) also suggest that the main effects of delay to a project are in the form of time and cost. They also concluded that the delay causes researched is also applicable to similar building construction projects in other developing countries.

2.7 African research on project management causes and effects of delays

Frimpong, Oluwoye and Crawford (2003), researched the causes of delays in groundwater projects in Ghana. The concluding factors causing delays to these projects noted are; poor contractor management, monthly payment difficulties from agencies, material procurement, poor technical performances, escalation of material prices. The two uncontrollable factors listed are bad weather and unfavorable geological conditions. They concluded that many problems in the projects resulted from poor resources management such as human, technical and material resource management. Their project was also limited to the pre construction and construction phases of a ground water project. It could be argued that due to negative factors in the construction and pre construction phase there could be negative impacts on the operation. If this were a turnkey project delays in the handover could take place. Thus this study should have been taken a step further to include project handover issues.

The construction industry plays a significant role in the Nigerian economy (Mansfield, Ugwu and Doran, 1994). This research focuses on developing countries based on findings in Nigeria. The main factors responsible for delays reported from the research are; poor contract management, financing and payment of completed works, changes in site conditions, shortages of materials, imported materials, and plant items, design changes and subcontractors and nominated suppliers. Other factors identified are excessive bureaucratic checking and approval procedures, unclear definitions by the client and insufficient geotechnical investigations at feasibility stage. Similar to mining the geotechnical and geological investigations are paramount to deciding on a mining project. Mansfield, Ugwu and Doran (1994), also warn against market overheating in a developing country due to improper project implementation, thus executing projects before they are required to add to economic growth. They recommended more focus on the thorough project analysis before authorization as well as proper monitoring and reviewing. This is equivalent to a proper feasibility study and reviews of the project management process. Training of contract managers and manpower overall was also seen as a problem at the time. The funding of a project must be adequate. A proper materials management system is required. There was also a call for government to relax trade tariffs and for the World Bank to assist developing countries.

Developing countries such as Zambia are dependent on the provision of infrastructure such as roads (Kaliba, Muya and Mumba, 2009). The main causes of delay identified are; delayed payments, financial process, financial difficulties, contract modification, economic problems, material procurement, changes in drawings, staffing problems, equipment unavailability, poor supervision, construction mistakes, poor coordination on site, changes in specifications, labor disputes and strikes. The recommendations made by Kaliba, Muya and Mumba, (2009), agree somewhat with those of Mansfield, Ugwu and Doran (1994), which are;

a) The proper timing of a project as well as proper scheduling of activities.
b) A well defined scope from inception to completion.
c) Proper project costing.
d) Effective communication between project role players.
e) Competent personnel are required to ensure effective project implementation.
f) Capacity building in the form of government assistance for entrepreneurs.
g) Legislation is required to ensure the protection of workers and the laws can ensure a grievance resolution procedure will ensure good corporate governance between the client, consultant and contractors.

2.8 South African research on project management causes and effects of delays

The delay analysis in South Africa (SA) seems to be written as part of literature related to other subjects in project management e.g. project maturity. The fact that delays take place is mentioned, but no full analysis has been done on delays specifically not in coal mining. South Africa has pertinent issues that can affect any project particularly when it comes to labor related issues.

Smith, Eastcroft, Mahmood and Rode (2006), researched the risk factors relevant to South African software projects. The authors suggest extending the research to compare the risks with other industries such as in the mining and construction industries. The top ten risks found from this study are:

a) Lack of top management commitment to the project
b) Unclear/ misunderstood scope/ objectives
c) Schedule Flaw
d) Lack of client responsibility, ownership and buy-in of the project and it's delivered systems
e) No planning or inadequate planning
f) Project not based on sound business case
g) Lack of available skilled personnel
h) Not managing change properly
i) Lack of adequate user involvement
j) Poor risk management

The risks numbered e, f, g, h are concluded to be unique to the software industry in SA. The risks, if realized, can result in project failure (Smith, Eastcroft, Mahmood and Rode, 2006). The risks listed have been identified as causes of delays as listed in this document. The risks perceived to be native to the SA software industry are also listed in other literature as causes of delay. The wording may not be exact, but the risks can be categorized from the extensive lists in Annexure D as:

a) Ineffective planning and scheduling of project by contractor listed by Assaf and Al-Hejji (2006) can be associated with e and c.

b) Impractical financial feasibility as listed by Yang, Yang and Kao (2009) can be associated with f.

c) Inadequate personal skills as listed by Yang, Yang and Kao (2009) can be associated with g. Inadequate skills is listed in the majority of developing country literature.

d) Change is mentioned by both Yang, Yang and Kao (2009) and Assaf and Al-Hejji (2006).

De Wet (2007) developed a model to check the health of projects in the coal mining industry in SA. The largest risk to the specific project studied was the exposure to both exchange rate and export price. This risk can result in a project delay early in the pre-feasibility and feasibility stages. Therefore it may be pertinent to test the relationship between risks associated with coal mining projects and the causes and effects of delays in coal mining projects.

2.9 Coal mining projects

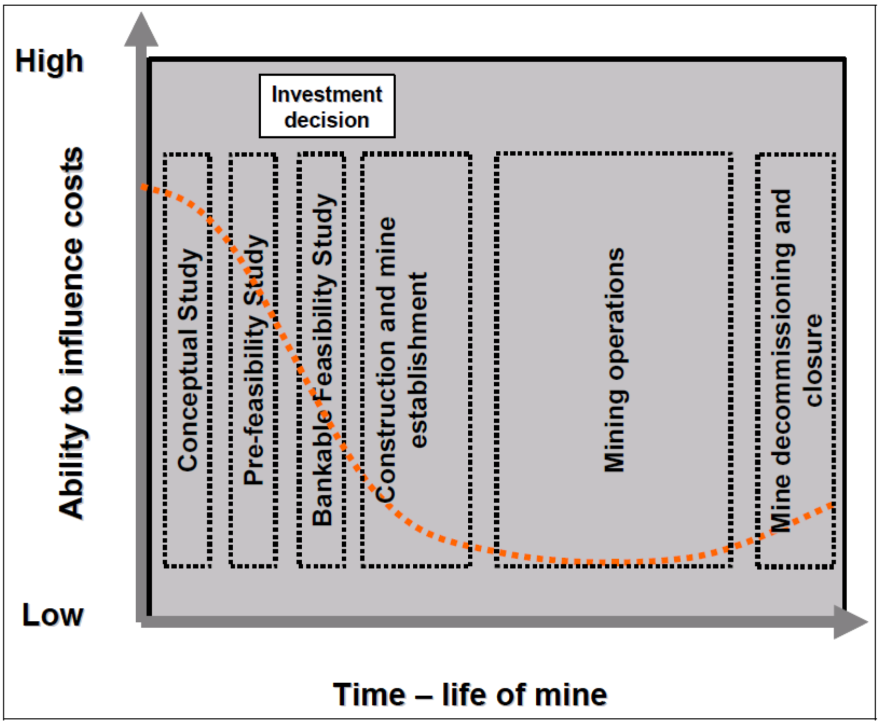
Mining projects have various sources of uncertainty that need to be managed to ensure success or at least the minimization of loss. These areas include; commodity prices, mineral reserves and ground conditions. Building flexibility into the mine project planning process will enable a decision making process that will minimize delays (Mayer and Kazakidis, 2007). Flexibility may be preparing various scenarios of portions of the mining process which will depend on the problem faced. To ensure some form of flexibility the mining organization should assess risks that could be encountered during the project phase of the mine. This may reduce delays, but may have an adverse effect on the planning process if too many scenarios are run. The inability of ESKOM to guarantee power supply to various mining organizations has caused that projects and operations require rethinking in terms of the way mining will take place (Wilhelm, 2008). This type of exogenous influence can cause the rerun of planning scenarios which could and has caused delays in the South African mining industry.

Some of the functions of a mining project are a required input from the mining organization, such as the geological assessment of a new mining reserve. These quality and quantity results are also reported in the annual reports under the competent persons report. This information leads into the mine feasibility study which considers the size of the reserves and the life of the mine which play an important economic role in the determination of the economic viability of the mine. This is confirmed by Li and Topuz, (1987) who found that the Mine size and mine life are the most important determinants of a new mine development project. Another confirmation of up front planning is made by

Noort and Adams (2006) earlier in this document, the initial planning or front end loading, must be sound and not reiterated to ensure that the mining project will commence successfully.

Figure 2.6 is a representation of a life of mine which includes the initial project steps of conceptual study, pre- feasibility study, bankable feasibility study and construction and mine establishment.

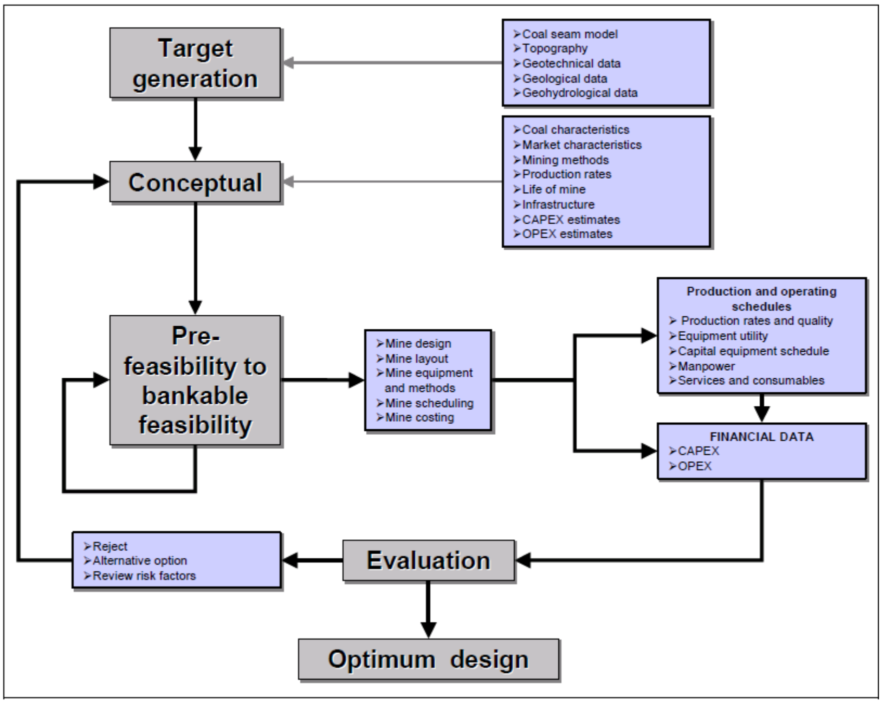
Figure 2.6 Mine life phases and their ability to influence costs (SACMA, 2005)



Source: SACMA, (2005)

Figure 2.7 is a representation of the mine planning phases and their requirements. This stage can spell technical and physical disaster for any mining project if not performed correctly (SACMA, 2005). Further, the data needed for effective planning is shown in Figure 2.7. As the decisions are taken further into the project planning phases the less influence the planning has on the capital and operational costs. This confirms previous statements that the planning phase of a mining project is essential to its success. It would also infer that this research should show major delay causes in the conceptual, pre-feasibility and feasibility phases of the project.

Figure 2.7 Components of mine planning (SACMA, 2005)



Source: SACMA, (2005)

From the literature it is clear that delays occur in all the projects researched. The types of delays vary very little between the various projects. Even though most of the research is based on projects in the construction industry there are several delays that basically cross borders in terms of all projects. An example of this is the changes that take place to the scope of the project usually initiated by the owner. Another would be poor initial planning. This planning is a salient point for the establishment of mining operations, as the planning phase is governed by what is expected to be buried underground in terms of the coal resource. All aspects of the project can run smoothly, but if the expected mineral is not in the expected position at the required grade the project will be delayed and even stopped. The final result may be project failure.

2.10 Summary

The construction industry has been exhaustively studied in the area of delays in projects internationally. A list of possible delays has evolved over the past 10 years that covers all major delays in this industry. The most extensive list is that of Yang, Yang and Kao (2009) which listed eighty possible delays of which eight are duplicated in some of the project steps. Assaf and Al-Hejji (2006) show a list of seventy three possible delays based on the various role players in the project. These two lists are shown in Annexure C. Most of the literature discusses the top ten causes of delay. The extensive list will serve as a base for this research. This research should address the specific delays experienced in the total project management process in coal mining. The effects of delays are mainly listed as impact on the timing of project delivery and cost implications. There may be some specific mining related effects that are not listed which are specific to coal mining such as coal quality specifications. This eventually may lead to a cost impact, but by acknowledging the prior effect the future project management teams reading this document may be able to react proactively to a potential negative loss.

The literature does not give an indication of whether there are delays in projects in the coal mining industry in South Africa or for that matter in which phase of the project life cycle the majority of these delays take place. The construction industry is closely related to the mining industry as all mining projects involve some form of construction in them. The information technology industry has also become an integral part of the mining industry and also forms part of the mining project processes. There seems to be a focus on risks in the mining projects in SA. These risks have been linked to some of the causes of delay in the construction industry. The determination of the mining specific delays will be sought in this document to enable project management teams in coal mining to anticipate delays and the effect thereof.

Chapter 3: Research Methodology

3.1 Introduction

The method of the research is set out in this chapter. The methodology is based on the research design, instrumentation, sampling process, data collection, measurement scales, limitations to the design and ethical considerations. The process to be followed to complete this research is:

a) Review the theory and practice based on available literature.

b) Setup a questionnaire to collect data.

c) Distribute the questionnaire to selected organizations.

d) Analyze the acquired data.

e) Present data in an understandable format such as graphs and tables.

f) Compile the final research report.

From the data gathered the causes and effects of project delays in the coal mining industry in South Africa can be determined and presented to assist in the reduction of these delays which negatively affect the mining projects.

3.2 Research design

3.2.1 *Research type*

a) Quantitative research method

According to Leedy and Ormrod (2005), quantitative research is a method used to answer questions about the relationships among measured variables with the purpose of explaining, predicting, and controlling phenomena. This method of research does not include generalizations as with a qualitative study.

Traditional quantitative research focuses on deduction, confirmation, explanation, theory/ hypothesis testing, prediction, standardized data collection and statistical analysis (Johnson and Onwuegbuzie, 2004). A list of strengths and weaknesses of quantitative research was also formulated by Johnson and Onwuegbuzie (2004) which is shown in Table 3.1

Table 3.1: Strengths and weaknesses of Quantitative Research, (Johnson and Onwuegbuzie, 2004, p.19)

	Strengths
a.	Testing and validating already constructed theories about how (and to a lesser degree, why) phenomena occur.
b.	Testing hypothesis that are constructed before the data are collected. Can generalize research findings when the data are based on random samples of sufficient size.
c.	Can generalize a research finding when it has been replicated on many different populations and sub populations.
d.	Useful for obtaining data that allow quantitative predictions to be made.
e.	The researcher may construct a situation that eliminates the confounding influence of many variables, allowing one to more credibly assess cause- and- effect relationships.
f.	Data collection using some quantitative methods is relatively quick (e.g., telephone interviews).
g.	Provides precise, quantitative, numerical data.
h.	Data analysis is relatively less time consuming (using statistical software).
i.	The research results are relatively independent of the researcher (e.g., effect size, statistical significance).
j.	It may have higher credibility with many people in power (e.g., administrators, politicians, people who fund programs).
k.	It is useful for studying large numbers of people.
	Weaknesses
a.	The researcher's categories that are used may not reflect local constituencies' understandings.

b.	The researcher's theories that are used may not reflect local constituencies' understandings.
c.	The researcher may miss out on phenomena occurring because of the focus on theory or hypothesis testing rather than on theory or hypothesis generation (called the confirmation bias).
d.	Knowledge produced may be too abstract and general for direct application to specific local situations, contexts, and individuals.

Source: Johnson and Onwuegbuzie, 2004, p.19

b) Qualitative research method

Tracy (2010), researched the use of criteria for research methodology and found in a review of the literature that the there are opposing views on this matter. Some researchers find that using criteria limits the bounds of research whereas others find that using criteria assists in aligning the researcher in the community of research undertaken. An analogy used is that of a chef, who needs to be guided in the formation of a masterpiece, especially during his learning phase. Eight generic quantitative research criteria are listed in Table 3.2 developed by Tracy (2010) to act as a platform for quantitative research.

Table 3.2: Eight Criteria for Excellent Qualitative Research, (Tracy 2009, p.840)

Criteria for quality(end goal)	**Various means, practices, and methods through which to achieve**
Worthy topic	**The topic of the research is**
	• Relevant
	• Timely
	• Significant
	• Interesting
Rich rigor	**The study uses sufficient, abundant, appropriate, and complex**
	• Theoretical constructs
	• Data and time in the field
	• Sample(s)

	• Context(s)
	• Data collection and analysis processes
Sincerity	**The study is characterized by**
	• Self-reflexivity about subjective values, biases, and inclinations of the researcher(s)
	• Transparency about the methods and challenges
Credibility	**The research is marked by**
	• Thick description, concrete detail, explication of tacit (non-textual) knowledge, and showing rather
	than telling
	• Triangulation or crystallization
	• Multivocality
	• Member reflections
Resonance	**The research influences, affects, or moves particular readers or a variety of audiences through**
	• Aesthetic, evocative representation
	• Naturalistic generalizations
	• Transferable findings
Significant contribution	**The research provides a significant contribution**
	• Conceptually/theoretically
	• Practically
	• Morally
	• Methodologically
	• Heuristically
Ethical	**The research considers**
	• Procedural ethics (such as human subjects)
	• Situational and culturally specific ethics
	• Relational ethics
	• Exiting ethics (leaving the scene and sharing the research)
Meaningful coherence	**The study**
	• Achieves what it purports to be about
	• Uses methods and procedures that fit its stated goals
	• Meaningfully

Source: Tracy 2009, p.840

It may be feasible that the eight criteria can be considered for excellent quantitative research but this will need to be tested. Table 3.3 lists the strengths and weaknesses of a qualitative research design.

Table 3.3: Strengths and weaknesses of Qualitative Research, (Johnson and Onwuegbuzie, 2004, p.20)

	Strengths
a.	The data are based on the participants' own categories of meaning.
b.	It is useful for studying a limited number of cases in depth.
c.	It is useful for describing complex phenomena.
d.	Provides individual case information.
e.	Can conduct cross- case comparisons and analysis.
f.	Provides understanding and description of people's personal experiences of phenomena (i.e., the "emic" or insider's viewpoint).
g.	Can describe, in rich detail, phenomena as they are situated and embedded in local contexts.
h.	The researcher identifies contextual and setting factors as they relate to the phenomenon of interest.
i.	The researcher can study dynamic processes (i.e., documenting sequential patterns and change).
j.	The researcher can use the primarily qualitative method of "grounded theory" to generate inductively a tentative but explanatory theory about a phenomenon.
k.	Can determine how participants interpret "constructs" (e.g., self- esteem, IQ).
l.	Data are usually collected in naturalistic settings in qualitative research.

m.	Qualitative approaches are responsive to local situations, conditions, and stakeholders' needs.
n.	Qualitative researchers are responsive to changes that occur during the conduct of a study (especially during extended fieldwork) and may shift the focus of their studies as a result.
o.	Qualitative data in the words and categories of participants lend themselves to exploring how and why phenomena occur.
p.	One can use an important case to demonstrate vividly a phenomenon to the readers of a report.
q.	Determine idiographic causation (i.e., determination of causes of a particular event).
	Weaknesses
a.	Knowledge produced may not generalize to other people or other settings (i.e., findings may be unique to the relatively few people included in the research study).
b.	It is difficult to make quantitative predictions.
c.	It is more difficult to test hypothesis and theories
d.	It may have a lower credibility with some administrators and commissioners of programs.
e.	It generally takes more time to collect the data when compared to quantitative research.
f.	Data analysis is often time consuming.
g.	The results are more easily influenced by the researcher's personal biases and idiosyncrasies.

Source: Johnson and Onwuegbuzie, 2004, p.20

c) Research method used

Based on the strengths and weaknesses of quantitative and qualitative research methods and the usefulness to this research the method chosen is quantitative. This is mainly due to the fact that the research is not exploratory in nature. Several studies have been conducted in the research of the causes and effects of delays in project management in various fields as shown in chapter 2. This study will only expand the study area into the coal mining sector of the economy. The data to be collected will be used to test previous research findings and expand into the coal mining industry which has previously not been tested. The quantitative research will allow for independent results without any bias from the researcher. Fundamental to this research is the ability to test the cause and effect relationships within the coal mining industry project delays. The research is based on the specific recorded results from coal mining projects and will not be exploratory in nature. Therefore subjectivity will be minimized. The research results will be used to predict generalizations about other coal mining projects in other areas of the world.

3.2.2 *Instrumentation*

The data collection phase of this research is of paramount importance to ensuring usable information to successfully test the hypotheses and determining what future research may be required in the coal mining industry in terms of the causes and effects of delays in projects.

Leedy and Ormrod (2005), suggest that survey research involves acquiring information about one or more groups of people which is typically measured by means of face to face interviews, telephonic interviews or written questionnaires. The internet is also mentioned which can involve the use of web based questionnaires. The goal is to learn about a population based on a sample. The use of face to face and telephonic interviews can be structured and semi structured (Leedy and Ormrod, 2005). Further, in structured interviews the questions are asked based on a pre determined list of questions and semi structured interviews have individually tailored questions to probe for more information or clarity.

Face to face interviews usually yield the best response rate. These types of interviews are usually formal and emotionally neutral in a quantitative study (Leedy and Ormrod, 2005). The authors further suggest that telephone interviews may be less time consuming and inexpensive, but the level of report that is possible will be less than with face to face interviews. The response rate is also not as high as with face to face interviews.

Leedy and Ormrod (2005), show that questionnaires can be sent out to potential respondents many kilometers away therefore reaching a large sample. The respondents will be able to be more truthful that in interviews due to the assurance of confidentiality. The disadvantage of questionnaires is that the return rate is low and is susceptible to misinterpretations. According to UMIACS (2011) the web-based questionnaire method assumes that respondents have access to a computer. The questionnaires may exclude some disabled respondents. The authors admit that there are few substantive differences between the paper type questionnaire and the web- based questionnaire. The differences that have been found are based on the design of the instrument.

For the purpose of this research an electronic questionnaire is the preferred method of sampling for data.

3.3 Sampling process

The population to be sampled is the coal mining organizations in South Africa. The sampling method is non probability sampling, more specifically purposive sampling as discussed by Leedy and Ormrod (2005). The reason for this method of sampling is due to the limited size of the population in the coal mining industry in South Africa. Mining organizations will be approached which are considered large mining organizations involved in expansion projects. The mining organizations to be approached are limited to the members of the Chamber of mines in South Africa:

- BHP Billiton Energy Coal South Africa

- Anglo Operations Limited, Anglo Coal Division
- Exxaro Resources Limited
- Xstrata Coal South Africa
- Umcebo Mining (Pty) Limited
- Sasol Mining (PTY) Limited
- Coal of Africa Limited
- Optimum Coal
- Total Coal South Africa
- Kangra Group (Pty) Limited
- Kuyasa Mining (Pty) Limited

3.4 Measurement scales

Measurement scales ultimately dictate the statistical procedures that will be used in the analysis of the collected data (Leedy and Ormrod, 2005).The measurement scales for this research will firstly be nominal, which restricts the data into discrete categories. Nominal measurement enables the analysis of variables such as gender, race and position in an organization.

Secondly the use of ordinal scales will be appropriate due to the ranking requirement of this study. As listed by Leedy and Ormrod (2005), with ordinal scale measurement the data can enable the determination of the median, percentile rank and Spearmen's rank order correlation.

In order to get a full analysis of the collected data it is required to thirdly use interval measurement scales to enable the calculation of means, standard deviations and further correlation calculations such as the Pearson product moment correlations. This measurement scale will enable the causes and effects of project delays in the coal mining industry to be ranked in various ways, such as the most likely to the least likely cause of a delay in coal mining projects.

3.5 Data collection

Questionnaires will be used as the instrument to collect data. The questionnaires will be emailed to the project management departments of the listed organizations. The request to complete the questionnaire is attached as Annexure E. To ensure the correct departments are engaged the head offices will be contacted telephonically in order to obtain data as well as permission to contact the separate operations if necessary. The permission request will be emailed as confirmation. The department in charge of external communication will be addressed to assist with the method of obtaining information as well as contact names for interviews and the questionnaire completion. The letter is attached as Annexure D.

The proposed questions are attached as Annexure F. These answered questions will serve as the data to answer the various hypotheses.

Table 3.4: Classification of questions

The full questionnaire is attached as Annexure F	
Section 1: Question1- 4	**Biographical details** The questions establish the background of the respondent in terms of the company they work, gender, age, experience and level in the project management structure.
Section 2: Question 1- 11	**General questions related to the literature on delays and their effects** To determine the experience of delays, where the delays take place in the project management process, and if classification and recording took place. The effects of delays in the organization are questioned to determine if they have been recorded.

Section 3:	Selection of possible delays listed
Question 1- 44	To determine what the specific delays are that have been experienced in the coal mining industry.

The study will be limited to the employees and employers in the coal mining industry, contractors used in coal mining projects and consultants used in coal mining projects. The geographical area of focus will be in the areas of Mpumalanga, Free State provinces in South Africa as well as the Waterberg area in Limpopo province. The study will not evaluate the sub-contractors and secondary consultants used.

3.6 Ethical considerations

Most ethical issues are grouped as; protection from harm, informed consent, right to privacy, and honesty with professional colleagues (Leedy and Ormrod, 2005) .To ensure that this research is managed in an ethical manner, there are various issues to consider. These are:

a) All communication and information with the various respondents will be treated in the highest confidence. No company information will be disclosed to other companies.

b) The completion of the questionnaire is completely voluntary.

c) All respondents will be treated with complete anonymity.

3.7 Perceived limitations of the research

The nature of the research has inherent limitations. Limitations were more specifically linked to biases in terms of the subjectivity of the questionnaires and non representativeness of the elements of the sample population. This research will not asses the success of the projects referred to or the maturity of the project management system of the organization.

3.8 Summary

This chapter has outlined the methodology followed in determining which research design to use, the sampling process to be representative of the population, the questionnaire design to ensue usable data as well as the method of collecting the data needed to address the various research questions. Within this methodology ethical issues have been addressed to ensure that anonymity and confidentiality are maintained. The next chapter will cover a complete analysis of the data collected.

Chapter 4: Research Results

4.1 Introduction

In chapter 3 the methodology of the research which consisted of the research design, sampling process and the questionnaire design, was set out. The questionnaire was subsequently sent out to possible respondents. The data collected from the respondents will be discussed in this chapter. The results conform to the questionnaire completed by the respondents as shown in Annexure F. These questions were grouped as biographical details, general questions related to the literature and finally specific delays as listed in the construction industry as well as possible delays related to the coal mining industry. This chapter presents the results obtained from the questionnaires in this order.

Thirty two respondents completed the questionnaire successfully. These respondents are all experienced in projects in the coal mining industry either in the consulting, contracting or mining disciplines.

4.2 Sample

The population sampled was the coal mining organizations in South Africa. Mining organizations were approached mostly by means of email. The sample was based on the coal mining companies listed as members of the Chamber of Mines of South Africa (Chamber of Mines of South Africa, 2011). The contact details were found on the websites of the various mining organizations. The mining consulting firms were searched for using the search engine Google as well as telephonic consultation with the mining organizations to determine which consulting firms to approach. The mining contractor firms were searched for by using the search engine Google as well as telephonic consultation with the mining organizations to determine which contracting firms to approach. The sample of companies requested to answer the questionnaire are listed in Table 4.1. The sampling method is non probability sampling, more specifically purposive sampling as discussed by Leedy and Ormrod (2005). The reason for this method of sampling is due to the limited size of the population in the coal mining industry in South Africa.

Table 4.1: Sample companies

Number	**Mining**	**Mining Consultant**	**Mining Contractor**
1	BHP Billiton Energy Coal South Africa	Jones & Wagner	Megacube
2	Anglo Operations Limited, Anglo Coal Division	VBKOM	Shaft Sinkers
3	Exxaro Resources Limited	Golder and Associates	AVENGE Grinaker LTA
4	Xstrata Coal South Africa	RUNGE	AVENGE Moolmans Mining
5	Umcebo Mining (Pty) Limited	Minxcon	MCC Group
6	Sasol Mining (PTY) Limited	A & B Global Mining	Murray and Roberts
7	Coal of Africa Limited	Marston	
8	Optimum Coal	Metallicon	
9	Total Coal South Africa		
10	Kangra Group (Pty) Limited		

11	Kuyasa Mining(Pty) Limited		

Most of the companies have email contact details and telephone numbers which ease the process of making contact. Some of the companies have a comment service which is linked to the web page. As a web site visitor you are able to add a contact name, contact telephone number and the comment to which the company will respond. Most of the companies responded an acknowledgement of receipt. Some of the companies did not communicate further. Some of the companies replied that they would complete one questionnaire on behalf of the company.

The intention was to receive as many responses as possible per company as the size of the project management departments of each company is unknown. Out of the eleven mining companies selected only six responded to the request to complete the questionnaire. Only one company respectfully declined to respond due to intellectual property risks. Out of the eight consulting companies four responded to the request to complete the questionnaire. Only two of the seven mining contractor companies responded to the request to complete the questionnaire.

4.3 Respondents

Table 4.2 shows the number of respondents per company approached for completion of the questionnaire. A total of 32 questionnaires were completed. In the column labeled “Number of respondents” the first value represents those that have completed the questionnaire successfully and the second value in brackets represents the possible respondents from that organization.

Table 4.2: Respondent companies

Mining Companies	Number of respondents
BHP Billiton Energy Coal South Africa	8 (8)
Exxaro Resources Limited	2 (4)
Umcebo Mining (Pty) Limited	3 (3)
Sasol Mining (PTY) Limited	1 (4)
Optimum Coal	1 (2)
Kangra Group (Pty) Limited	1 (1)
Anglo Coal	1 (4)
Consulting Companies	
Jones & Wagner	4 (4)
VBKOM	1 (2)
Golder and Associates	4 (6)
Metallicon	1 (2)
Contractor Companies	
AVENGE Grinaker LTA	3 (3)
AVENGE Moolmans Mining	2 (3)

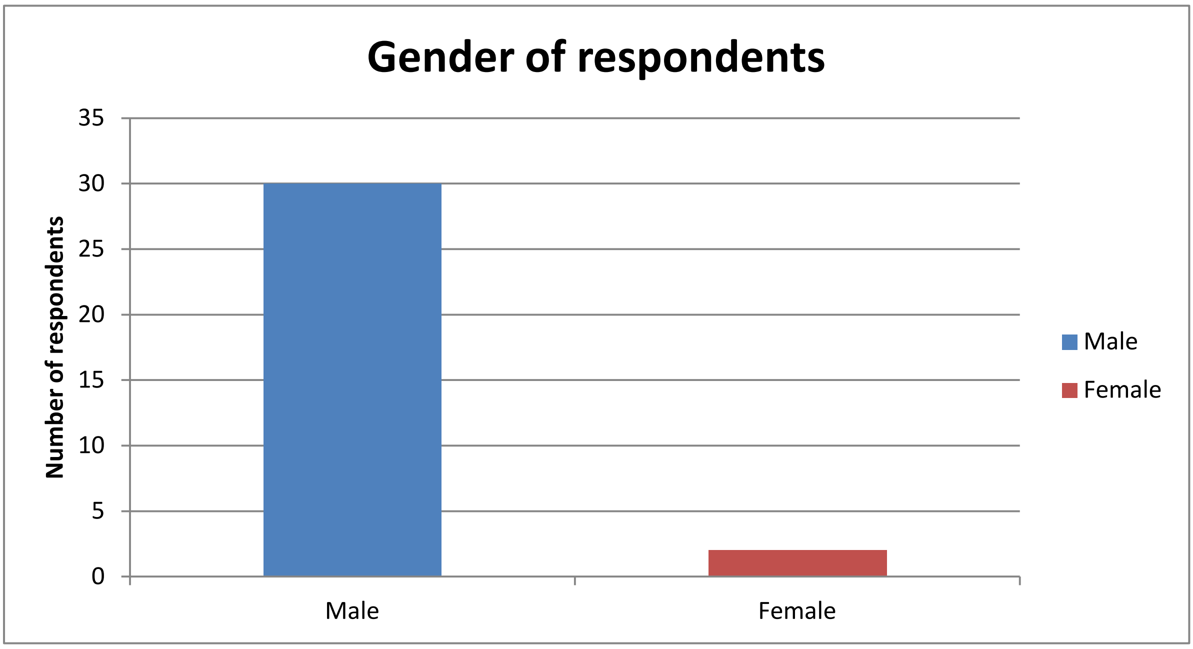
4.4 *Biographic data*

4.4.1 *Gender of respondents*

Table 4.3: Gender of respondents

Gender	Male	Female
Number of respondents	30	2

Figure 4.1: Gender of respondents



As shown in Table 4.3, 27 of the 29 respondents are male which is equal to 98%. 2 of the respondents are female which equates to 2%.

4.4.2 *Age of respondents*

Table 4.4: Age of respondents

Age	<20 years	21-30 years	31-40 years	41-50 years	51- 65 years
Number of respondents	0	1	14	7	10

Figure 4.2: Age of respondents

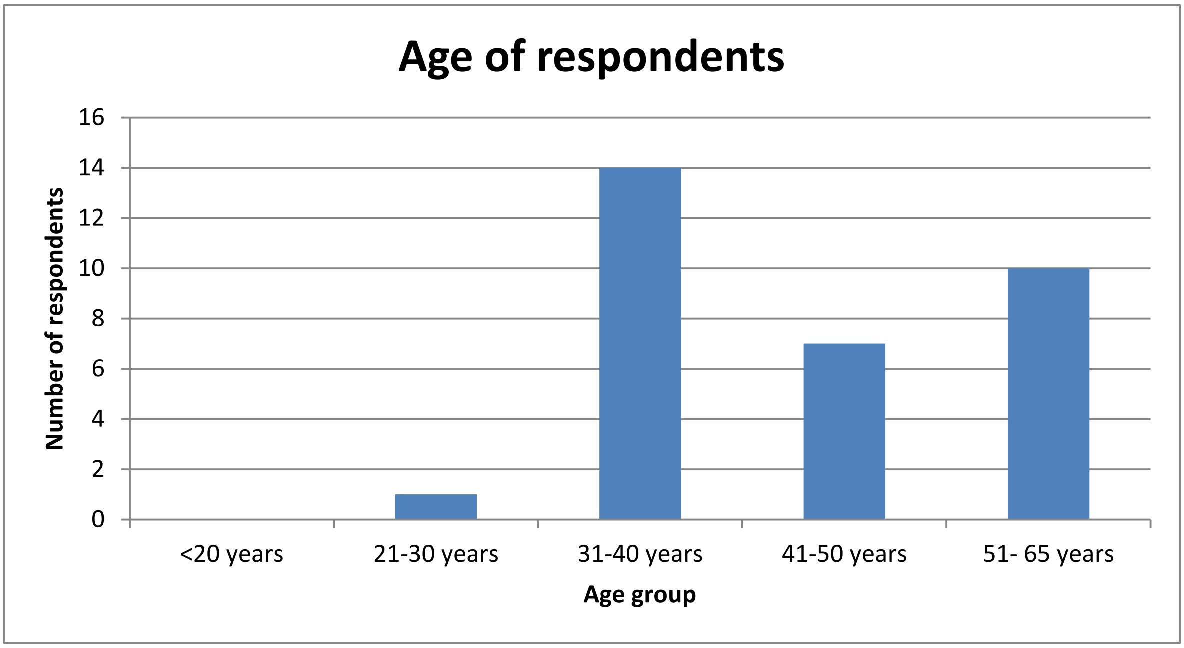


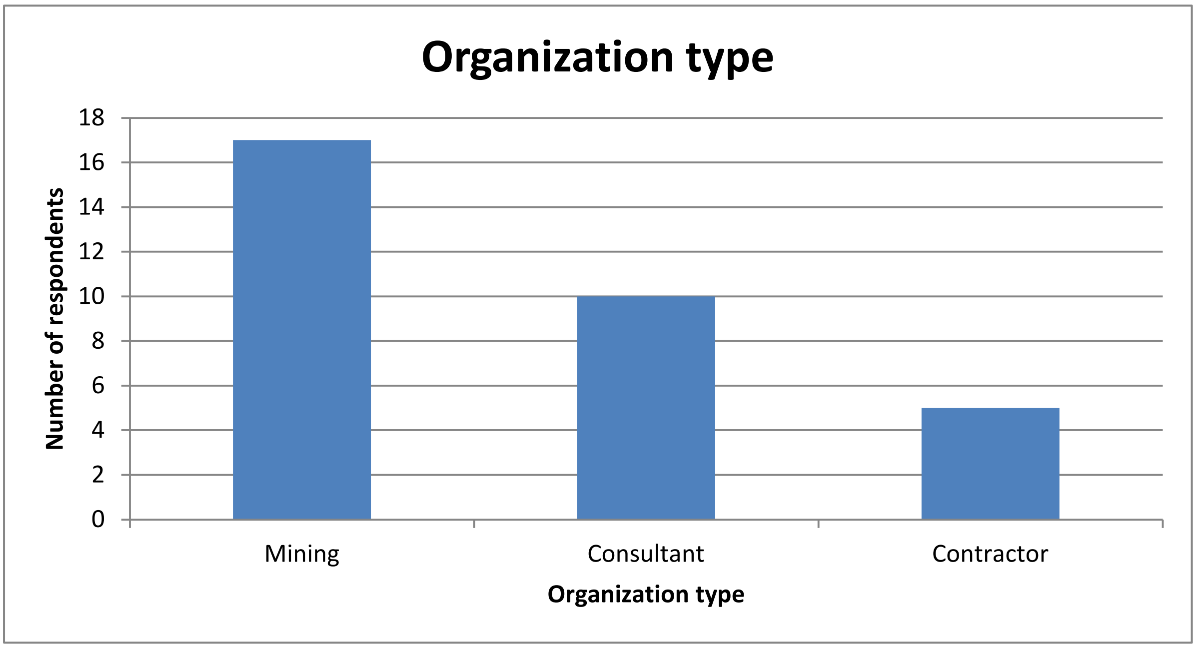
Table 4.4 shows the number of respondents per age group. None of the respondents are under the age of 20 years. The majority of the respondents (n=14 or 44%) are in the age group 31 to 40 years. The next largest group is in the age group 51 to 65 years (n=10 or 31%). The number of respondents in the 41 to 50 age group is 7 which equates to 24%. The smallest number of respondents is in the 21 to 30 age group (n=1or 3%).

4.4.3 *Organization of respondents*

Table 4.5: Organization of respondents

Organization	Mining	Consultant	Contractor
Number of respondents	**17**	**10**	**5**

Figure 4.3: Organization of respondents



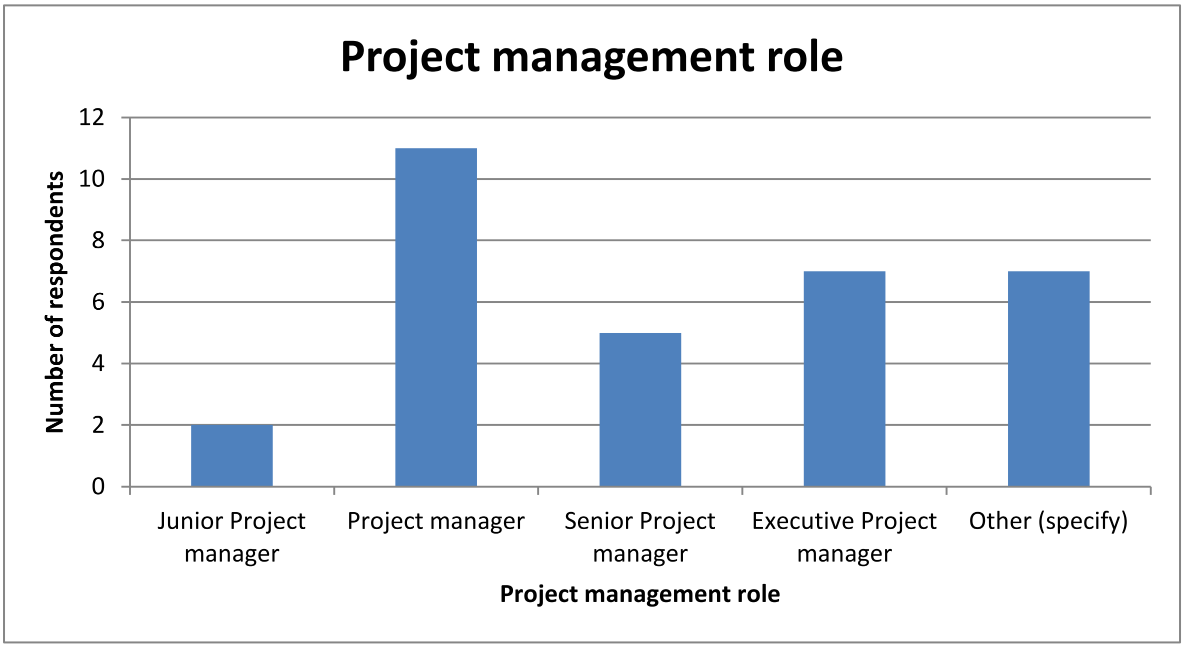
From Table 4.5 the clear majority of respondents are from the mining industry (n=17 or 53%). The consultant's are the second most represented (n=10 or 31%) and the mining contractors are in the minority (n=5 or 16%).

4.4.4 *Project management role of respondents*

Table 4.6: Project management roles of respondents

Project management roles	**Junior Project manager**	**Project manager**	**Senior Project manager**	**Executive Project manager**	**Other**
Number of respondents	2	11	5	7	7

Figure 4.4: Project management roles of respondents



In Table 4.6 and Figure 4.4 the majority of the respondents are in the role of project manager (n=11 or 34%). This is followed by executive project manager (n=7 or 22%), other (n=7 or 22%), senior project manager (n=5 or 16%) and junior project manager (n=2 or 6%). The category of other includes roles such as project engineer, commercial manager, planning manager and mining engineer. The majority of the respondents are in a senior position in the organizations they represent.

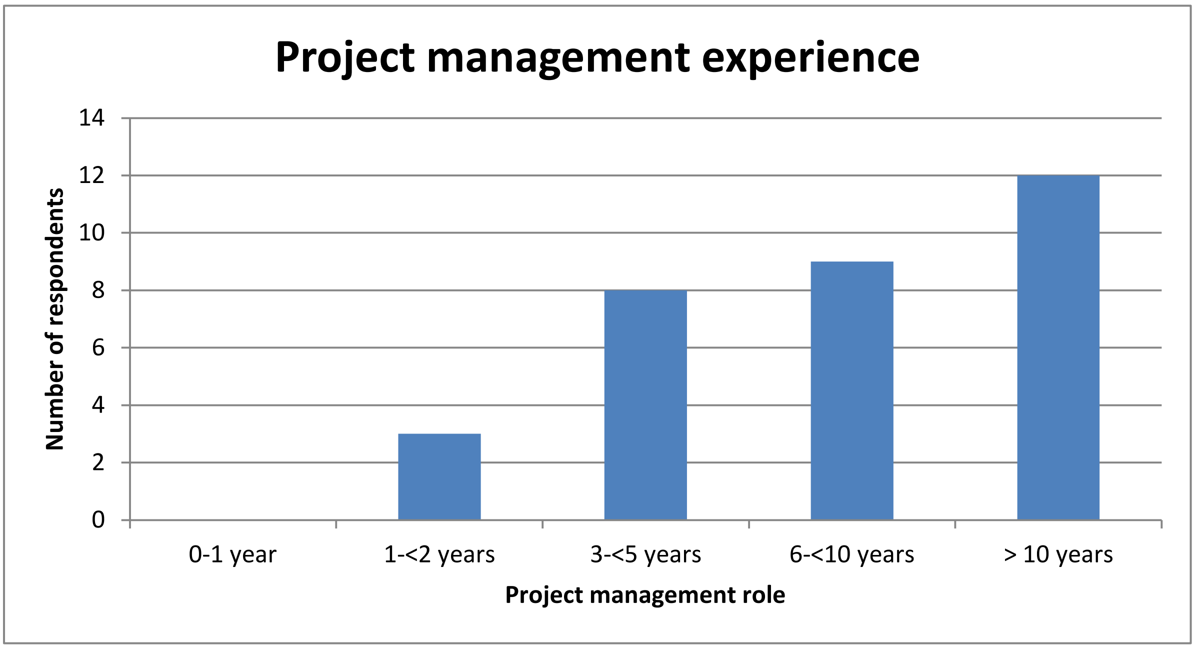
4.4.5 *Project management experience of respondents*

Table 4.7 and Figure 4.5 shows that the majority of the respondents have experience exceeding 10 years (n=12 or 38%). This is followed by the 6 to 10 year category (n=9 or 28%), then the 3 to 5 year category (n=8 or 25%). Finally in the 1 to 2 year category (n=3 or 9%). None of the respondents fell within the 0 to 1 year category. The majority of the respondents have more than 5 years experience.

Table 4.7: Project management experience of respondents

Project management Experience	0-1 year	1-<2 years	3-<5 years	6-<10 years	> 10 years
Number of respondents	0	3	8	9	12

Figure 4.5: Project management roles of respondents



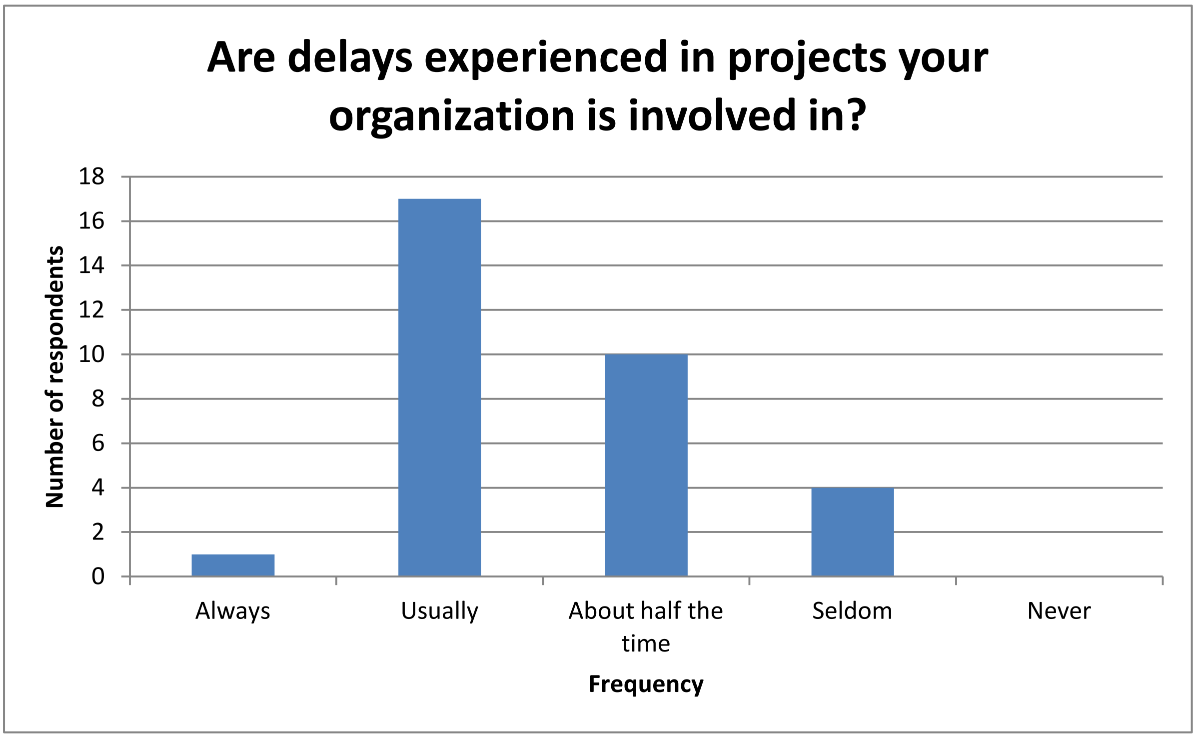
4.5 General questions related to the literature on delays and their effects

4.5.1 *Experiencing delays*

Table 4.8: Response to the question: Are delays experienced in projects your organization is involved in?

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	1	17	10	4	0

Figure 4.6: Response to the question: Are delays experienced in projects your organization is involved in?



The response by the majority of the respondents to the question posed shows that they usually (n=17 or 53%) expect delays. Nine (n=10 or 31%) indicated that they experience delays about half the time and four (n=4 or 13%) indicated that they seldom experience delays. Only one (n=1 or 3%) respondent always experienced delays. None of the respondents have never experienced delays.

4.5.2 *Delays in the project management process*

The project management process is generally divided into life cycle phases. The basic phases are:

a) Conception

b) Selection

c) Planning, scheduling, monitoring and control

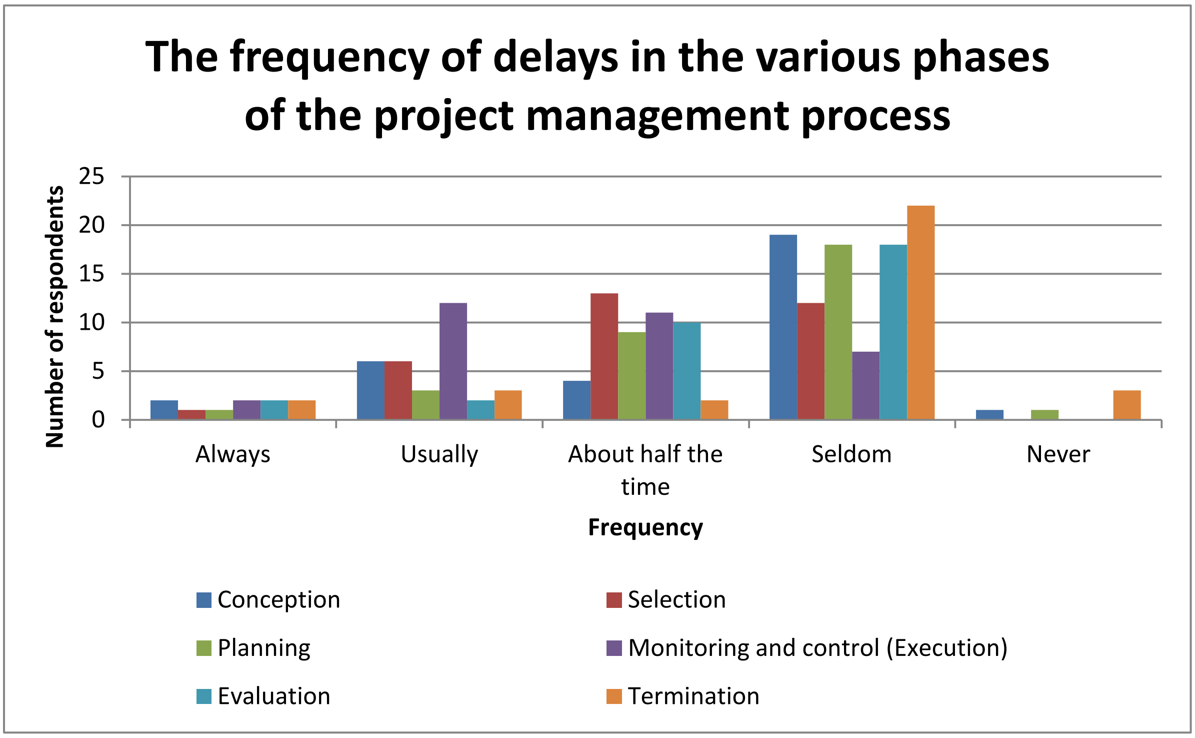
d) Evaluation and termination

Based on the project life cycle, the respondents selected the frequency of delays experienced in each section. Table 4.9 and Figure 4.7 depict the results from the respondents.

Table 4.9: frequency of delays experienced in each section of the project management life cycle sections

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Conception	2	6	4	19	1
Selection	1	6	13	12	0
Planning,	1	3	9	18	1
monitoring and control (Execution)	2	12	11	7	0
Evaluation	2	2	10	18	0
Termination	2	3	2	22	3

Figure 4.7: Response to the question: Are delays experienced in projects your organization is involved in?



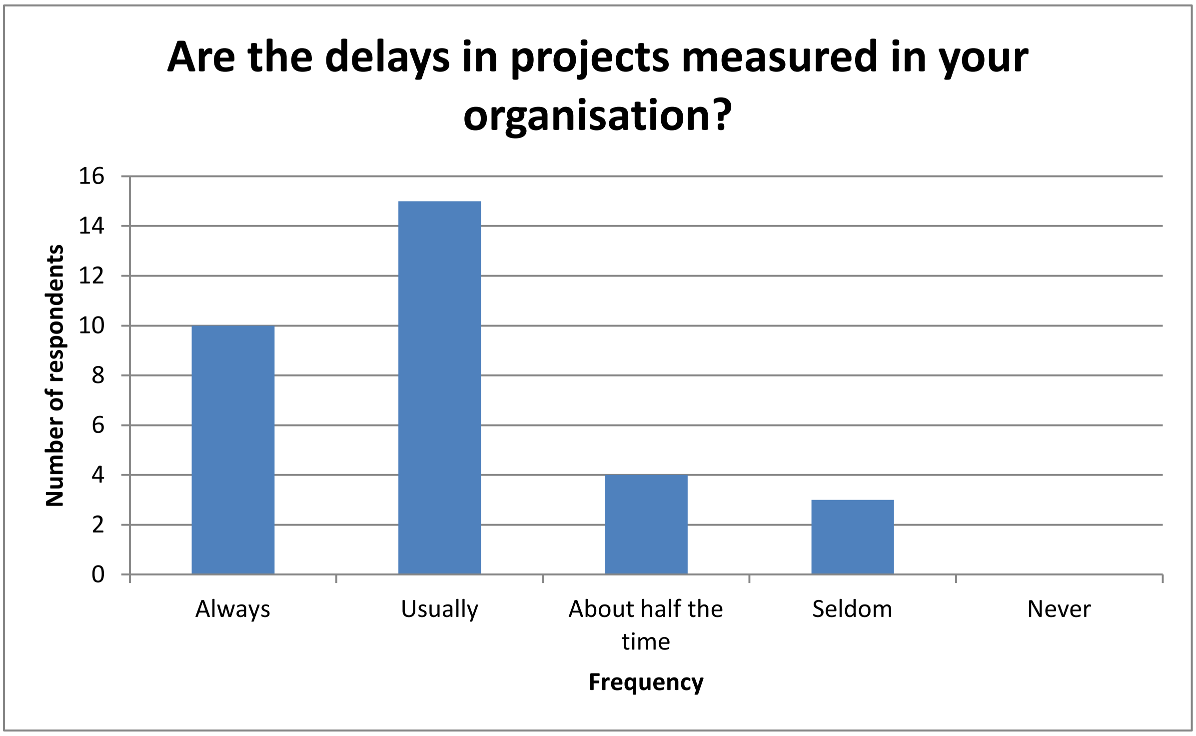
The respondents consider delays in the conception phase take place seldom (n=19 or 59%). The selection phase of a project shows a majority response of about half the time (n=13 or 41%) followed closely by seldom (n=12 or 38%). The data shows that delays seldom take place in the planning phase (n=18 or 56%). The respondents indicate that the in the monitoring and control phase delays usually take place (n=12 or 38%). The evaluation phase (n=18 or 56%) and termination phase (n=22 or 69%) results show that delays in these areas seldom take place.

4.5.3 *Measuring delays*

Table 4.10: frequency of measuring delays in projects in your organization?

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	10	15	4	3	0

Figure 4.8: Response to the question: Are delays in projects measured in your organization?



As illustrated in Table 4.10 and Figure 4.8 the majority of the respondents indicate that delays are usually measured (n=15 or 47%). Nine (n=10 or 31%) of the respondents indicate that they always measure the delays experienced in their projects.

4.5.4 *Measuring delay classification*

As illustrated in Table 4.11 and Figure 4.9 the majority of the respondents indicated that the delays in their projects are usually (n=16 or 50%) classified according to the criteria of critical and non critical, excusable and non excusable, compensable and non- compensable, and concurrent and non- concurrent. Five (n=5 or 16%) of the respondents indicated that their organizations always measure delays according to the criteria listed. Six (n=6 or 19%) of the respondents indicated that they seldom measure delays according to the listed criteria and three (n=3 or 9%) of respondents never classify their project delays.

Table 4.11: Frequency of measuring delays according to a measurement criterion in projects in your organization?

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	5	16	2	6	3

Figure 4.9: Response to the question: Are delays classified according to a project management criterion?

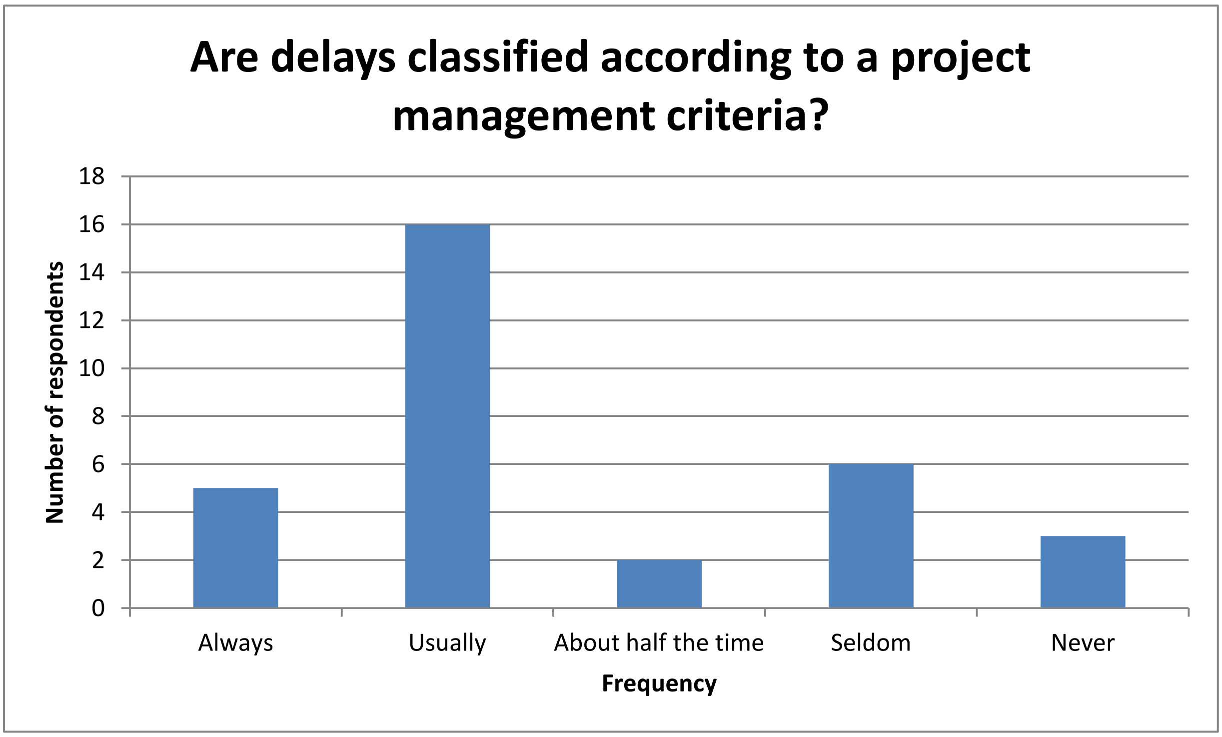


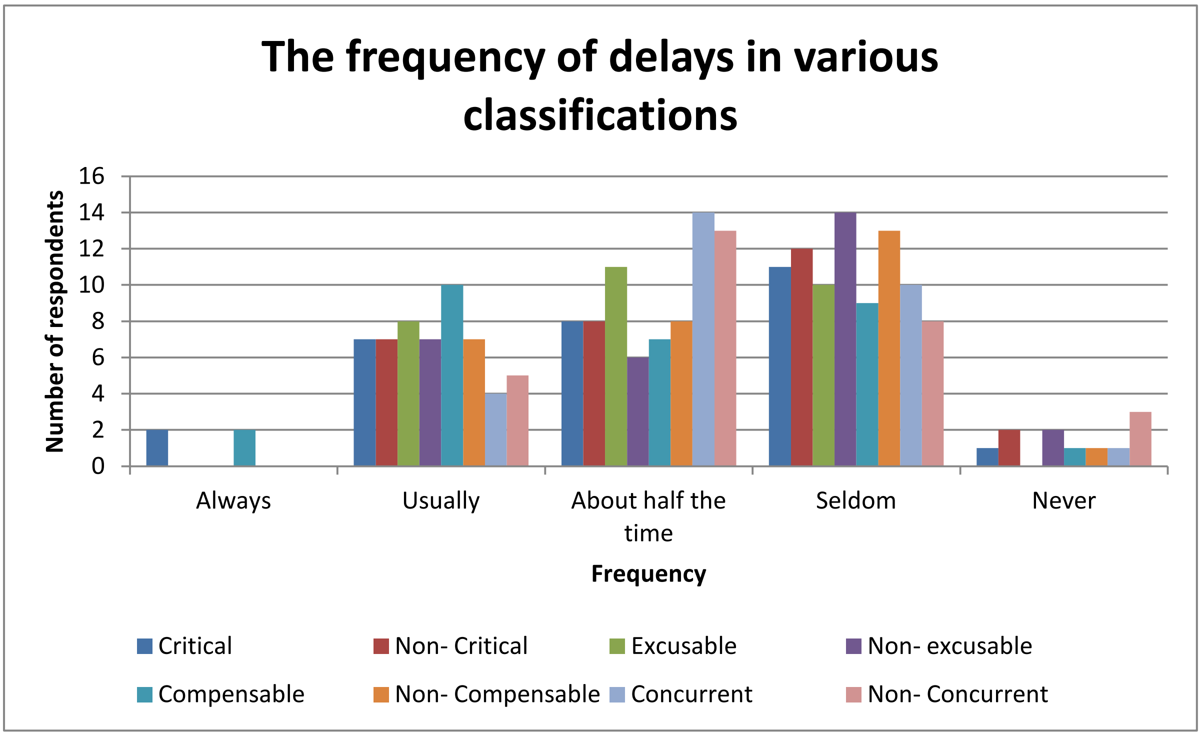
Table 4.12 and Figure 4.10 show the results to the frequency of project delays classified in accordance with the criteria of critical and non critical, excusable and non excusable, compensable and non- compensable, and concurrent and non-concurrent. The majority of the respondents (n=12 or 38%) of respondents indicated that there are seldom critical and non critical delays in coal mining projects. Excusable delays are mostly experience about half the time as indicated

by the majority of the respondents (n=13 or 41%). Fourteen (n=14 or 44%) of the respondents indicated that non excusable delays are seldom experienced. The compensable delays experienced by the respondents show a double maximum value which is ten (n=10 or 31%) indicated that compensable delays are usually experienced and seldom experienced. The non compensable delays are seldom experienced as indicated by the majority (n=13 or 41%) of the respondents. The concurrent and non concurrent delays as indicated by the majority (n=16 or 50%) of the respondents occur about half the time.

Table 4.12: Frequency of measuring delays according to classification in projects in your organization?

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Critical	2	9	8	12	1
Non critical	0	9	9	12	2
Excusable	0	8	13	11	0
Non excusable	0	8	8	14	2
Compensable	2	10	9	10	1
Non compensable	0	8	10	13	1
Concurrent	0	4	16	11	1
Non concurrent	0	5	16	8	3

Figure 4.10: Frequency of measuring delays according to classification in projects in your organization?



4.5.5 *Delays from the perspective of Owners, Consultants and Contractors*

From the perspective of the coal mining owner organizations, as shown in Table 4.13 and Figure 4.11, the use of consultants usually occurs as indicated by the majority of the respondents (n=10 or 59%). Four (n=4 or 24%) of the respondents indicated that they always use consultants. Only one (n=1 or 6%) respondent indicated that they only seldom use consultants and none of the mining respondents indicated that they never use consultants.

Table 4.13: Frequency of the use of consultants in coal mining projects by owner organizations

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	4	10	2	1	0

Figure 4.11: Frequency of the use of consultants in coal mining projects by owner organizations

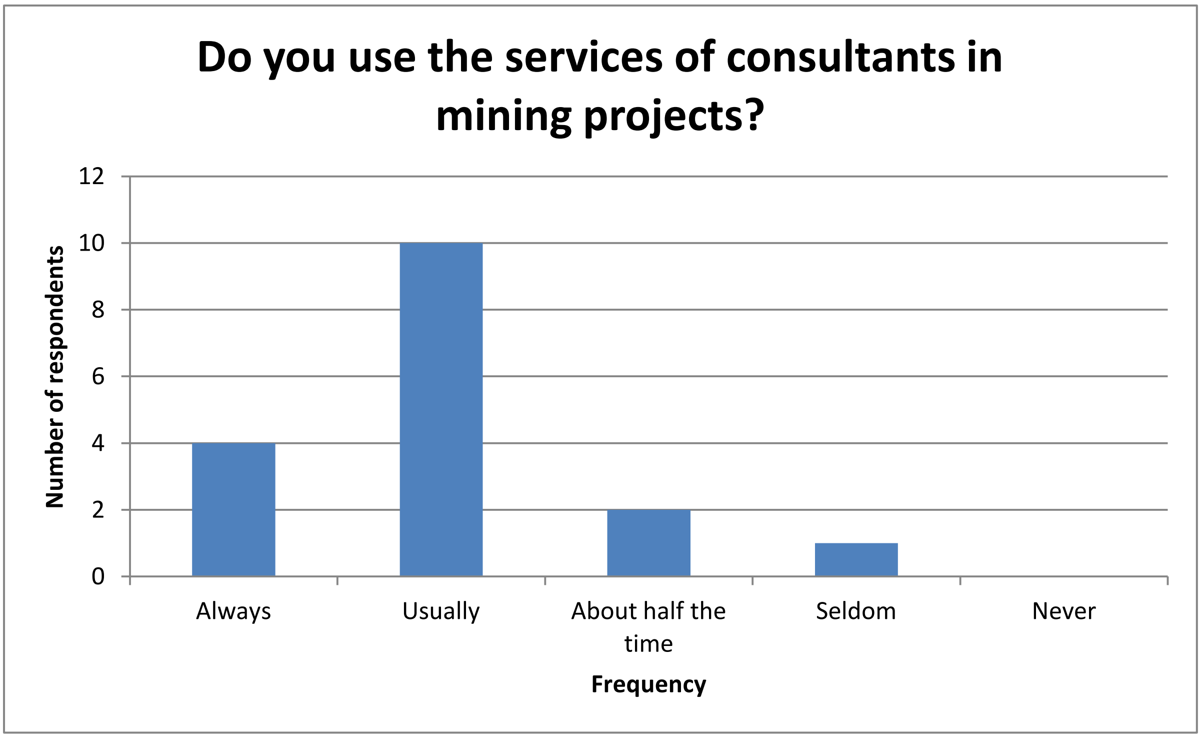
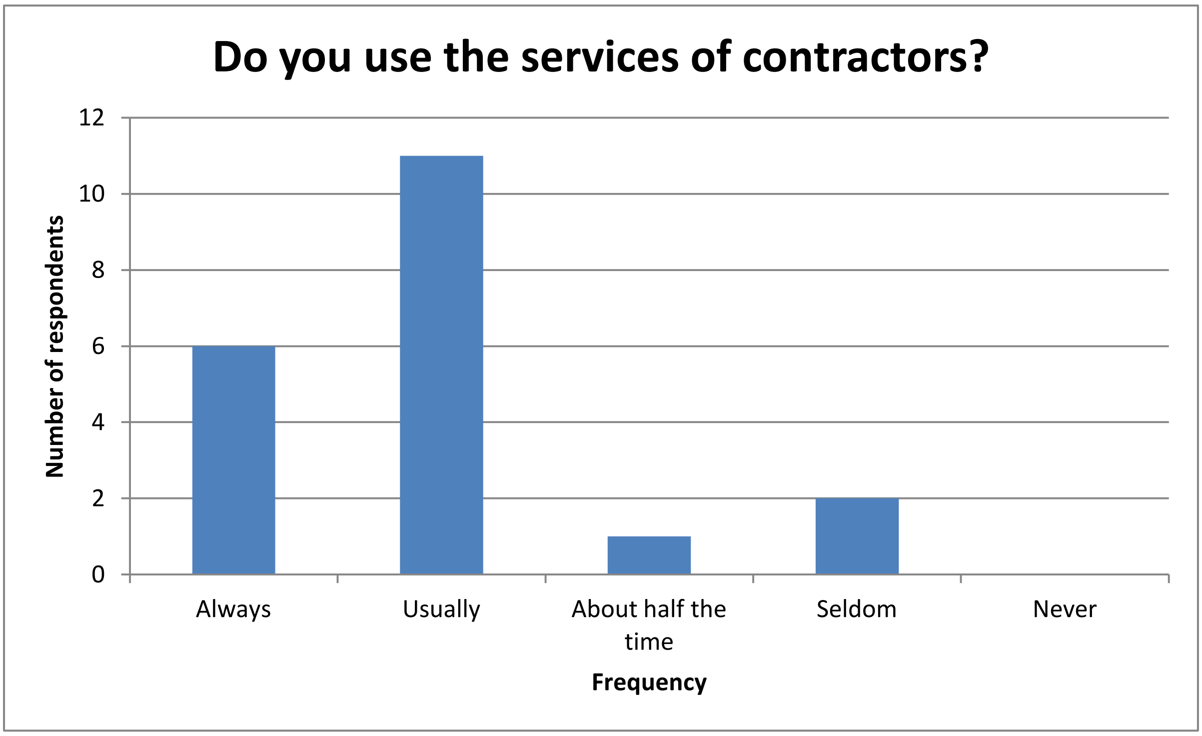


Table 4.14 and Figure 4.12 show that the use of contractors usually occurs as indicated by the majority of the respondents (n=11 or 65%). Six (n=6 or 35%) of the respondents indicated that they always use consultants. Only one (n=2 or 12%) respondent indicated that they only seldom use consultants and none of the mining respondents indicated that they never use consultants. The use of consultants and contractors by coal mining organizations indicate a similar trend.

Table 4.14: Frequency of the use of contractors in coal mining projects by owner organizations

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	6	11	1	2	0

Figure 4.12: Frequency of the use of contractors in coal mining projects by owner organizations

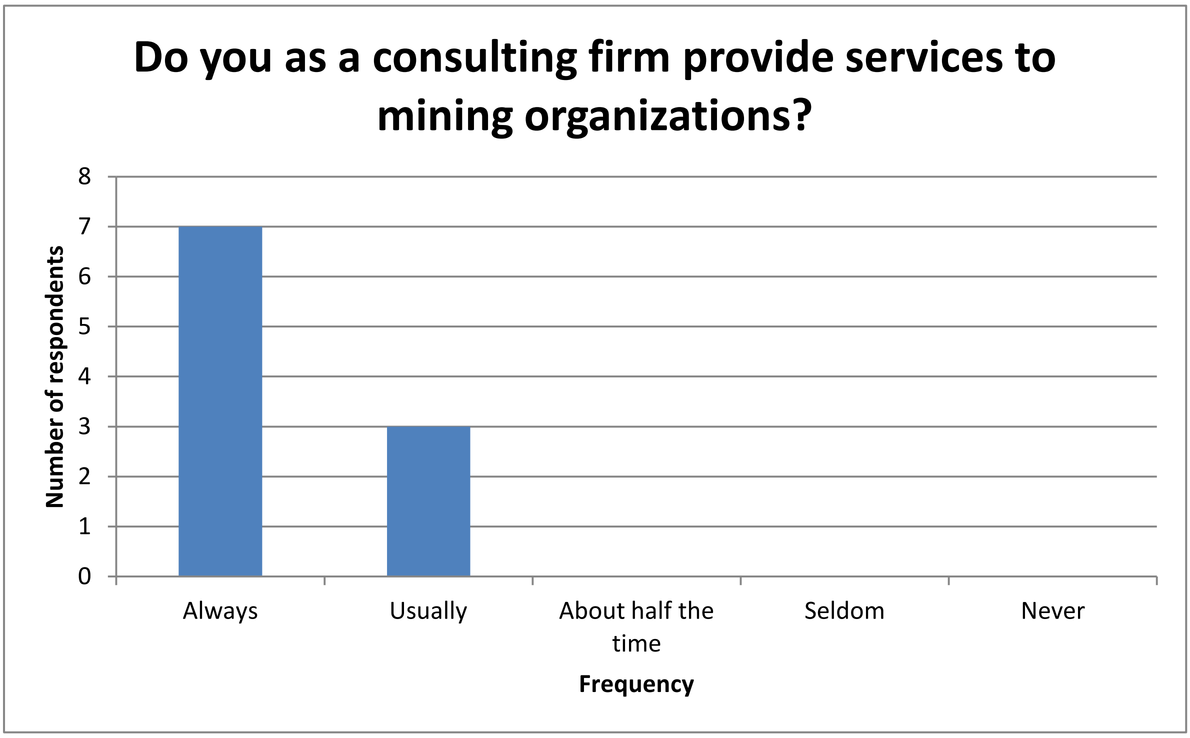


From the perspective of the consultants, as shown in Table 4.15 and Figure 4.13, the consultation work done for mining organizations always occurs as indicated by the majority of the respondents (n=7 or 70%). The remainder of the respondents (n=3 or 30%) indicated that they usually render a consulting service to coal mining organizations.

Table 4.15: Frequency of the consultation by consultants to owners of coal mining projects

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	7	3	0	0	0

Figure 4.13: Frequency of the consultation by consultants to owners of coal mining projects

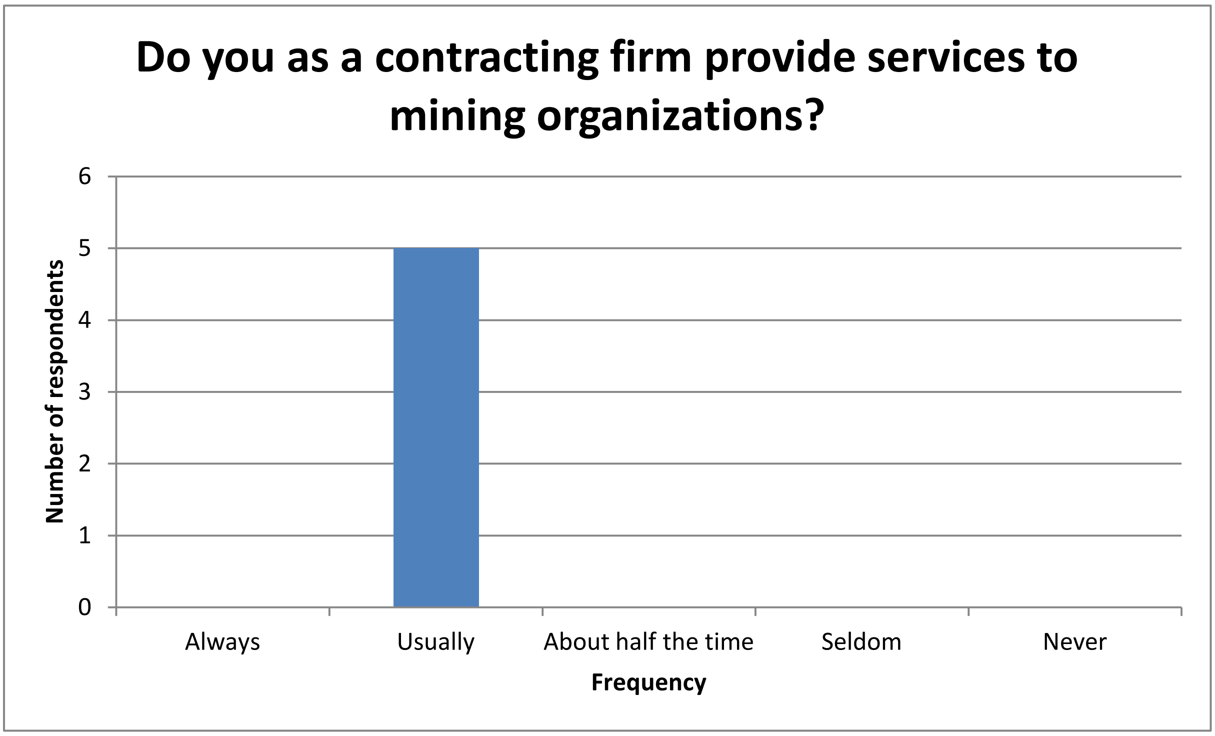


From the perspective of the mining contractor, the mining organizations usually use the services of a mining contractor as shown in Table 4.16 and Figure 4.14. This is a similar response as that given by the mining organizations in Table 4.14 and Figure 4.11.

Table 4.16: Frequency of the contracting services provided by contractors to owners of coal mining projects

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	0	5	0	0	0

Figure 4.14: Frequency of the contracting services provided by contractors to owners of coal mining projects



4.5.6 *The effects of delays experienced*

Table 4.17 and Figure 4.15 illustrate that the majority of the respondents (n=20 or 63%) usually experience an increase in project delivery timing due to delays. Five (n=5 or 16%) responded that they always experience an increase in project delivery timing due to delays. Only four (n=4 or 13%) seldom experienced an increase in project delivery timing due to delays and none of the respondents never experienced the increase.

Table 4.17: Frequency of an increase in project delivery timing

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	5	20	3	4	0

Figure 4.15: Frequency of an increase in project delivery timing

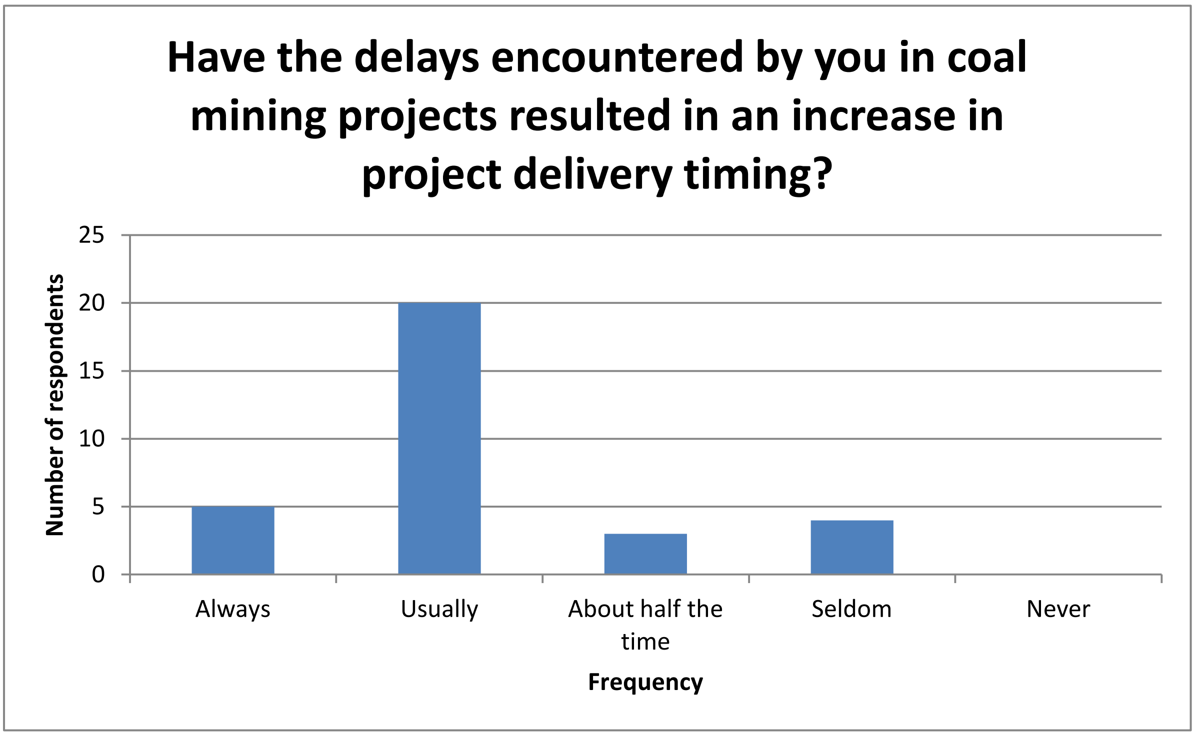


Table 4.18 and Figure 4.16 illustrate that the majority (n=17 or 53%) of the respondents have usually experienced an increase in the project costs due to delays. Four (n=4 or 13%) of the respondents has always experienced an increase of project costs due to delays. Seven (n=7 or 22%) of the respondents have seldom experienced and increase in project costs and one (n=1 or 3%) respondent has never experience an increase in project costs due to delays.

Table 4.18: Frequency of an increase in project cost

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	4	17	3	7	1

Figure 4.16: Frequency of an increase in project cost

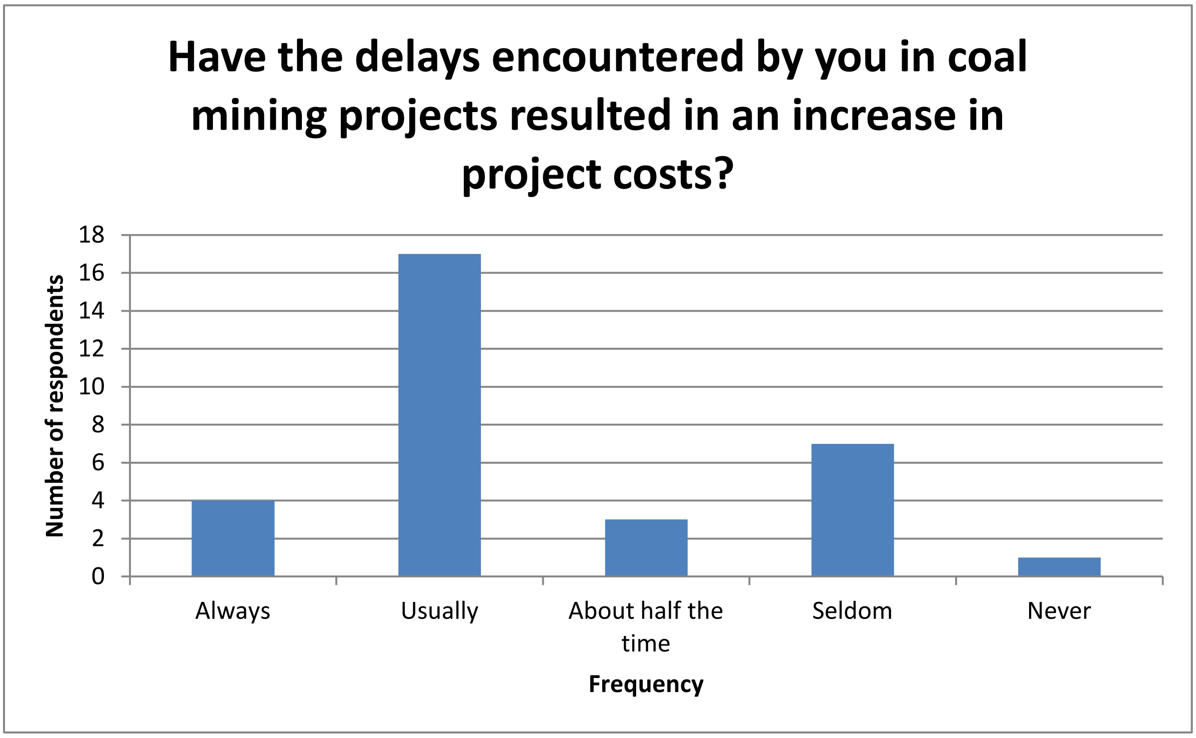


Table 4.19 and Figure 4.17 illustrate that the majority of the respondents (n=12 or 38%) usually record the effects of delays experienced as they occur. Nine (n=9 or 28%) have responded that they always record the effects of the delays experienced in their projects. None of the respondents indicated that they never record the effects of delays as they occur.

Table 4.19: Frequency of the measuring of the effects of delays

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	9	12	7	4	0

Figure 4.17: Frequency of the measuring of the effects of delays

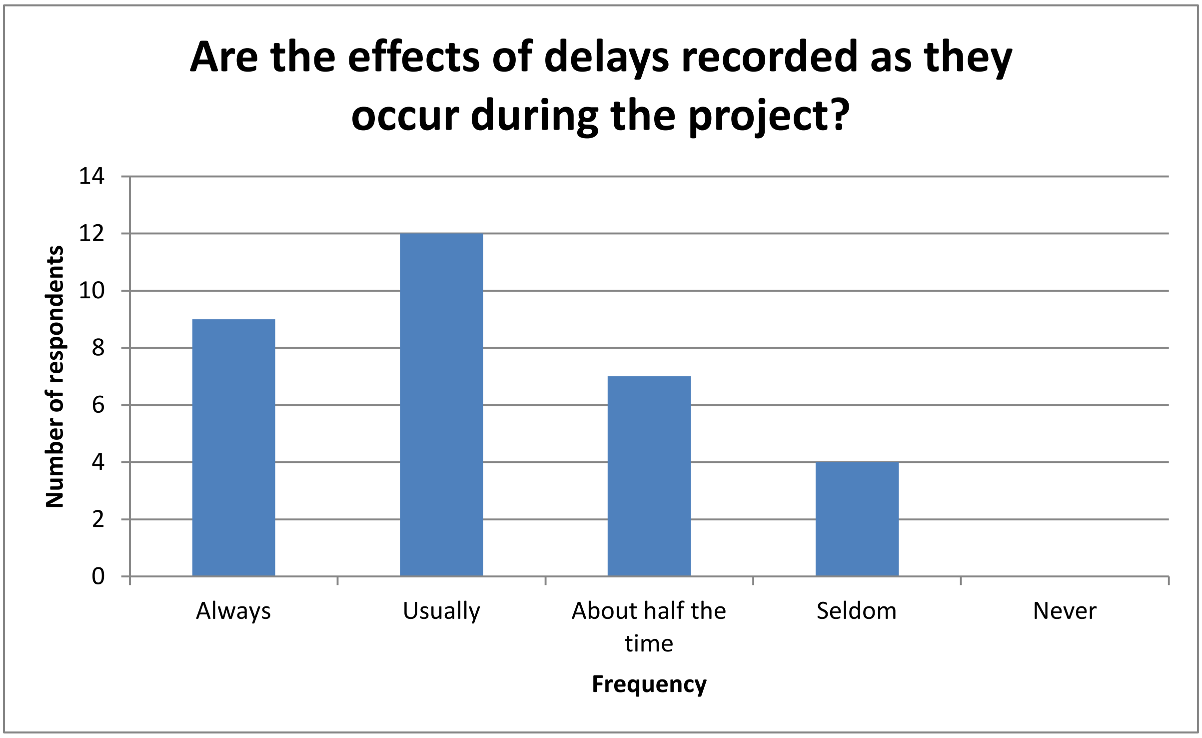
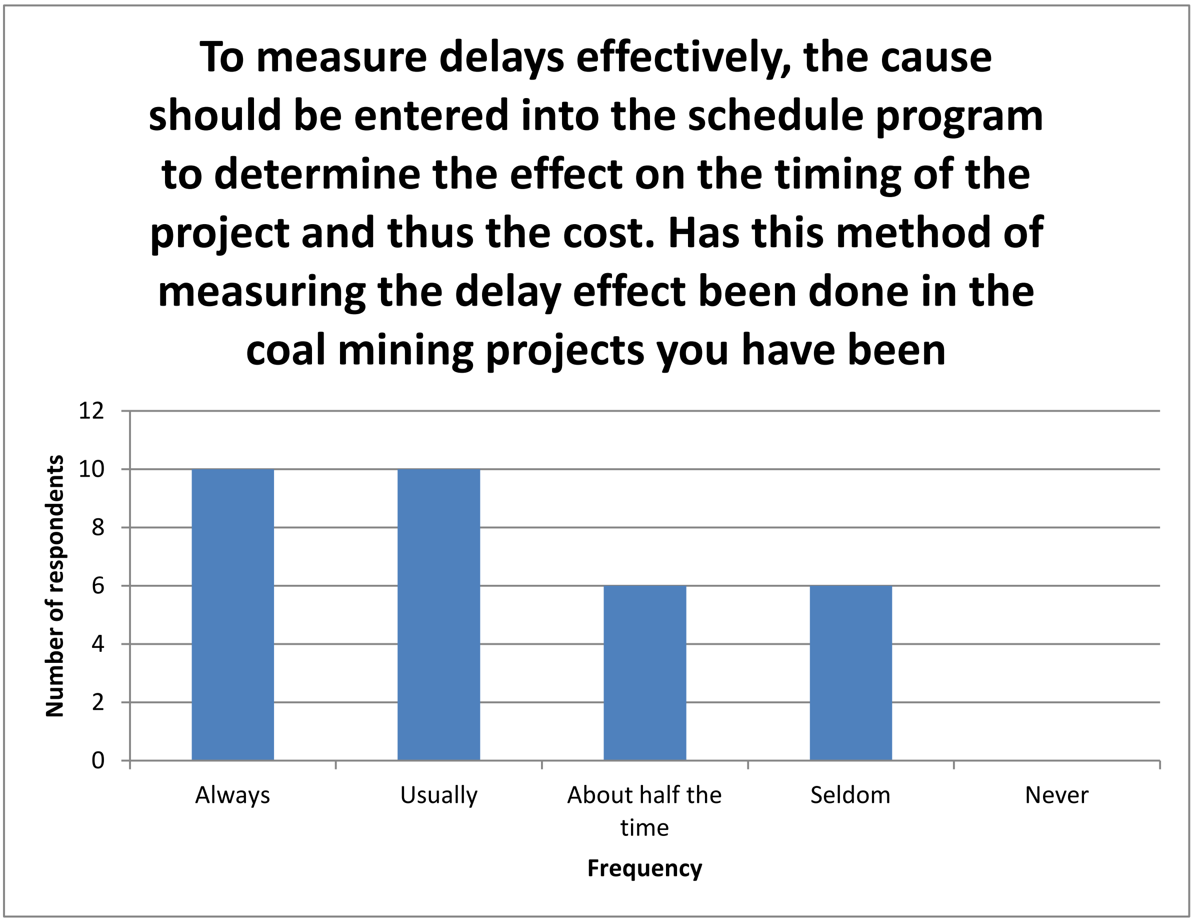


Table 4.20 and Figure 4.18 shows a split majority with regard to using the project schedule to determine the effect of timing on the project due to delays. The majority of the respondents indicated that they always (n=10 or 31%) and usually (n=10 or 31%) use the schedule method to determine the effects of timing due to delays. Six (n=6 or 19%) of the respondents indicated that they use this method about half the time and the same number (n=6 or 19%) indicated that they seldom use this method. None of the respondents indicate that they never use the schedule method to determine the effect of delays on the project timing.

Table 4.20: Frequency of using the project schedule to determine the effects of delays

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	10	10	6	6	0

Figure 4.18: Frequency of using the project schedule to determine the effects of delays

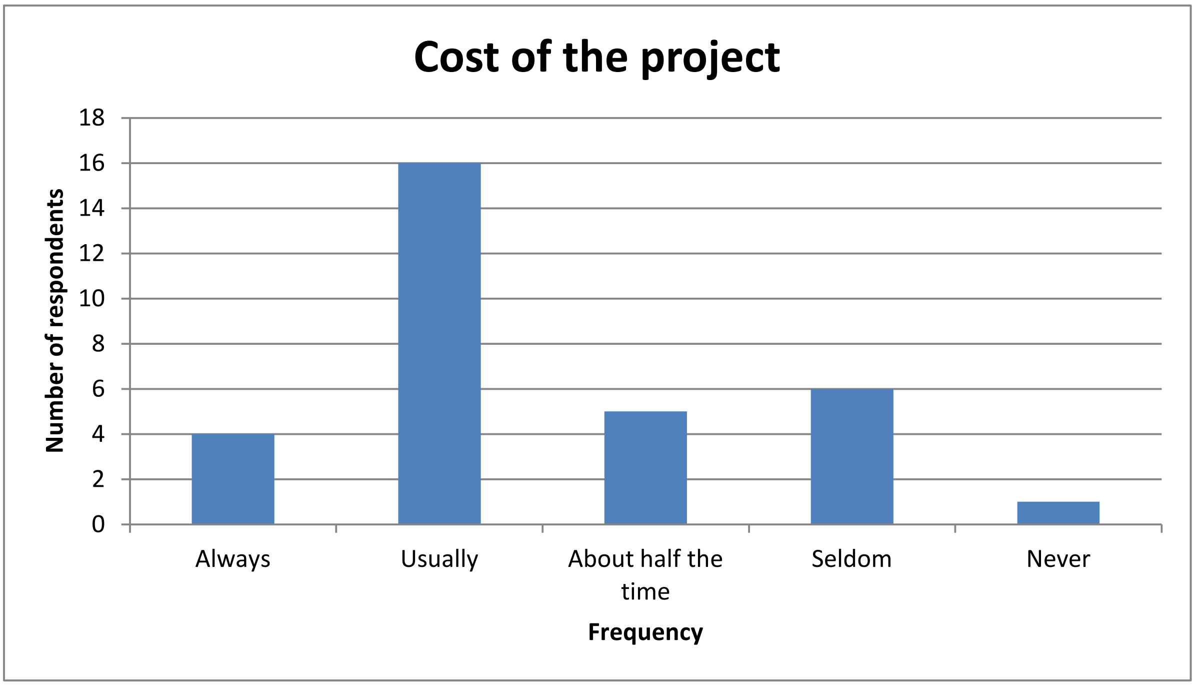


Some large mining organizations rate risks based on cost, people, environment, corporate image and safety. Project delays in coal mining can have a negative effect on these elements listed. Table 4.21 and Figure 4.19 illustrate the frequency that the respondents indicated the negative impact of delays on the cost of projects they have been involved with. The majority (n=16 or 50%) of the respondents indicated that the cost is usually negatively affected. Four (n=4 or 13%) indicated that cost is always negatively affected by delays and five (n=5 or 16%) indicated only half the time, six (n=6 or 19%) seldom and one (n=1 or 3%) indicated that cost is never negatively affected.

Table 4.21: Frequency of negative cost effects on a coal mining project due to delays

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	4	16	5	6	1

Figure 4.19: Frequency of negative cost effects on a coal mining project due to delays



The majority (n=14 or 44%) of the respondents indicated, as illustrated in Table 4.22 and Figure 4.20, that talent and skills management only negatively affect coal mining projects about half the time. Twelve (n=12 or 38%) indicated that this occurs seldom and one (n=1 or 3%) indicated it never occurs. Five (n=5 or 16%) indicated that talent and skills management usually negatively affects the projects.

Table 4.22: Frequency of negative talent and skills management effects on a coal mining project due to delays

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	0	5	14	12	1

Figure 4.20: Frequency of negative talent and skills management effects on a coal mining project due to delays

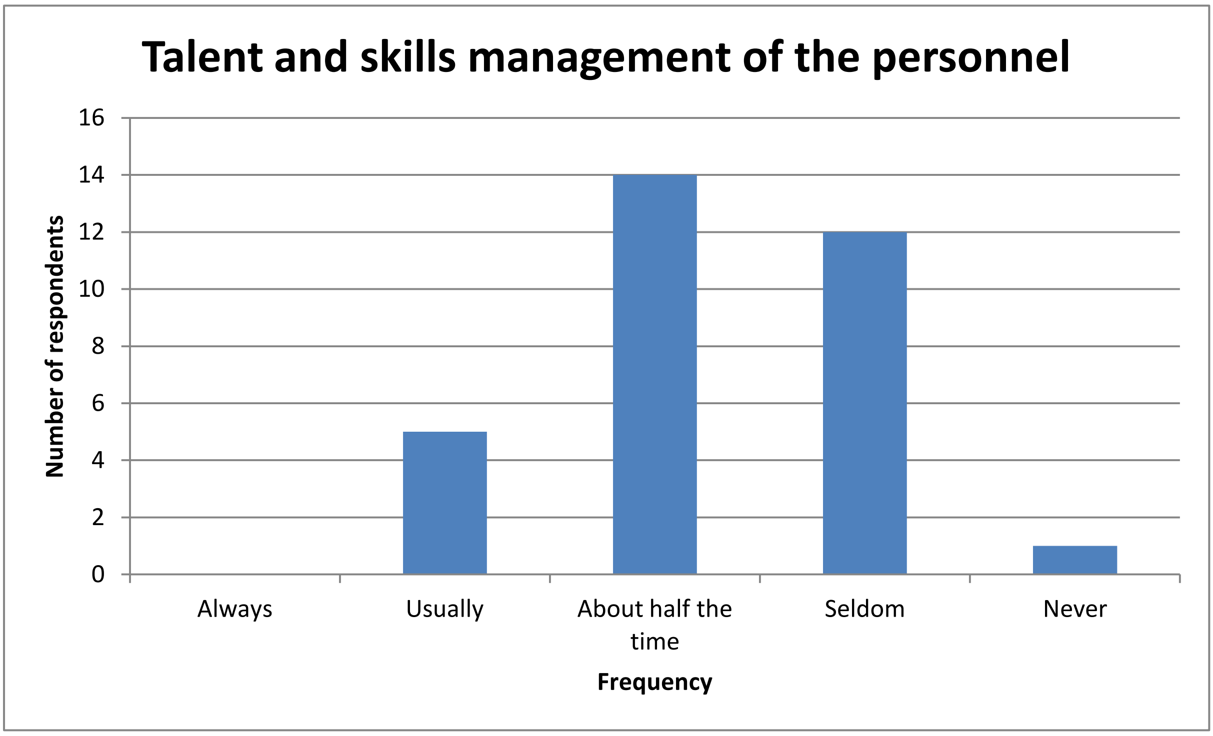


Table 4.23 and Figure 4.21 illustrate that the majority (n=19 or 59%) of the respondents indicated that there is only seldom negative effects experienced on the environment in coal mining projects. Five (n=5 or 16%) indicated that there are never negative environmental effects, four (n=4 or 13%) indicated about half the

time, three (n=3 or 9%) indicated usually and only one (n=1 or 3%) indicated always.

Table 4.23: Frequency of negative environmental effects on a coal mining project due to delays

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	1	3	4	19	5

Figure 4.21: Frequency of negative environmental effects on a coal mining project due to delays

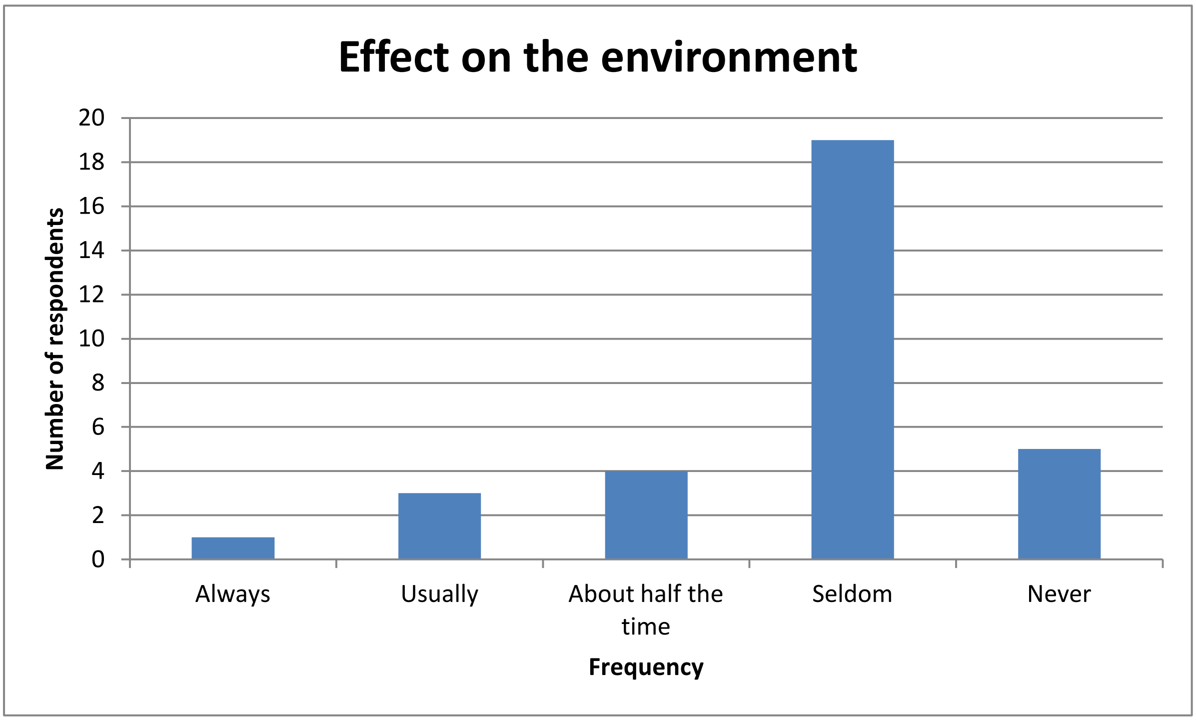


Table 4.24 and Figure 4.22 illustrates that the majority (n=17 or 53%) of the respondents have indicated that there are seldom negative corporate image effects due to the delays experienced in coal mining projects. Six (n=6 or 19%) of the

respondents indicated that this never occurs, four (n=4 or 13%) that negative corporate image effects usually occur and two (n=2 or 6%) that it always occurs. Three (n=3 or 9%) of the respondents indicated that negative corporate image effects occur due to project delays about half the time.

Table 4.24: Frequency of negative corporate image effects on a coal mining project due to delays

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	2	4	3	17	6

Figure 4.22: Frequency of negative corporate image effects on a coal mining project due to delays

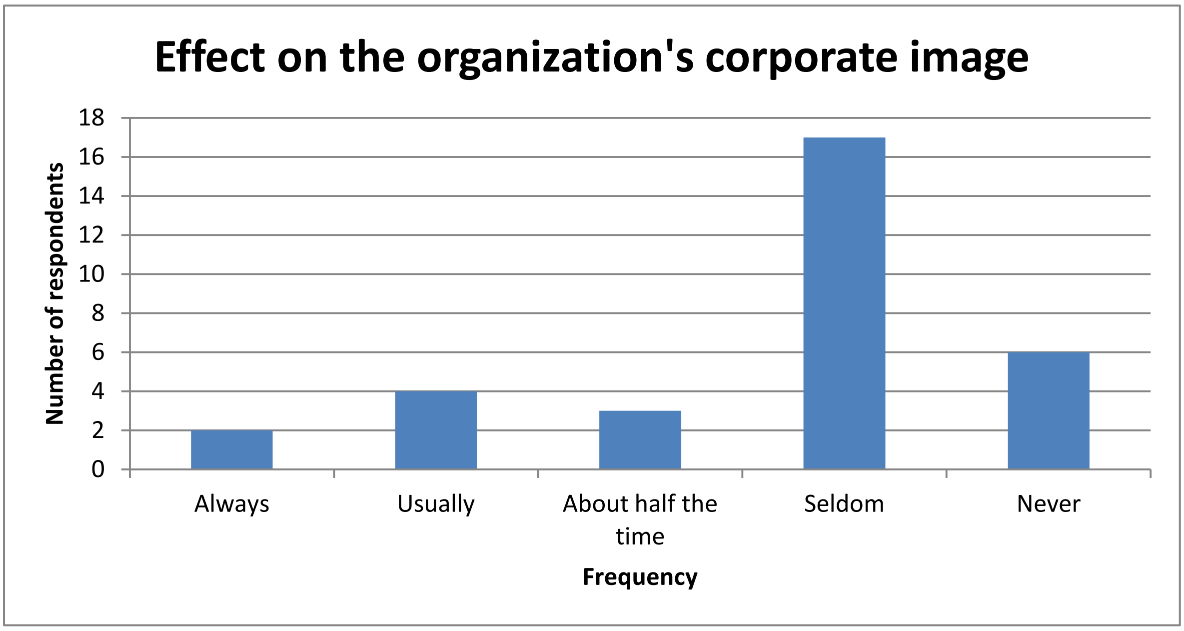


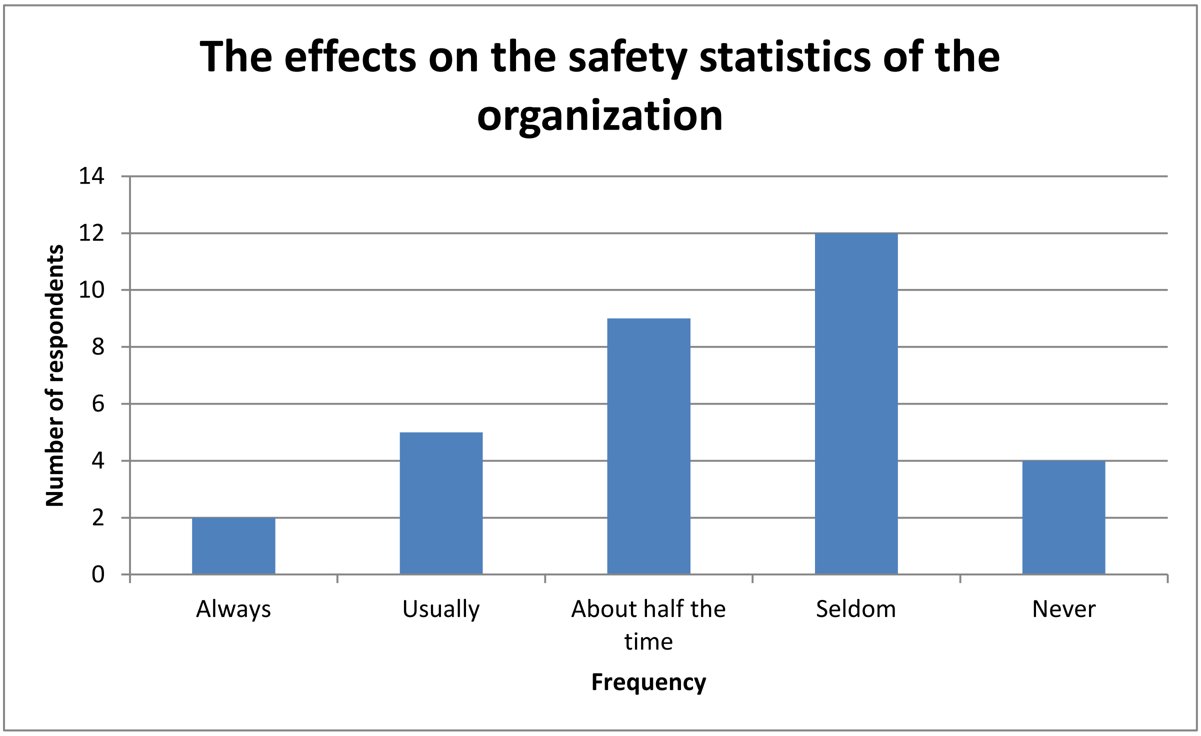
Table 4.25 and Figure 4.23 illustrate the negative safety effects experienced by the respondents. The majority (n=12 or 38%) indicate that there are seldom negative safety effects due to delays in coal mining projects. Four (n=4 or 13%) indicated that the safety effects never occur, nine (n=9 or 28%) that they occur about half the

time, five (n=5 or 16%) that they usually occur and two (n=2 or 6%) that they always occur.

Table 4.25: Frequency of negative safety effects on a coal mining project due to delays

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Frequency by respondents	2	5	9	12	4

Figure 4.23: Frequency of negative safety effects on a coal mining project due to delays



4.6 *Identifying types of delays related to the literature on delays and their effects*

4.6.1 *Delays due to labor*

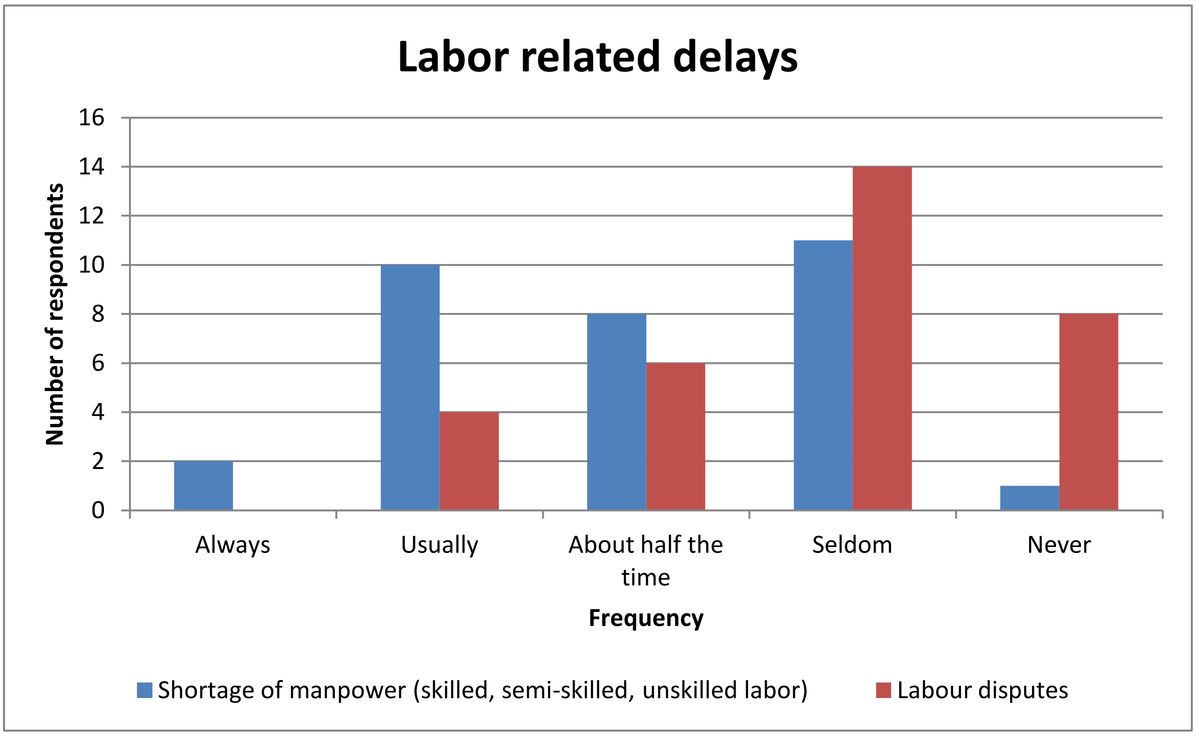
As illustrated in Table 4.26 and Figure 4.24 two areas of labor related delays were listed as possible delays in coal mining projects. The respondents indicated that as for shortage of manpower (skilled, semi-skilled, unskilled labor), by a small margin, the majority (n=11 or 34%) believe that it is seldom experienced. Ten (n=10 or 31%) of the respondents indicated that the shortage of manpower is usually a cause of delays and eight (n=8 or 25%) indicated that it is a delay about half the time.

The majority (n=14 or 44%) of the respondents indicated that labor disputes are seldom causes of delay. Eight (n=8 or 25%) indicated that labor disputes are never a cause of delay and six (n=6 or 19%) indicated that labor is a delay about half the time.

Table 4.26: Frequency of labor related delays in coal mining projects

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Shortage of manpower (skilled, semi-skilled, unskilled labor)	2	10	8	11	1
Labor disputes	0	4	6	14	8

Figure 4.24: Frequency of labor related delays in coal mining projects



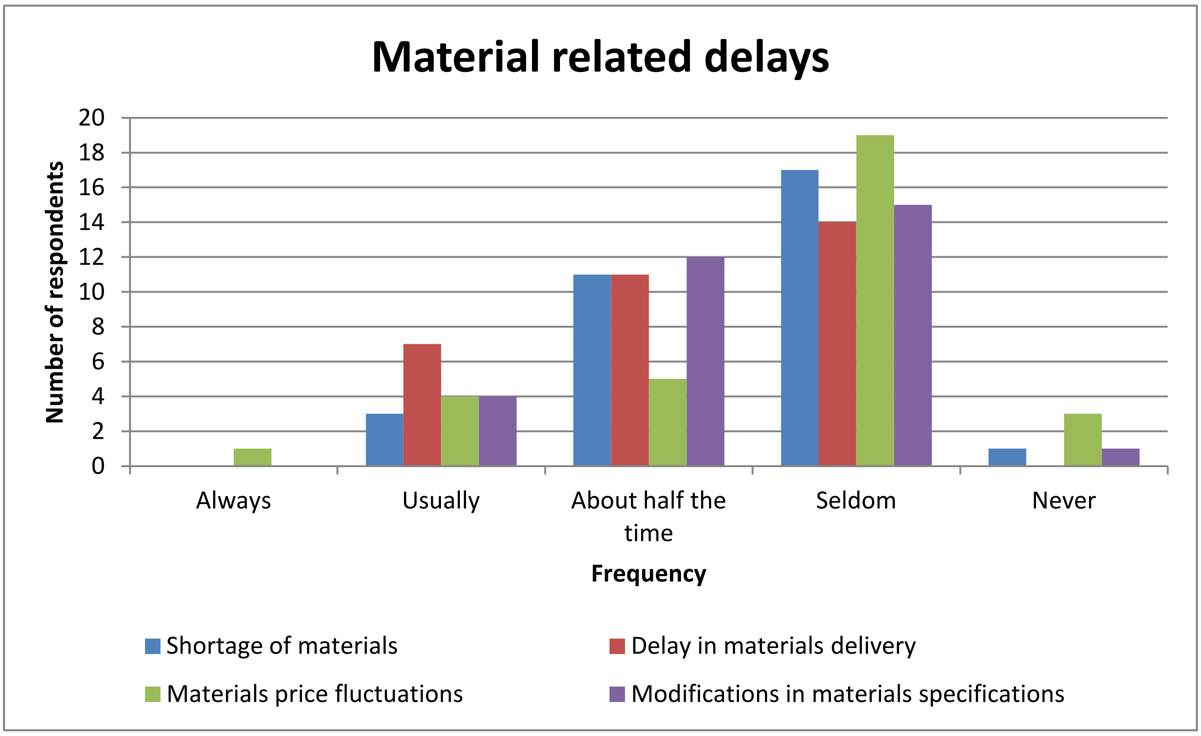
4.6.2 *Delays due to materials*

As illustrated in Table 4.27 and Figure 4.25 the majority of the respondents indicated that shortage of material (n=17 or 53%), Delay in material delivery (n=14 or 44%), Materials price fluctuations (n=19 or 59%) and modifications in materials specifications (n=15 or 47%) are seldom causes of delay in coal mining projects. The next highest frequency of respondents indicated that shortage of material (n=11 or 34%), Delay in material delivery (n=11 or 34%), Materials price fluctuations (n=5 or 16%) and modifications in materials specifications (n=12 or 38%) are experienced about half the time.

Table 4.27: Frequency of material related delays in coal mining projects

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Shortage of materials	0	3	11	17	1
Delay in materials delivery	0	7	11	14	0
Materials price fluctuations	1	4	5	19	3
Modifications in materials specifications	0	4	12	15	1

Figure 4.25: Frequency of material related delays in coal mining projects



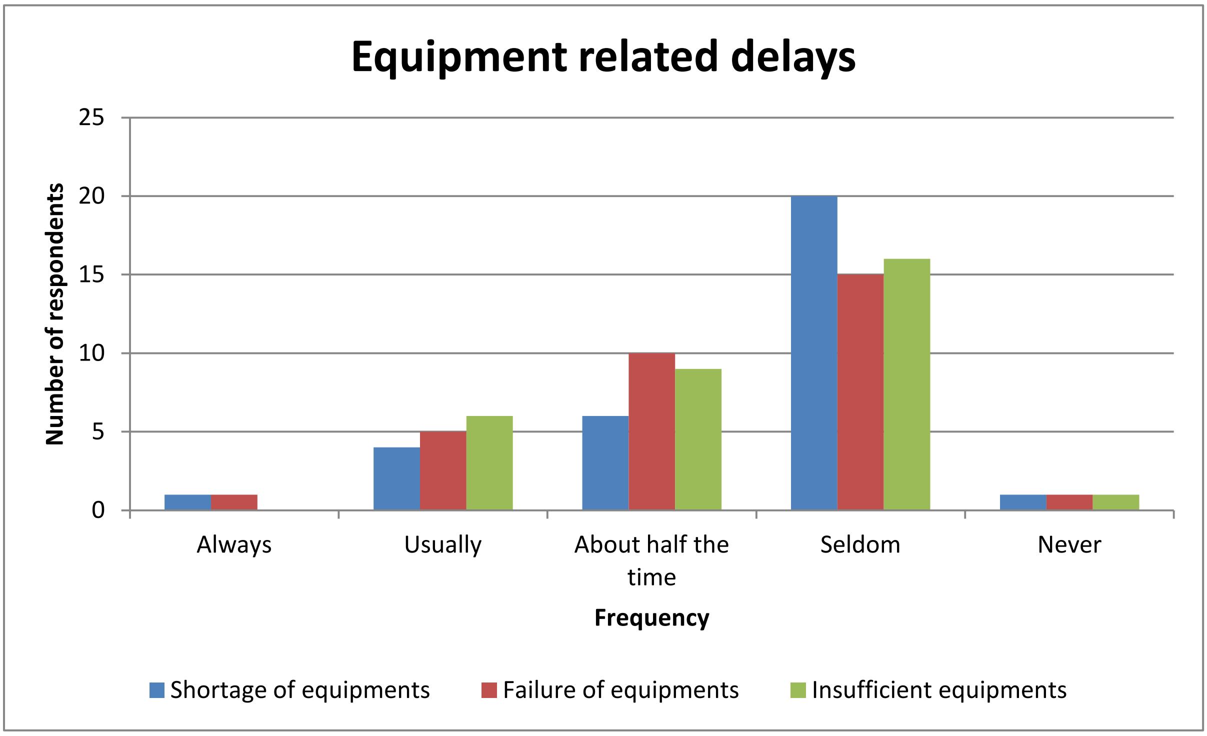
4.6.3 *Delays due to equipment*

As illustrated in Table 4.28 and Figure 4.26 the majority of the respondents indicated that; shortage of equipment (n=20 or 63%), failure of equipment (n=15 or 47%) and insufficient equipment (n=16 or 50%) are seldom causes of delay in coal mining projects. The next highest frequency is that these possible delays occur about half the time where shortage of equipment is six (n=6 or 19%), failure of equipment is 10 (n=10 or 31%) and insufficient equipment is 9 (n=9 or 28%).

Table 4.28: Frequency of equipment related delays in coal mining projects

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Shortage of equipments	1	4	6	20	1
Failure of equipments	1	5	10	15	1
Insufficient equipments	0	6	9	16	1

Figure 4.26: Frequency of equipment related delays in coal mining projects



4.6.4 *Delays due to contractors*

The contractor related delays are divided into three tables and graphs to reduce the amount of information into manageable amounts per graph and table.

As illustrated in Table 4.29 and Figure 4.27 the first delay listed is due to the lack of contractor's administrative personnel to which the majority (n= 12 or 38%) of the respondents indicated is a cause of delay about half the time. The next cause of delay has a split response by the respondents. The shortage of technical professionals in the contractor's organization was indicated as about half the time (n=10 or 31%) and seldom (n=10 or 31%) by the same proportion of respondents. Further, nine (n=9 or 28%) of the respondents indicated that this shortage of professionals is usually a delay in coal mining projects.

The majority (n=13 or 41%) of respondents indicated that the insufficient coordination of the parties by the contractor is a cause of delay about half the time.

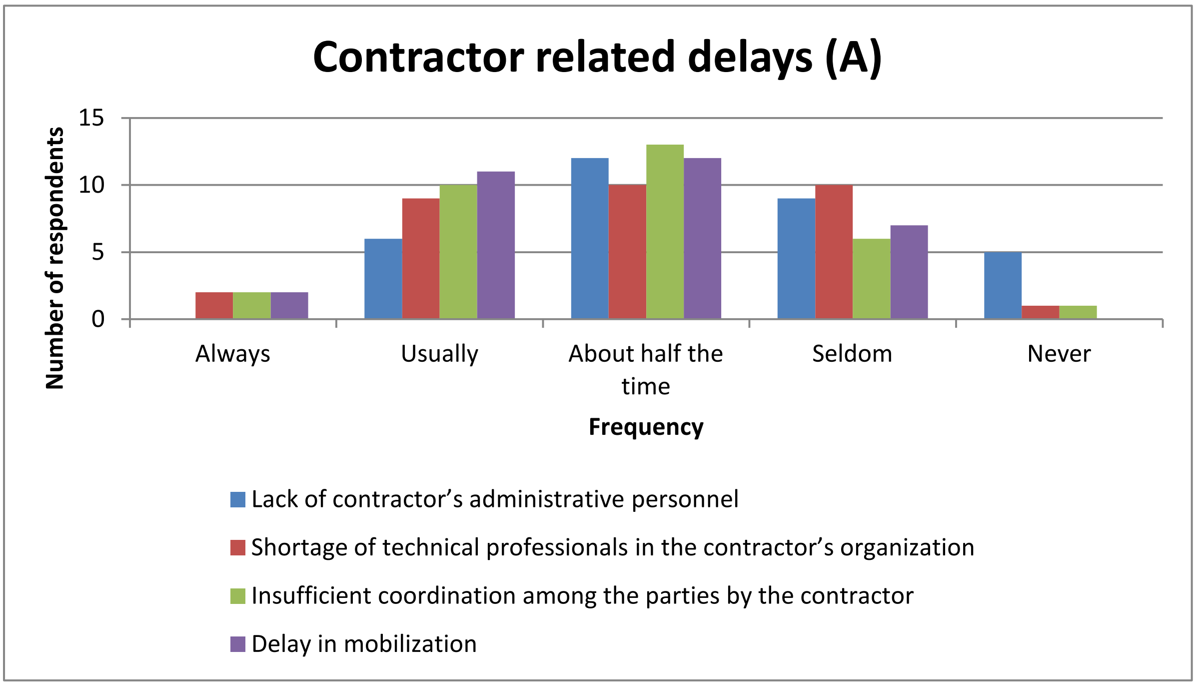
This is followed by ten (n=10 or 31%) of the respondents indicating that insufficient coordination is usually a cause of delay in coal mining projects.

The majority (n=12 or 38%) of respondents indicated that the delay in mobilization occurs about half the time and eleven (n=11 or 34%) of the respondents indicated that it is usually a cause of delay.

Table 4.29: Frequency of contractor related delays in coal mining projects (A)

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Lack of contractor's administrative personnel	0	6	12	9	5
Shortage of technical professionals in the contractor's organization	2	9	10	10	1
Insufficient coordination among the parties by the contractor	2	10	13	6	1
Delay in mobilization	2	11	12	7	0

Figure 4.27: Frequency of contractor related delays in coal mining projects (A)



In the next set of contractor related delays, as illustrated in Table 4.30 and Figure 4.28, the majority of the respondents (n=13 or 41%) indicated that about half the time the safety rules and regulations are not followed. Nine (n=9 or 28%) of the respondents indicated that it is seldom that the safety rules and regulations are not followed by the contractor organizations. Seven (n=7 or 22%) of the respondents indicated that they usually do not follow the safety rules and regulations.

Seventeen (n=17 or 53%) of the respondents indicated that the contractors assign incompetent staff to the projects which constitutes the majority. Nine (n=9 or 28%)of the respondents indicated that the contractors seldom assign incompetent staff to the projects.

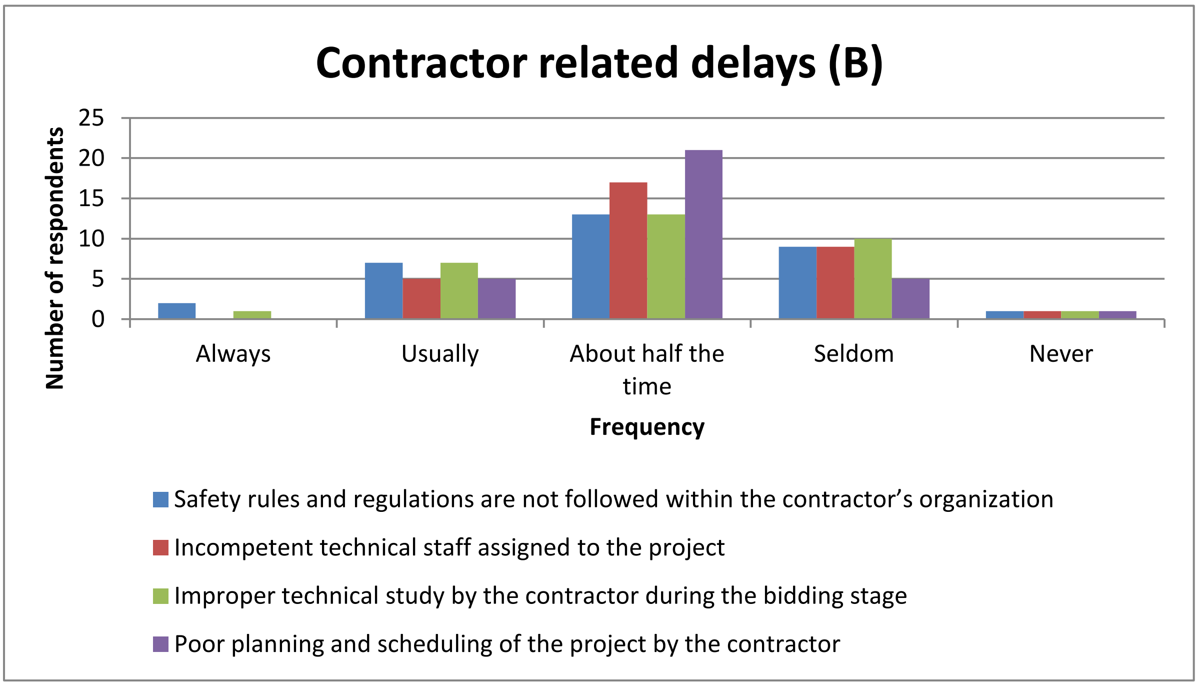
The majority (n=13 or 41%) of the respondents indicated that about half the time delays are caused due to the contractor conducting improper technical studies during the bidding stage. Ten (n=10 or 31%) of the respondents indicated that this seldom causes a delay in coal mining projects.

Poor planning and scheduling by the contractor was indicated by the majority (n=21 or 66%) of respondents as a cause of delay about half the time.

Table 4.30: Frequency of contractor related delays in coal mining projects (B)

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Safety rules and regulations are not followed within the contractor's organization	2	7	13	9	1
Incompetent technical staff assigned to the project	0	5	17	9	1
Improper technical study by the contractor during the bidding stage	1	7	13	10	1
Poor planning and scheduling of the project by the contractor	0	5	21	5	1

Figure 4.28: Frequency of contractor related delays in coal mining projects (B)



As illustrated in Table 4.31 and Figure 4.29 the majority (n=15 or 47%) of the respondents have indicated that the contractors conduct improper handling of the project progress which causes delays about half the time in coal mining projects.

Fourteen (n=14 or 44%), the majority, of the respondents indicated that the contractors that exercise ineffective quality control usually causes delays in coal mining projects.

The use of unacceptable construction techniques by the contractor was indicated by the majority of the respondents as seldom (n=13 or 41%) causing project delays in coal mining projects.

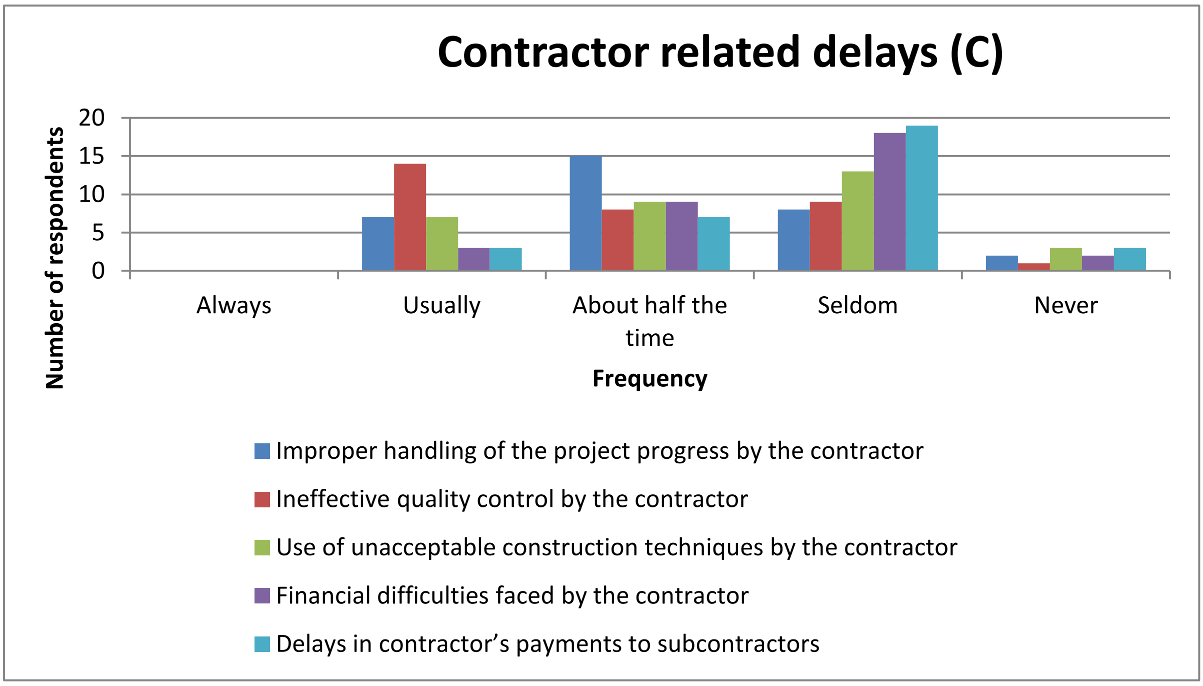
The majority of the respondents (n=18 or 56%) indicated that the contractors are seldom faced with financial difficulties contributing to project delays.

The delay of the payment of sub contractors by contractors seldom causes delays in coal mining projects as indicated by the majority (n= 19 or 59%) of the respondents..

Table 4.31: Frequency of contractor related delays in coal mining projects (C)

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Improper handling of the project progress by the contractor	0	7	15	8	2
Ineffective quality control by the contractor	0	14	8	9	1
Use of unacceptable construction techniques by the contractor	0	7	9	13	3
Financial difficulties faced by the contractor	0	3	9	18	2
Delays in contractor's payments to subcontractors	0	3	7	19	3

Figure 4.29: Frequency of contractor related delays in coal mining projects (C)



4.6.5 *Delays due to the owners*

The respondents indicated a split response to the delay due to site preparation as illustrated in Table 4.32 and Figure 4.30. The split majority response is twelve (n=12 or 38%) for the delay usually occurs and twelve (n=12 or 38%) as the delay occurs seldom. The clarification can be found in the eight (n=8 or 25%) respondents that indicated that this delay occurs about half the time.

The majority of respondents (n=15 or 47%) indicated that delays in contractor claim settlements can cause delays about half the time.

The majority of the respondents (n=21 or 66%) indicated that work suspensions by the owner seldom cause delays in coal mining projects.

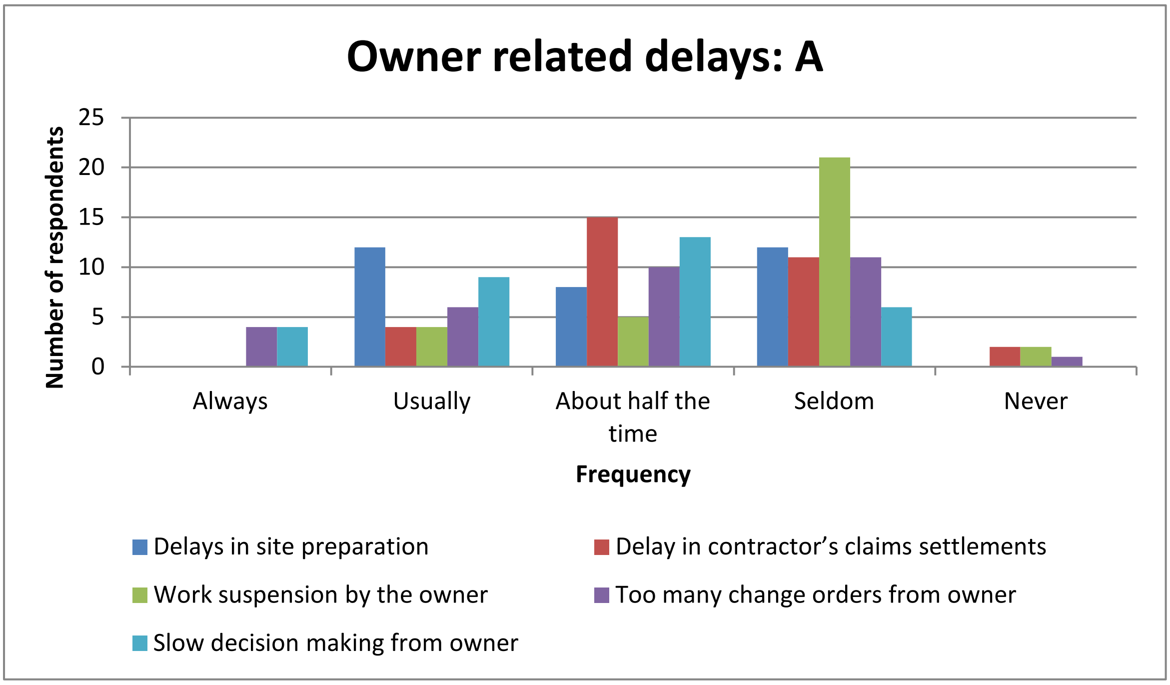
Eleven (n=11 or 34%) of the respondents indicated that too many change orders seldom cause delays. However, ten (n=10 or 31%) indicated that they cause delays about half the time, six (n=6 or 9%) usually and four (n=41 or 4%) always.

Slow decision making is indicated as causing delays about half the time by the majority (n=13 or 41%) of the respondents. Nine (n=9 or 28%) of the respondents indicated that these change orders can usually cause delays, six (n=6 or 19%) respondents indicated seldom and four (n=4 or 13%) always.

Table 4.32: Frequency of owner related delays in coal mining projects (A)

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Delays in site preparation	0	12	8	12	0
Delay in contractor's claims settlements	0	4	15	11	2
Work suspension by the owner	0	4	5	21	2
Too many change orders from owner	4	6	10	11	1
Slow decision making from owner	4	9	13	6	0

Figure 4.30: Frequency of owner related delays in coal mining projects (A)



As illustrated in Table 4.33 and Figure 4.31 interference by the owner in the construction operations is seldom a cause of delay in the coal mining projects as indicated by the majority (n=16 or 50%) of the respondents.

The majority (n=19 or 59%) of the respondents indicated that delays in the progress payments by the owner is seldom a cause of delays in coal mining projects.

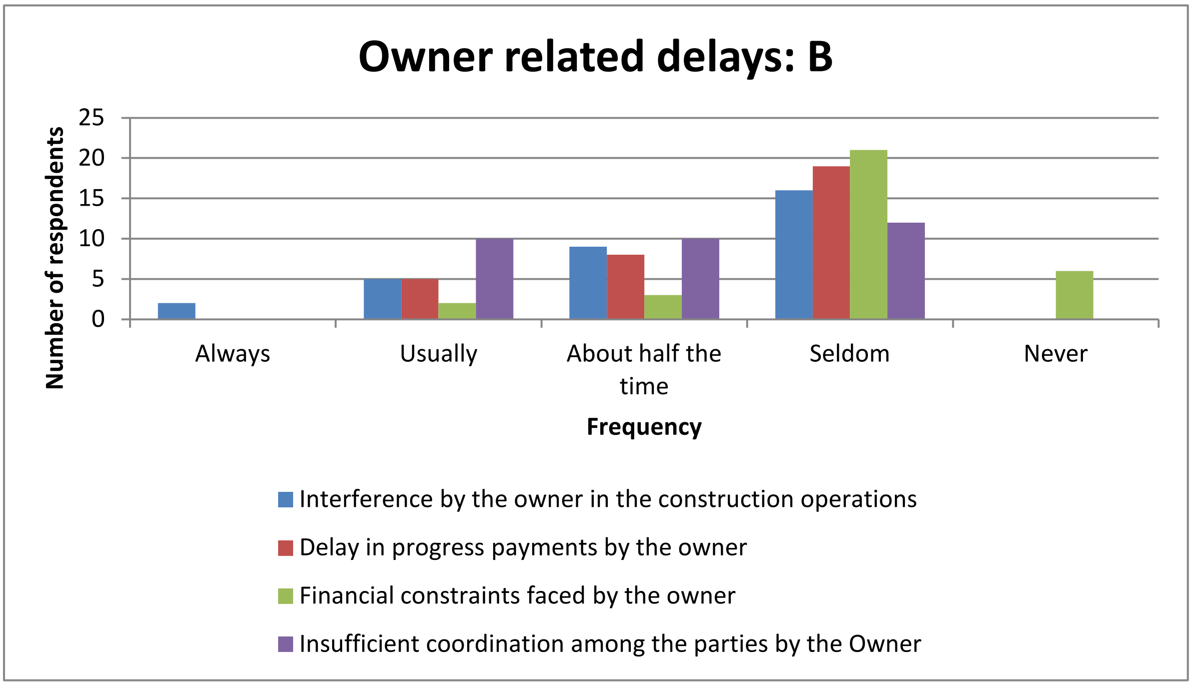
The majority (n=21 or 66%) of the respondents also indicated that financial constraints by the owner seldom cause delays in the projects in coal mining.

The majority (n=12 or 38%), by a small margin) of the respondents indicated that insufficient coordination among parties by the owner in seldom a cause of delay. Ten (n=10 or 31%) indicated that it usually is a cause of delays and another ten (n=10 or 31%) indicated that it is a cause of delay about half the time.

Table 4.33: Frequency of owner related delays in coal mining projects (B)

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Interference by the owner in the construction operations	2	5	9	16	0
Delay in progress payments by the owner	0	5	8	19	2
Financial constraints faced by the owner	0	2	3	21	6
Insufficient coordination among the parties by the Owner	0	10	10	12	0

Figure 4.31: Frequency of owner related delays in coal mining projects (B)



4.6.6 *Delays due to the consultants*

As illustrated in Table 4.34 and Figure 4.32 the ambiguities and mistakes in specifications and drawings seldom causes delays in coal mining projects as indicated by the majority (n=15 or 47%) of the respondents and twelve (n=12 or 38%) of the respondents indicated that it is a cause about half the time.

The majority (n=16 or 50%) of the respondents indicated that poor qualification of consultant engineer's staff assigned to the project seldom cause delays in the coal mining projects.

The delay in approval of contractor submissions by the engineer is seldom a cause of delay as indicated by the majority (n=16 or 50%) of the respondents.

Poor coordination by the consultant engineer with the parties involved is also seldom a cause of delay as indicated by the majority (n=16 or 50%) of the respondents.

The majority (n=19 or 59%) of the respondents indicated that slow response by the consultant engineer regarding testing and inspection is seldom a cause of delay in coal mining projects.

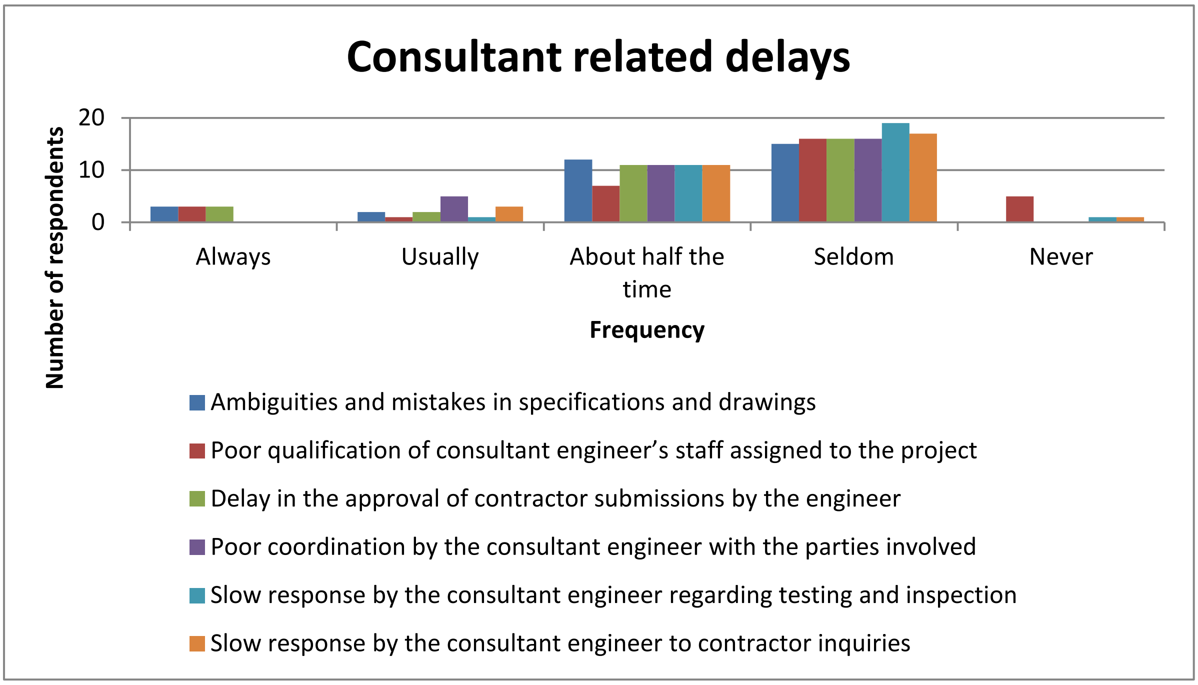
Slow response by the consultant engineer to contractor inquiries is seldom a cause of delay in coal mining projects as indicated by the majority of the respondents (n=17 or 53%).

Table 4.34: Frequency of consultant related delays in coal mining projects

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Ambiguities and mistakes in specifications and drawings	3	2	12	15	0
Poor qualification of consultant engineer's staff assigned to the project	3	1	7	16	5
Delay in the approval of contractor submissions by the engineer	3	2	11	16	0

Poor coordination by the consultant engineer with the parties involved	0	5	11	16	0
Slow response by the consultant engineer regarding testing and inspection	0	1	11	19	1
Slow response by the consultant engineer to contractor inquiries	0	3	11	17	1

Figure 4.32: Frequency of consultant related delays in coal mining projects



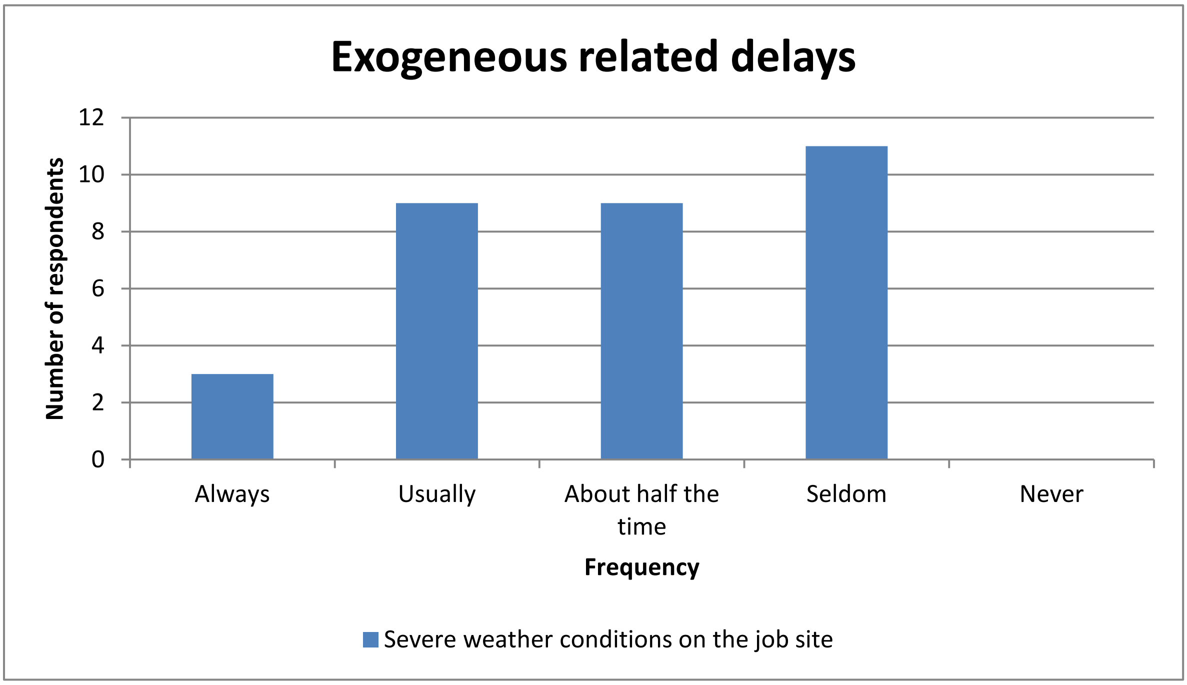
4.6.7 *Delays due to exogenous factors (weather)*

Table 4.35 and Figure 4.33 illustrate the cause of delays due to extreme weather conditions as indicated by the respondents. The majority (n=11 or 33%) , by a small margin, indicated that extreme weather delays seldom cause delays in coal mining projects. Nine (n=9 or 28%) indicated that this cause occurs about half the time and another nine (n=9 or 28%) indicated that it is usually a cause of delay.

Table 4.35: Frequency of exogenous related delays in coal mining projects

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Exogenous factors (weather)	3	9	9	11	0

Figure 4.33: Frequency of exogenous related delays in coal mining projects



4.6.8 *Delays due to government regulations*

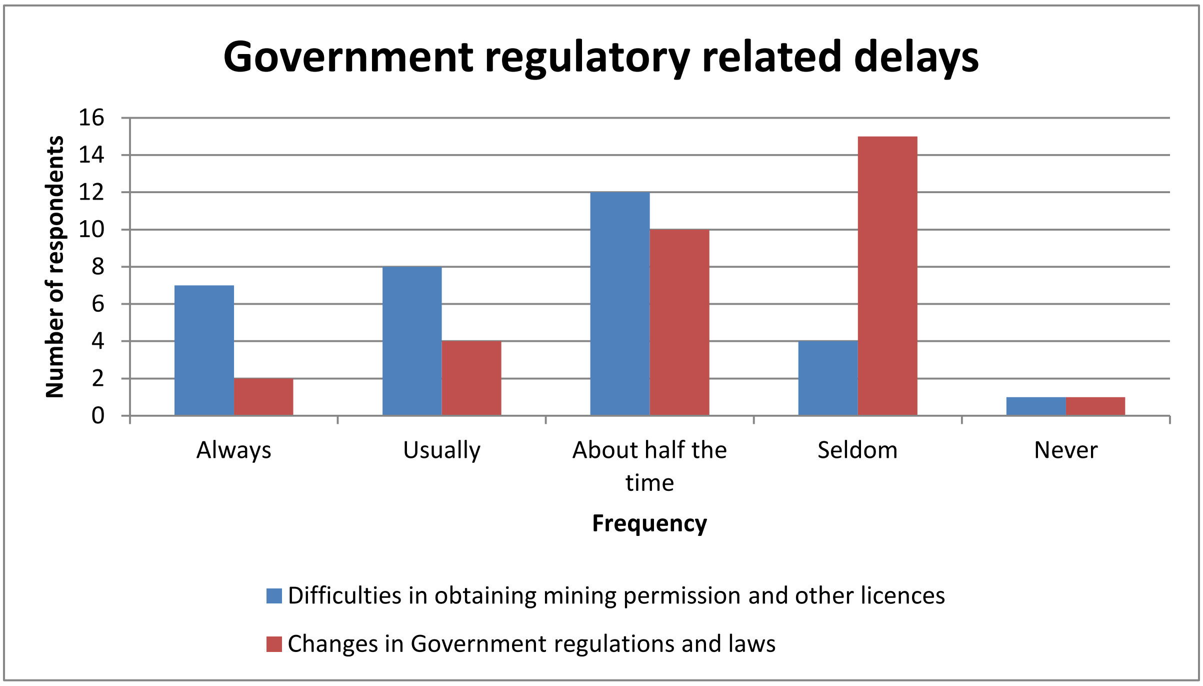
As indicated in Table 4.36 and Figure 4.34 the majority (n=12 or 38%) of the respondents indicated that difficulty in obtaining mining permissions and other licenses cause's delays about half the time. Eight (n=8 or 25%) of the respondents indicated that it usually causes delays and seven (n=7 or 22%) indicated that it always causes delays. Only four (n=4 or 13%) indicated that it is seldom a cause of delay and one (n=1 or 3%) indicated that it is never a cause of delay in coal mining projects.

Changes in government regulations and laws are seldom a cause of delay as indicated by the majority (n=15 or 47%) of the respondents. Ten (n=10 or 31%) of the respondents indicated that it is a cause of delay about half the time, four (n=4 or 13%) indicated usually, two (n=2 or 6%) always and one (n=1 or 3%) never in coal mining projects.

Table 4.36: Frequency of government regulatory related delays in coal mining projects

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Difficulties in obtaining mining permission and other licenses	7	8	12	4	1
Changes in Government regulations and laws	2	4	10	15	1

Figure 4.34: Frequency of government regulatory related delays in coal mining projects



4.6.9 *Factors related to coal mining projects that are possible delays*

Table 4.37 and Figure 4.35 illustrate the opinion of the respondents with regard to possible delays that are particularly related to coal mining. The first potential delay has a split decision by the respondents. Twelve (n=12 or 38%) have indicated that they agree that the reporting of exploration results can cause delays and twelve (n=12 or 38%) have indicated that they disagree. Seven (n=7 or 22%) are undecided and one (n=1 or 3%) strongly agrees.

The majority (n=16 or 50%) of the respondents have indicated that they agree that geological interpretation can be a possible delay. Three (n=3 or 9%) strongly agree, seven (n=7 or 22%) are undecided and six (n=6 or 19%) disagree.

The majority of respondents (n=16 or 50%) agree that database integrity is a possible delay. One (n=1 or 3%) strongly agrees, Seven (n=10 or 31%) are undecided and five (n=5 or16%) disagree.

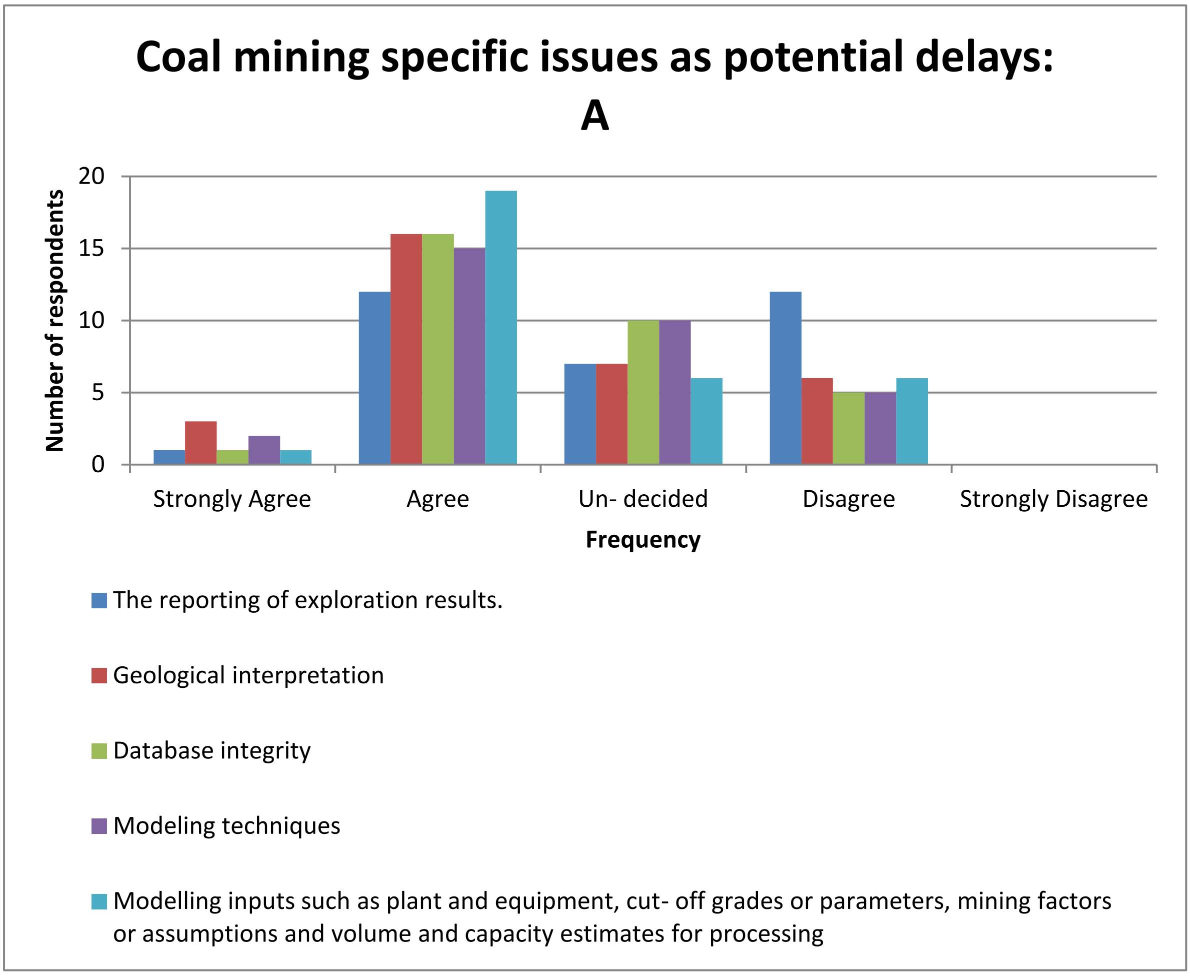
According to the majority (n=15 or 47%) of respondents, they agree that modeling techniques are a possible delay. Two (n=2 or 6%) strongly agree, ten (n=10 or 31%) are undecided and five (n=5 or 16%) disagree.

The respondents also agree (n=19 or 59%) that modeling inputs are a possible delay. One respondent (n=1 or 3%) strongly agrees, six (n=6 or 19%) are undecided and six (n=6 or 19%) disagree.

Table 4.37: Opinion of respondents with regard to possible delays in coal mining projects (A)

	Strongly agree	Agree	Un-decided	Disagree	Strongly disagree
The reporting of exploration results.	1	12	7	12	0
Geological interpretation	3	16	7	6	0
Database integrity	1	16	10	5	0
Modeling techniques	2	15	10	5	0
Modeling inputs such as plant and equipment, cut- off grades or parameters, mining factors or assumptions and volume and capacity estimates for processing	1	19	6	6	0

Figure 4.35: Opinion of respondents with regard to possible delays in coal mining projects (A)



As illustrated in Table 4.38 and Figure 4.36 the majority (n=16 or 50%) of respondents indicated that ground conditions could result in project delays in coal mining projects. Eight (n=8 or 25%) of the respondents strongly agree, three (n=3 or 9%) are undecided and five (n=5 or 13%) disagree.

The majority (n=19 or 59%) of respondents agree that running too many scenarios can cause delays. Five (n=5 or 19%) strongly agree, three (n=3 or 9%) are undecided and five (n=5 or 19%) disagree.

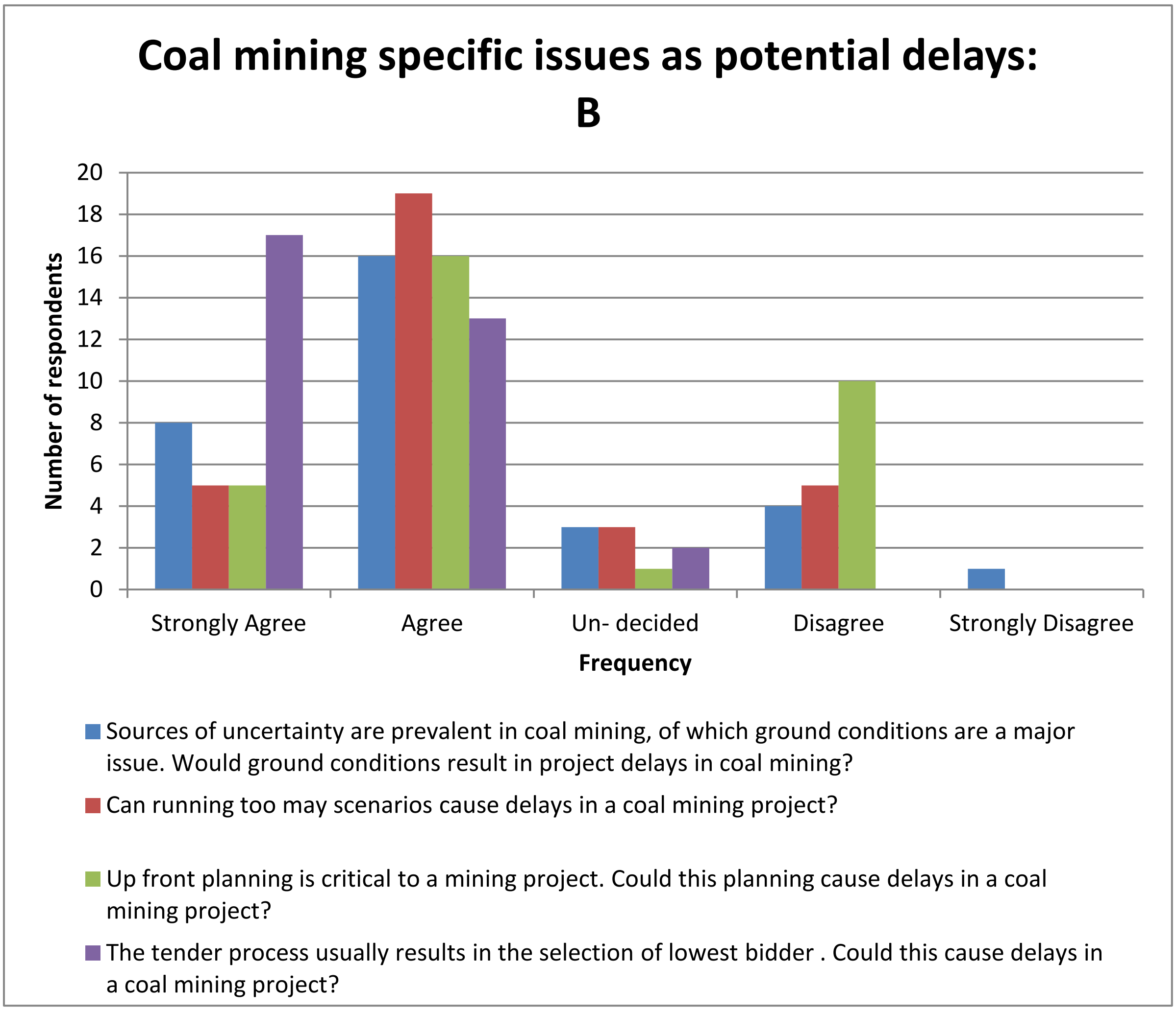
The majority (n=16 or 50%) of the respondents agree that upfront planning could cause delays. Five (n=5 or 19%)strongly agree, one(n=1 or 3%) is undecided and ten (n=10 or 31%) disagree.

The selection of the lowest bidder during the tender process is a possible cause of delay. The majority (n=17 or 53%) of the respondents strongly agree, thirteen (n=13 or 41%) agree and two (n=2 or 6%) are undecided.

Table 4.38: Opinion of respondents with regard to possible delays in coal mining projects (B)

	Strongly agree	Agree	Un-decided	Disagree	Strongly disagree
Would ground conditions result in project delays in coal mining?	8	16	3	4	1
Can running too may scenarios cause delays in a coal mining project?	5	19	3	5	0
Up front planning is critical to a mining project. Could this planning cause delays in a coal mining project?	5	16	1	10	0
The tender process usually results in the selection of lowest bidder. Could this cause delays in a coal mining project?	17	13	2	0	0

Figure 4.36: Opinion of respondents with regard to possible delays in coal mining projects (B)



4.6.10 *Delays due to specific mining issues*

The following potential delays were agreed to in section 4.6.9. In this section the respondents have indicated the frequency of these delays experienced. The information is split into two tables and two graphs for ease of presentation.

As illustrated in Table 4.39 and Figure 4.37 the reporting of exploration results are seldom a cause of delay as indicated by the majority (n=15 or 47%) of the respondents.

The majority (n=17 or 53%) of the respondents indicated that geological interpretation is seldom a cause of project delays.

As for database integrity the majority (n=16 or 50%) of respondents indicated that this would cause delays about half the time.

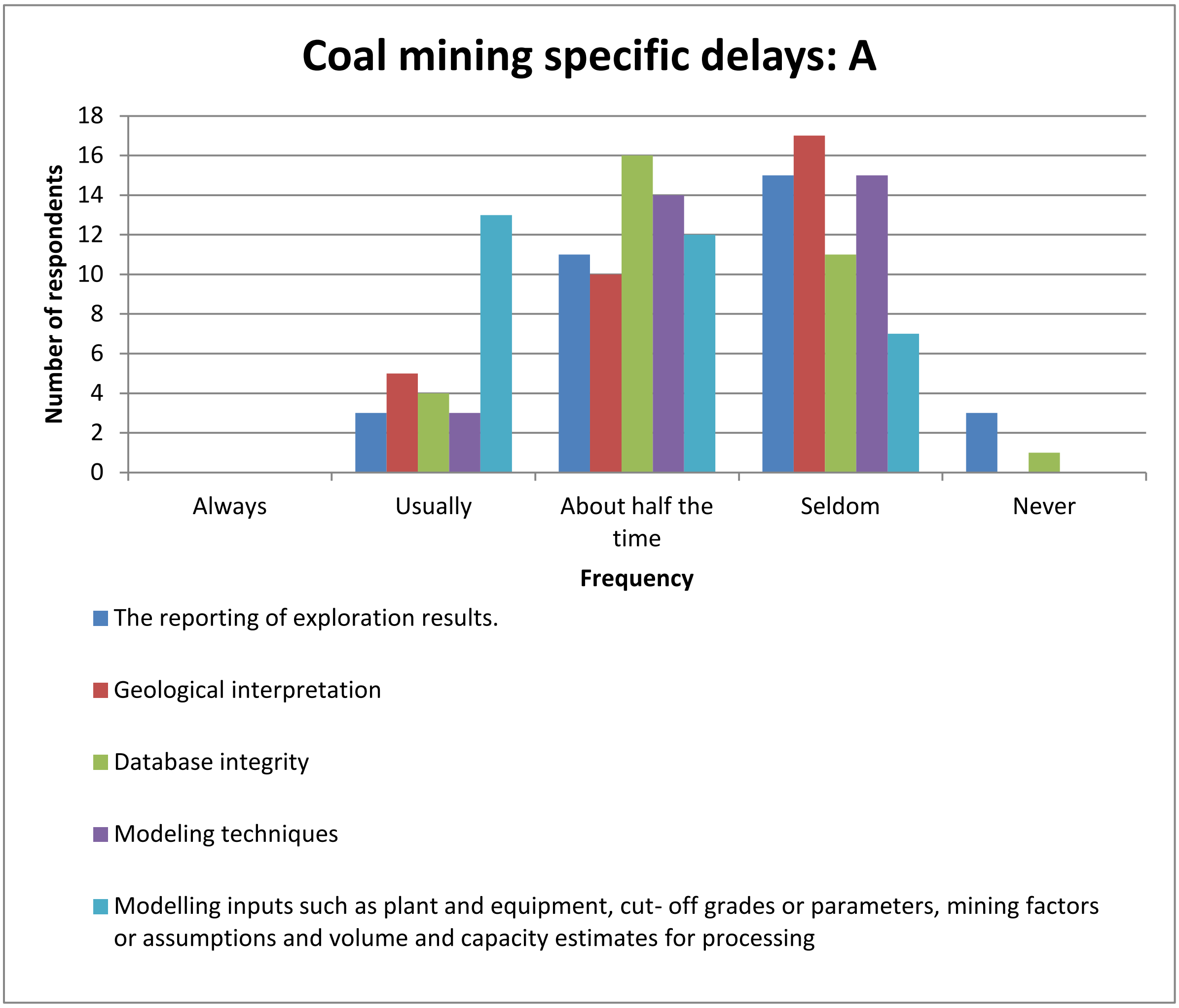
The majority (n=15 or 47%) of respondents indicate that modeling techniques are seldom the cause of delays. This is however a small margin as fourteen (n=14 or 44%) indicated that it would cause delays about half the time.

Modeling inputs are usually causes of delay as indicated by the majority (n=13 or 41%) of the respondents. Twelve (n=12 or 38%) of the respondents indicated that modeling inputs cause delays about half the time.

Table 4.39: Frequency of specific mining related delays in coal mining projects (A)

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
The reporting of exploration results.	0	3	11	15	3
Geological interpretation	0	5	10	17	0
Database integrity	0	4	16	11	1
Modeling techniques	0	3	14	15	0
Modeling inputs	0	13	12	7	0

Figure 4.37: Frequency of specific mining related delays in coal mining projects (A)



As illustrated in Table 4.40 and Figure 4.38 ground conditions are indicated as delays about half the time by the majority (n=13 or 41%) of the respondents. Nine (n=9 or 28%) of the respondents indicated that ground conditions are usually causes of delay and nine (n=9 or 28%) of the respondents indicated that ground conditions are seldom causes of delay.

The majority (n=12 or 38%), by a small margin, indicated that running too many scenarios seldom cause delays. Eleven (n=11 or 34%) indicated about half the time and eight (n=8 or 25%) indicated usually.

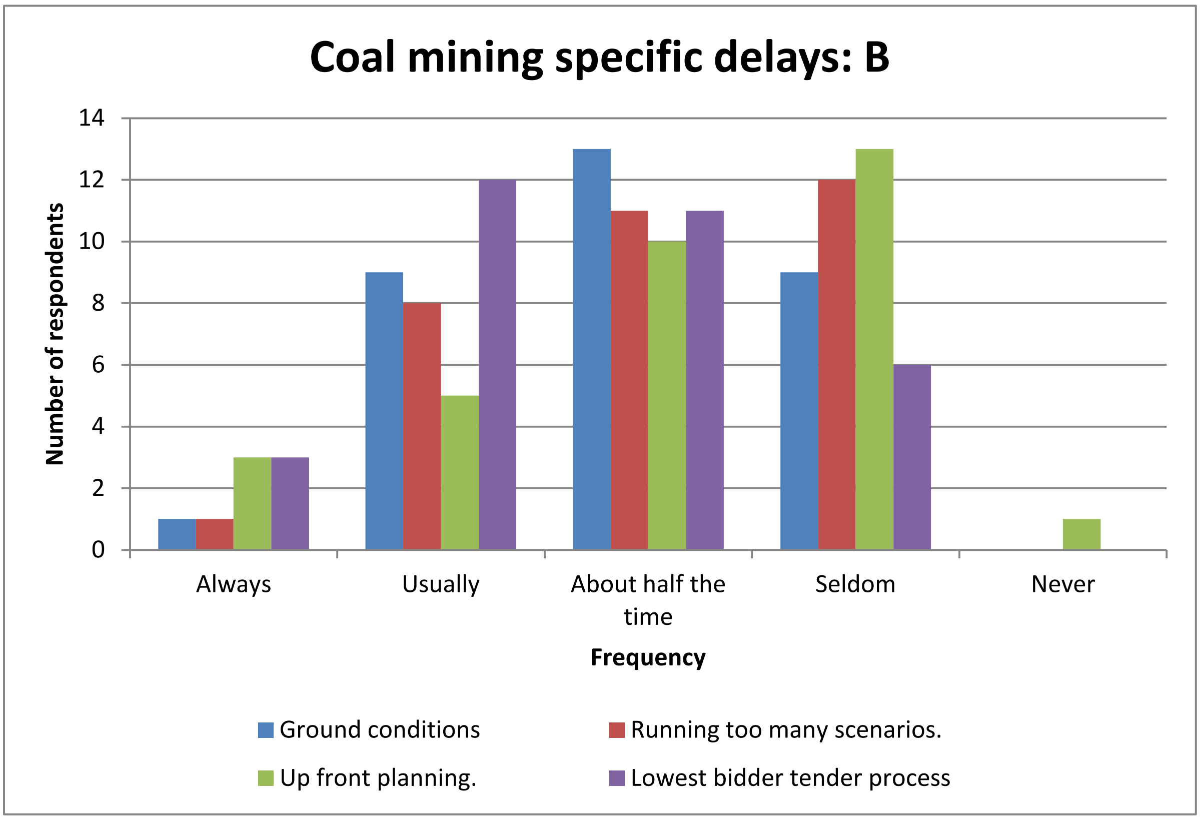
The majority (n=13 or 41%) of the respondents indicated that up-front planning is seldom a cause of delay, however, ten (n=10 or 31%) indicated that it is a cause of delay about half the time.

Using the lowest bidder tender process is usually a case of delay as indicated by the majority (n=12 or 38%) of the respondents even though it is a small margin. Eleven (n=11 or 34%) of the respondents indicated that it is a cause of delay about half the time.

Table 4.40: Frequency of specific mining related delays in coal mining projects (A)

Frequency of occurrence	Always	Usually	About half the time	Seldom	Never
Ground conditions	1	9	13	9	0
Running too many scenarios	1	8	11	12	0
Up front planning	3	5	10	13	1
Lowest bidder tender process	3	12	11	6	0

Figure 4.38: Frequency of specific mining related delays in coal mining projects (A)



4.7 *Conclusion*

The unprocessed data has been presented in this chapter. The questions answered by the respondents were closed ended. The analysis and interpretation of the data will be conducted in the next chapter.

Chapter 5: Synthesis and Analysis of Results

5.1 *Introduction*

The data collected was presented in raw format in chapter 4. This data will be used to answer the research questions posed and for accepting or rejecting the research hypotheses.

5.1.1 *Analysis description*

In order to test the hypothesis a questionnaire was designed and distributed. The questionnaire is a likert type and the data from the respondents is probably ordinal in nature. This is due to the fact that the distance between the options of; always, usually, about half the time, seldom and never is not fixed. Thus the distance between always and usually may not be the same as between usually and about half the time. Diamantopoulos and Schlegelmilch (2006) suggest that this data be treated as interval data to ensure the use of powerful modes of measurement and analysis. Therefore it is assumed that the distances between the response options in the questionnaires are equal for this research. The absolute frequency, cumulative frequency and relative frequency distributions will be calculated. The results of this data will be presented as frequency distributions. The p–value will be calculated to test the hypotheses and test various relationships.

As described by Diamantopoulos and Schlegelmilch (2006), the p-value is a calculated value that indicates the level of evidence against the null hypothesis. If the p-value is low the evidence against the null hypothesis is strong. The level of significance is set as the indicator of whether to accept the null hypothesis or not. In this chapter the level of significance used is 95%. Thus if the p-value is less than 0.05 the null hypothesis can be rejected.

5.1.2 *Hypothesis testing*

Hypothesis testing is a statistical approach to making inferences about the population from sample statistics. Thus by using a sample of data the aim is to determine if a particular proposition concerning the population is likely to hold or not (Diamantopoulos and Schlegelmilch, 2006). Further, the hypotheses in this research are based on the null hypotheses type. This type of hypothesis always includes a statement of inequality. Only a null hypothesis can be tested, not a directional or exploratory hypothesis. If the null hypothesis is rejected the alternative hypothesis is automatically accepted which is the complement of the null hypothesis.

The following hypotheses are tested in this chapter:

H_o1: There are no delays in coal mining projects in South Africa.

$H_1$1: There are delays in coal mining projects in South Africa.

H_o2: The delays experienced in projects in the coal mining industry in South Africa are not measured effectively.

$H_1$2: The delays experienced in projects in the coal mining industry in South Africa are measured effectively.

H_o3: The effects of delays in projects in the coal mining industry in South Africa are not measured effectively.

$H_1$3: The effects of delays in projects in the coal mining industry in South Africa are measured effectively.

H_o4: The majority of delays are not experienced during the planning phase of the project process

$H_1$4: The majority of delays are experienced during the planning phase of the project process.

H_o5: The majority of delays are not experienced during the execution phase of the project process.

$H_1$5: The majority of delays are experienced during the execution phase of the project process.

5.1.2.1 Significance level

The significance level is set at 5 %(= 0.05) for the entire hypothesis testing (H_o1 to H_o5). According to Diamantopoulos and Schlegelmilch (2006) it is ideal to keep the significance level as low as possible to avoid making a type I or type II error. By choosing 5% level of significance it is indicating that the chance of making a mistake on the hypothesis acceptance or rejection can take place 5 out of 100 times.

Table 5.1: Decision criteria for accepting or rejecting the null hypothesis

Decision	Population inference
H_on is accepted	> 0.05
H_on is rejected	≤ 0.05

5.2 There are no delays in coal mining projects in South Africa (H_o1)

The question posed to the respondents to test this hypothesis is:

- Are delays experienced in projects your organization is involved in?

As illustrated in Table 5.2 the majority of the respondents (53%) indicated that they usually experience delays. Thirty one (31%) indicated that they experience delays about half the time. Only 3% indicated that they always experience delays and 13% only seldom. None of the respondents indicated that they never experience delays. The relative frequency column in Table 5.2 shows that 87% of the respondents experienced delays half the time and more in the projects they have been involved in.

Table 5.2: Frequency distribution for H_o1

Variables	Scale	Absolute frequency	Cum frequency	Relative frequency
Delays experienced	5) Always	1	1	3%
	4) Usually	17	18	56%
	3) About half the time	10	28	87%
	2) Seldom	4	32	100%
	1) Never	0	0	0%

5.2.1 ***Hypothesis testing of H_o1***

To test the first hypothesis the Chi- Square test method will be used. The software program used to do this test is called Minitab. This type of test requires expected sample values based on the hypothesis made. In the case of H_o1 equal proportions will be used due to the lack of information from previous literature specifically based on delays in the coal mining industry. This is illustrated in Figure 5.1.

Figure 5.1: Observed and expected values for H_o1

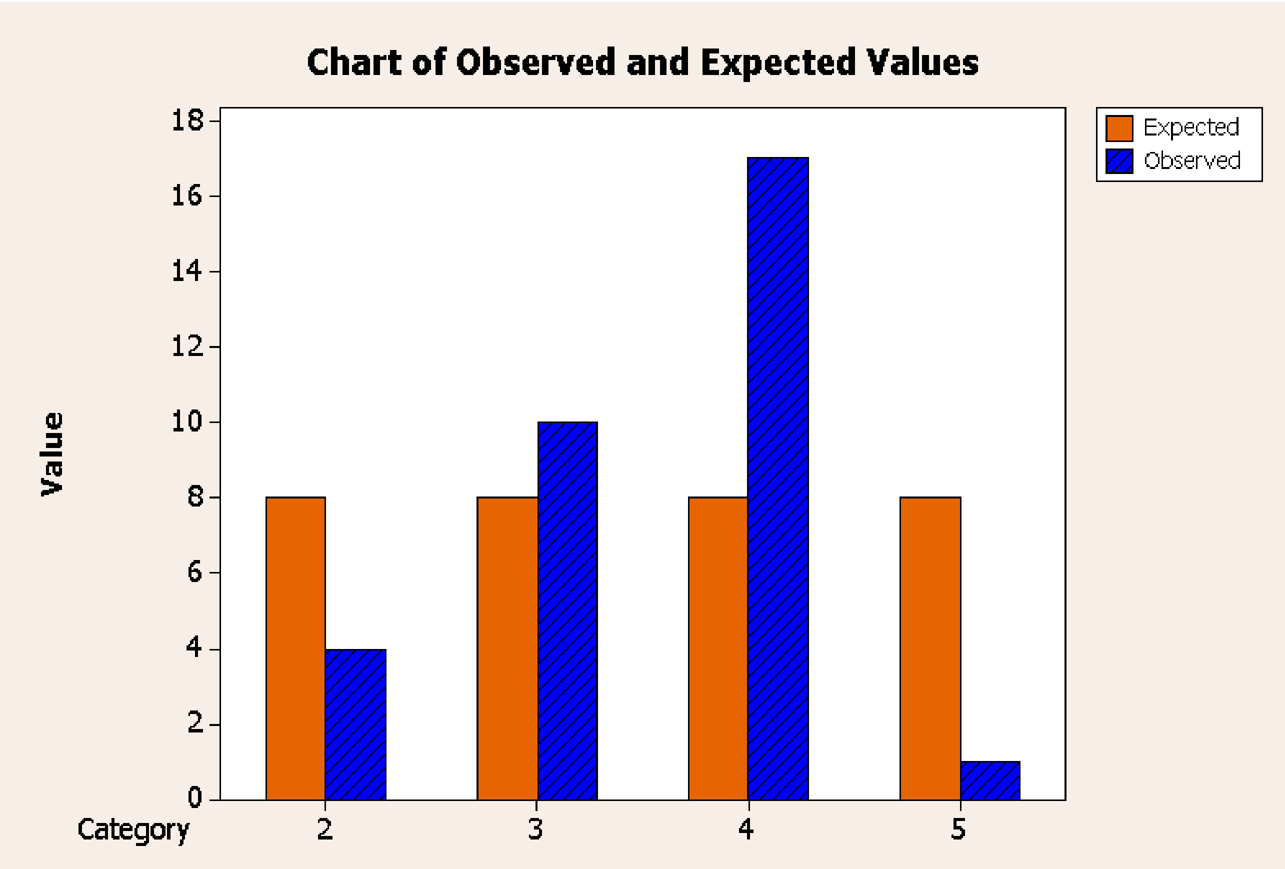


Table 5.3: Chi- square test results for H_o1

Number of samples (N)	Degrees of freedom (DF)	Chi- Square (Chi- Sq)	P- Value
32	3	18.75	0.000

Table 5.3 shows the results from the Chi- square test for H_o1. The p value is less than 0.05 which results in the rejection of the null hypothesis (there are no delays in coal mining projects in South Africa) and acceptance of the alternative hypothesis (there are delays in coal mining projects in South Africa).

5.3 The delays experienced in projects in the coal mining industry in South Africa are not measured effectively (H_o2)

As illustrated in Table 5.4 the majority of the respondents (47%) had indicated that their organizations usually measure the delays in the coal mining industry projects. Thirty one percent (31%) had indicated that their organizations always measure delays. None of the respondents indicated that they never measure delays.

The effective measurement of delays would mean that some sort of method of measuring the delays is adopted. As discussed in chapter 2, Trauner (2009) categorized delays into; critical and noncritical, excusable and non-excusable, compensable or non-compensable, and concurrent and non- concurrent. As illustrated in Table 5.4 the majority of the respondents (66%) indicated that their organizations measure the delays using the categorized method listed by Trauner (2009). In total 66% of the respondents indicated between usually and always that the delays are measured according to the categorized method.

Table 5.4: Frequency distribution for H_o2

Variables	Scale	Absolute frequency	Cum frequency	Relative frequency
Delays Measured	5) Always	10	10	31%
	4) Usually	15	25	78%
	3) About half the time	4	29	91%

	2) Seldom	3	32	100%
	1) Never	0	0	0%
Method of measuring delays	5) Always	5	5	16%
	4) Usually	16	21	66%
	3) About half the time	2	23	72%
	2) Seldom	6	29	91%
	1) Never	3	32	100%

5.3.1 ***Hypothesis testing of H_o2***

To test the second hypothesis the one sample Chi- Square test method and the one sample t- test will be used. The Chi- square test requires expected sample values based on the hypothesis made to test the nature of the population distribution. In the case of H_o2 equal proportions will be used due to the lack of information from previous literature specifically based on delays in the coal mining industry. This is illustrated in Figure 5.2.

Figure 5.2: Observed and expected values for H_o2

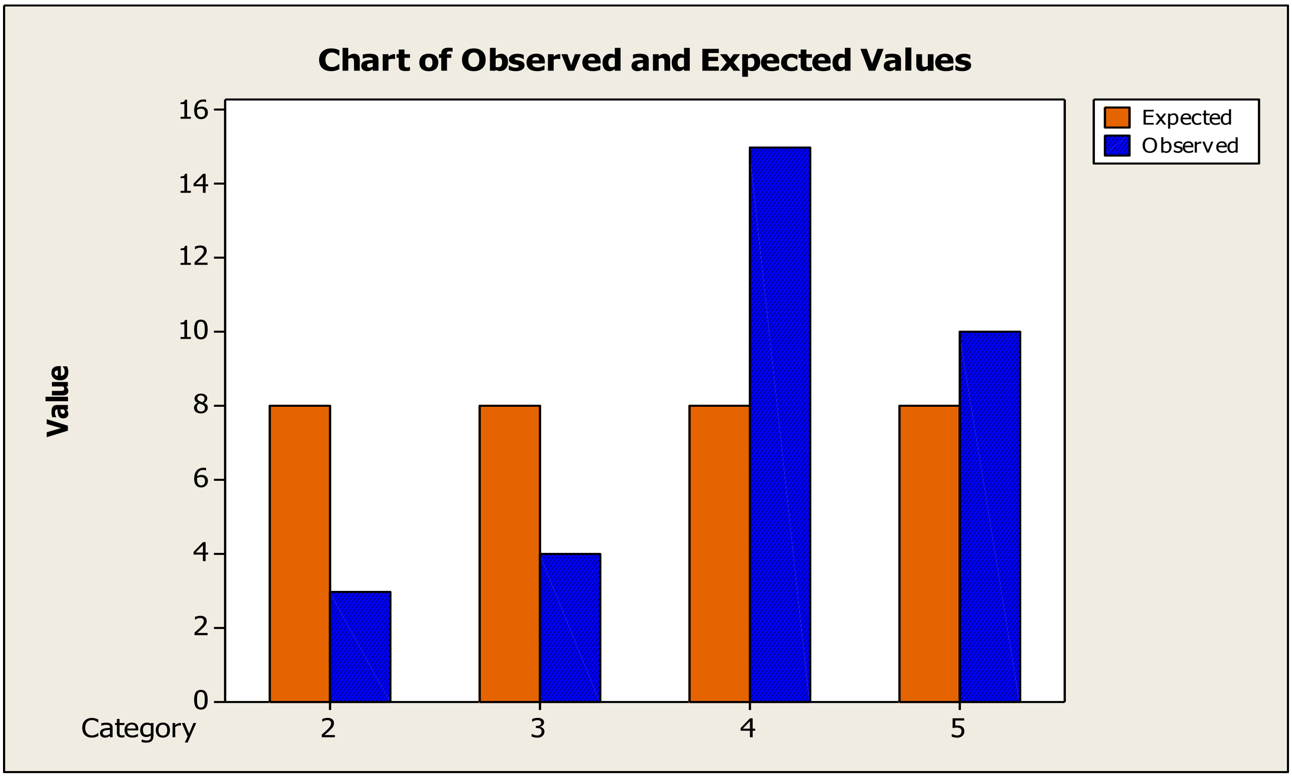


Table 5.5: Chi- square test results for H_o2

Number of samples (N)	Degrees of freedom (DF)	Chi- Square (Chi-Sq)	P- Value
32	3	11.75	0.008

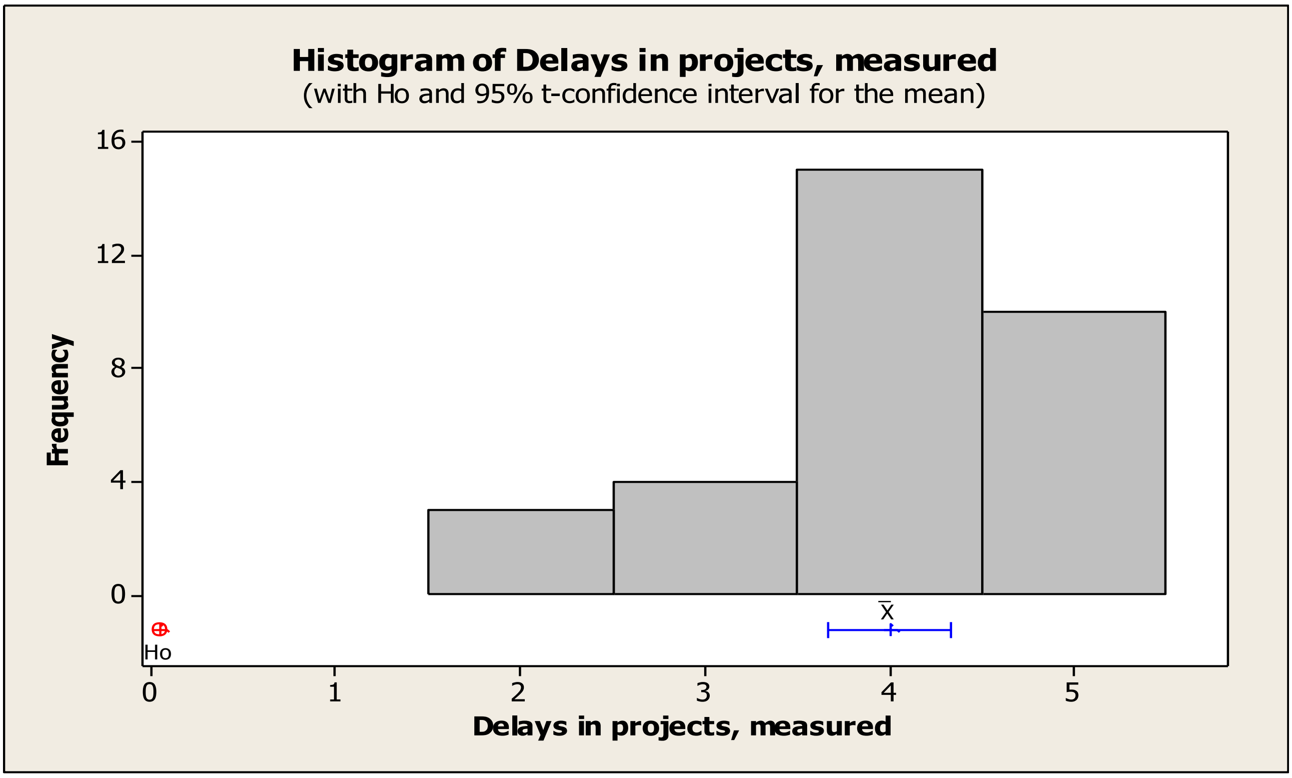
Table 5.5 shows the results from the Chi- square test for H_o2. The p value is less than 0.05 which results in the rejection of the null hypothesis (The delays experienced in projects in the coal mining industry in South Africa are not measured effectively) and acceptance of the alternative hypothesis (The delays experienced in projects in the coal mining industry in South Africa are measured effectively).

As an alternative test the one sample t- test was performed. This test also reports the mean and standard deviation. The results are shown in Table 5.6. The p- value is zero which results in a rejection of the null hypothesis H_o2. The mean is 4.0 and standard deviation 0.916 which is also illustrated in Figure 5.7. The mode, as shown in Table 4.10, is 4. The mode is the better measure to indicate the majority response as it is the most recurring value.

Table 5.6: One sample t- test results for H_o2

Number of samples (N)	Mean (X)	Standard Deviation (Std dev)	P- Value
32	4.0	0.916	0.000

Figure 5.3: Histogram for H_o2



Minitab uses the Pearson's product moment correlation to measure association. To measure the relationship between the measuring of the delays and the effectiveness of the method (classifying the delays) the Pearson's correlation is used. The results are shown in Table 5.7. There is a weak positive linear relationship between the two samples.

This relationship suggests that the measuring of delays is done effectively in the coal mining industry in South Africa.

Table 5.7: Pearson's correlation measure of measuring delays and classifying delays

Number of samples (N)	Correlation coefficient (r)	P- Value
32	0.312	0.082

5.4 The effects of delays in projects in the coal mining industry in South Africa are not measured effectively (H_o3)

Table 5.8 illustrates the frequency distribution of the effects of delays measured as indicated by the respondents as well as the response to the method of measure which indicates effectiveness. The majority of the respondents (38%) indicated that the effects of delays are usually measured. The mode is equal to 4. None of the respondents indicated that they never measure the effects of the delays experienced.

As discussed in chapter 2, Strumpf (2000) indicated that a delay may or may not extend the project schedule. Trauner (2009) also suggests the use of the schedule to determine the type of delays which have a direct bearing on the effects of those delays in terms of timing and cost. The second measure in Table 5.9 is result of the respondents' answers to the use of a method of measuring the effects of delays. The majority of the respondents were split in their response. Thirty one percent (31%) indicated that they always use the schedule method to measure the effects of delays and 31% indicated that they usually use this method. None of the respondents indicated that they never use this method of measuring the effects of the delays experienced.

Table 5.8: Frequency distribution for H_o3

Variables	Scale	Absolute frequency	Cum frequency	Relative frequency
Effects Measured	5) Always	9	9	28%
	4) Usually	12	21	65%
	3) About half the time	7	28	87%
	2) Seldom	4	32	100%
	2) Never	0	0	0%
Method of measuring Effects	5) Always	10	10	31%
	4) Usually	10	20	62%
	3) About half the time	6	26	81%
	2) Seldom	6	32	100%
	2) Never	0	0	0%

5.4.1 *Hypothesis testing of H_o3*

To test the third hypothesis the one sample Chi- Square test method and the one sample t- test will be used. The Chi- square test requires expected sample values based on the hypothesis made to test the nature of the population distribution. In the case of H_o3 equal proportions will be used due to the lack of information from previous literature specifically based on delays in the coal mining industry. This is illustrated in Figure 5.4.

Figure 5.4: Observed and expected values for H_o3

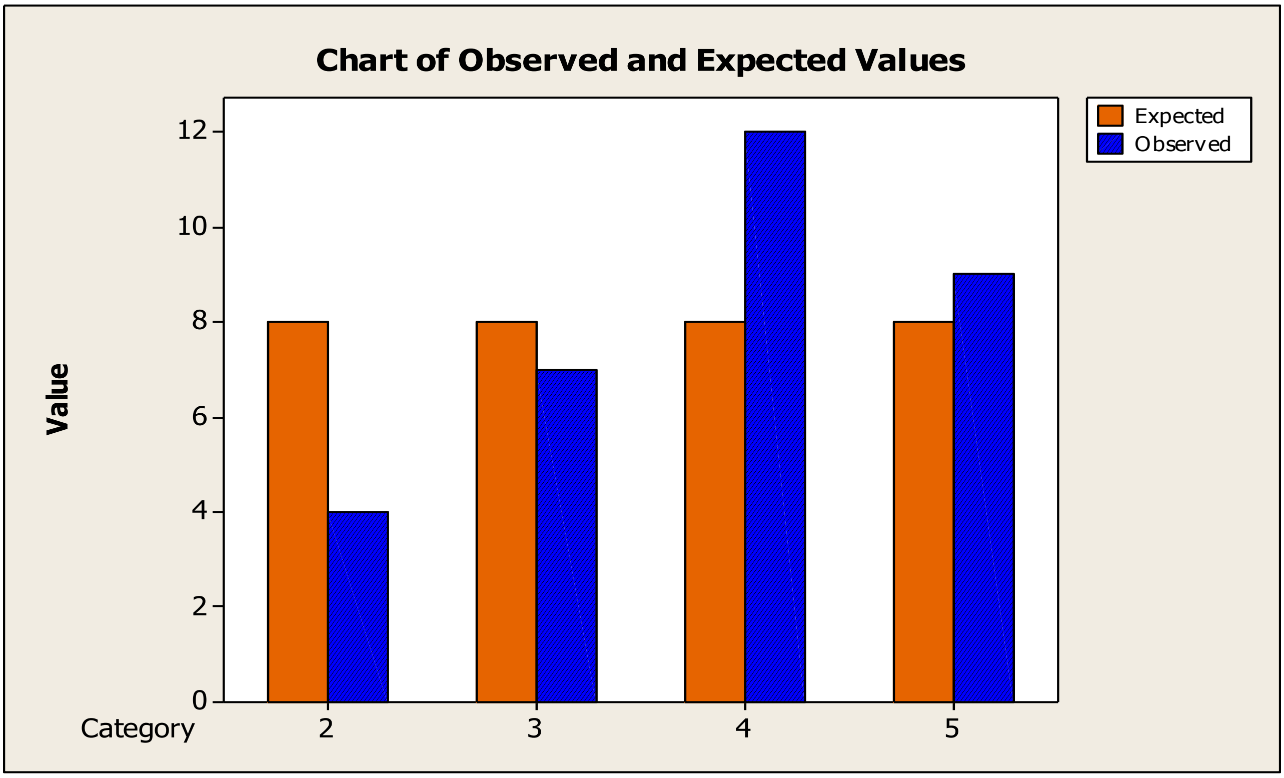


Table 5.9: Chi- square test results for H_o3

Number of samples (N)	Degrees of freedom (DF)	Chi- Square (Chi-Sq)	P- Value
32	3	4.25	0.236

Table 5.9 illustrates the results from the Chi- square test for H_o3. The p- value suggests that the null hypothesis should be accepted as there is only a small difference between the equal values and the sample values as shown in Figure 5.4. Using the one sample t- test the results are different as illustrated in Table 5.10. The mean is 3.8 and standard deviation 0.998. The p- value of 0.000 indicates a that the sample mean reflects the population mean and thus the null hypothesis (the effects of delays in projects in the coal mining industry in South Africa are not measured effectively) should be rejected and the alternative hypothesis (the effects of delays in projects in the coal mining industry in South Africa are measured effectively) accepted.

To measure the relationship between the measuring of the effects of delays and the effectiveness of the method (Schedule method) the Pearson's correlation is used. The results are shown in Table 5.11. The results indicate that there is a moderate to strong relationship between the measuring of the effects of the delays and the schedule method used. The p- value indicates that this relationship is highly significant.

Table 5.10: One sample t- test results for H_o3

Number of samples (N)	Mean (X)	Standard Deviation (Std dev)	P- Value
32	3.813	0.998	0.000

Figure 5.5: Histogram for H_o3

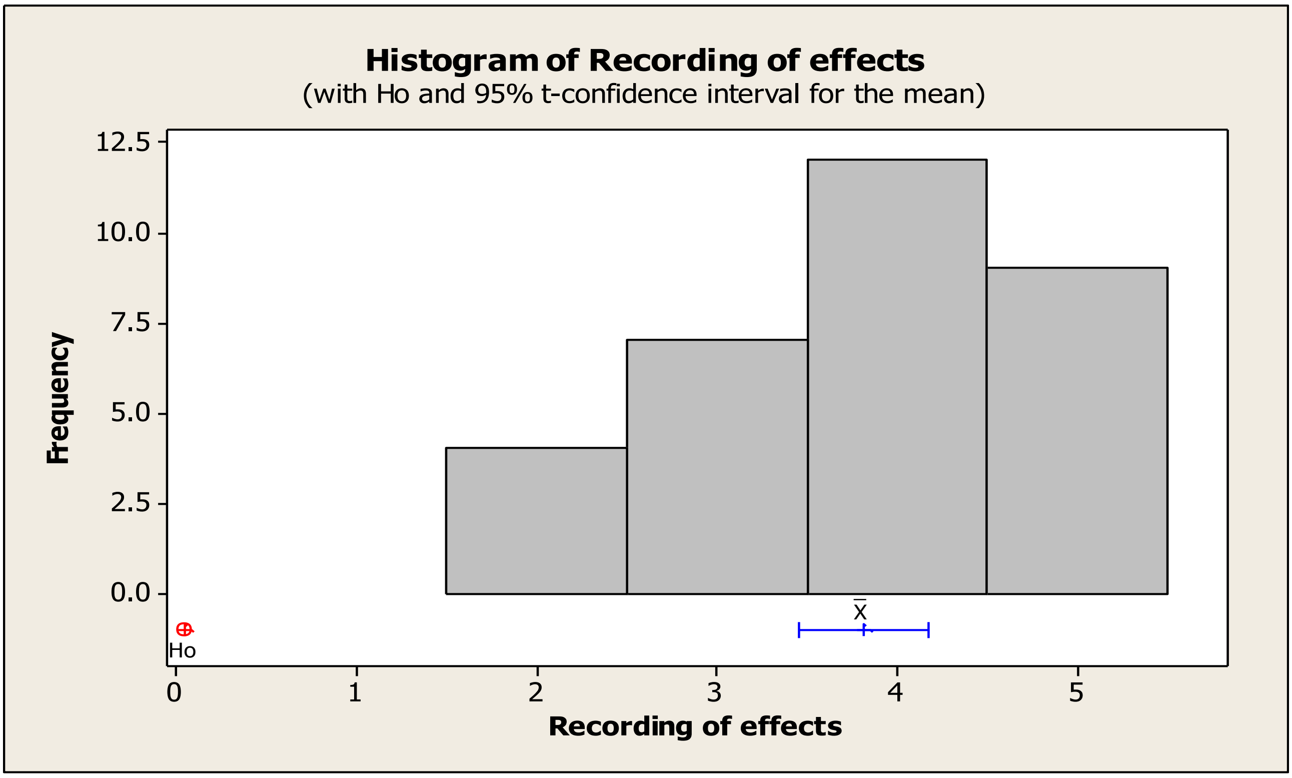


Table 5.11: Pearson's correlation measure of measuring the effects of delays and using the schedule method to determine the effects

Number of samples (N)	Correlation coefficient (r)	P- Value
32	0.774	0.000

5.5 The majority of delays are not experienced during the planning phase of the project process (H_o4)

Table 5.12 illustrates the frequency distribution of the delays experienced in the various project management phases. In the conceptual phase the majority (59%) of the respondents indicated that delays are seldom experienced in this phase. In the selection phase 41% of the respondents indicated that delays are experienced in this phase about half the time. In the planning phase 56% of the respondents indicated that the delays are seldom experienced. In the execution phase the majority (38%) of the respondents indicated that delays usually occur in this phase. In the evaluation phase the majority (56%) of respondents indicated that delays seldom occur. Finally the majority (69%) of respondents indicated that delays seldom take place in the termination phase of project management in coal mining projects.

Table 5.12: Frequency distribution for H_o4

Variables	Scale	Absolute frequency	Cum frequency	Relative frequency
Conception phase	5) Always	2	2	6%
	4) Usually	6	8	25%
	3) About half the time	4	12	38%
	2) Seldom	19	31	97%
	1) Never	0	0	0%

Selection phase	5) Always	1	1	3%
	4) Usually	6	7	22%
	3) About half the time	13	20	63%
	2) Seldom	12	32	100%
	1) Never	0	0	0%
Planning phase	5) Always	1	1	3%
	4) Usually	3	4	12%
	3) About half the time	9	13	40%
	2) Seldom	18	31	96%
	1) Never	1	32	100%
Monitoring and control (Execution) phase	5) Always	2	2	6%
	4) Usually	12	14	44%
	3) About half the time	11	25	78%
	2) Seldom	7	32	100%
	1) Never	0	0	0%
Evaluation phase	5) Always	2	2	6%
	4) Usually	2	4	12%
	3) About half the time	10	14	43%
	2) Seldom	18	32	100%
	1) Never	0	0	0%

Termination phase	5) Always	2	2	6%
	4) Usually	3	5	15%
	3) About half the time	2	7	21%
	2) Seldom	22	29	90%
	1) Never	3	32	100%

5.5.1 ***Hypothesis testing of H_o4***

To test the forth hypothesis the two sample t- test method will be used. Diamantopoulos and Schlegelmilch (2006) suggest the use of the two sample t- test when testing two or more measures by the same group. This test requires that the planning phase data be compared with the other phases separately in order to accept or reject the null hypothesis. In order to reject the null hypothesis all the test results must indicate a p- value below 0.05. This will indicate that the majority of delays do take place in the planning phase which is stated in the alternative hypothesis. Table 5.13 shows the results obtained from the statistical tests run using the Minitab software package. The first result is between the planning and conceptual phases. The conceptual phase mean is slightly higher than the planning phase mean at 2.66. The standard deviation is 1.04 which is also higher than the planning phase indicating a slightly larger deviation from the mean and therefore wider spread of results. The p- value result is 0.701 at a significance level of 95%.

The second test between the planning and selection phase yielded a p- value of 0.947. The selection phase mean is slightly higher than the planning phase mean at 2.875. The standard deviation is slightly lower than the planning phase standard deviation indicating slightly more concentrated values about the mean than for the planning phase results.

The third measure is between the planning and execution phase. The p- value was calculated as 1.000. The mean value of the execution phase data is much higher than that of the planning phase which is 3.281 and the standard deviation slightly higher at 0.888.

The standard deviation indicates a similar spread of data about the mean as with the planning phase data.

The forth measure is between the planning phase and the evaluation phase. The p- value result is 0.668. The mean of the evaluation phase data is slightly higher than the planning phase at 2.625. The standard deviation is also slightly higher at 0.871. The standard deviation indicates a similar spread about the mean as the planning phase data.

The final measure is between the planning phase and the termination phase. The mean value of the termination phase data is lower than the planning phase data at 2.340. The standard deviation of the termination phase data is higher than the planning phase data at 1.0 which indicates a broader spread of data about the mean than all the other measures in this test. The p- value is 0.211which is the lowest p- value calculated.

From the resulting p- values calculated, which are all greater than 0.05 it is concluded that the null hypothesis (The majority of delays are not experienced during the planning phase of the project process) must be accepted and the alternative hypothesis (The majority of delays are experienced during the planning phase of the project process) rejected.

Table 5.13: Two sample t- test results for H_o4

Paired test	Variables	Number of samples (N)	Mean (X)	Standard Deviation (Std dev)	P- Value
Planning and conceptual	Planning	**32**	2.531	0.842	0.701
	Conceptual	**32**	2.66	1.04	
Planning and	Planning	**32**	2.531	0.842	0.947

selection	Selection	**32**	2.875	0.833	
Planning and execution	Planning	**32**	2.531	0.842	1.000
	Execution	**32**	3.281	0.888	
Planning and evaluation	Planning	**32**	2.531	0.842	0.668
	Evaluation	**32**	2.625	0.871	
Planning and termination	Planning	**32**	2.531	0.842	0.211
	Termination	**32**	2.340	1.0	

5.6 The majority of delays are not experienced during the execution phase of the project process (H_o5)

The data presented in Section 5.5 as per Table 5.12 is applicable to this section.

5.6.1 *Hypothesis testing of H_o5*

To test the fifth hypothesis the two sample t- test method will once again be used. The results of the tests are tabulated in Table 5.14. In the first measure the mean for the execution phase is 3.281 and the standard deviation is 0.888. The conceptual phase mean is lower than the execution phase mean at 2.66. The standard deviation is higher than the execution phase standard deviation at 1.04 indicating a wider spread of data about the mean. The p- value is 0.006.

The second measure between the execution phase and selection phase results in a p-value of 0.032. The selection phase mean is lower than that of the execution phase at 2.875. The standard deviation is slightly lower at 0.833.

The third measure is between the execution phase and the planning phase. The planning phase mean is significantly less than the execution phase. The standard deviation is slightly less at 0.842. This indicates a similar spread of data about the mean. The p- value is 0.000.

The forth measure is between the execution phase and the evaluation phase. The evaluation phase mean is 2.625 which is lower than the mean of the execution phase data. The standard deviation is slightly lower at 0.871 indicating a similar spread about the mean as with the execution data. The p- value is 0.002.

The final measure is between the execution phase and the termination phase. The termination phase mean is significantly lower than the execution phase mean at 2.340. The standard deviation is higher at 1.000. This indicates a wider spread of data about the mean. The p- value is 0.000.

As illustrated in Table 5.14 the p- values are all below the significance level of 0.05. Thus the null hypothesis (The majority of delays are not experienced during the execution phase of the project process) is rejected and the alternative hypothesis (The majority of delays are experienced during the execution phase of the project process) accepted.

Table 5.14: Two sample t- test results for H_05

Paired test	Variables	Number of samples (N)	Mean (X)	Standard Deviation (Std dev)	P- Value
Execution and conceptual	Execution	**32**	3.281	0.888	0.006
	Conceptual	**32**	2.66	1.04	
Execution and selection	Execution	**32**	3.281	0.888	0.032
	Selection	**32**	2.875	0.833	
Execution and planning	Execution	**32**	3.281	0.888	0.000
	Planning	**32**	2.531	0.842	
Execution and evaluation	Execution	**32**	3.281	0.888	0.002
	Evaluation	**32**	2.625	0.871	
Execution and termination	Execution	**32**	3.281	0.888	0.000
	Termination	**32**	2.340	1.0	

5.7 Are consultants and contractors used in the coal mining industry in South Africa?

In chapter 4, section 4.5.5, the data from the questionnaires are tabled and discussed. The responses from the respondents were tabulated separately as per the questionnaire. To answer the question to whether consultants and contractors are used in the coal mining industry the results from the questionnaire were combined. The consultant respondents were requested to indicate whether they have done consultation work for the mining companies. These responses were added to the mining organization respondents to analyze the results. Similarly the contractor responses were added to the mining organization respondents responses. Therefore the sample size for the use of consultants and contractors are 27 and 22 respectively as shown in Table 5.15. The mean and mode of both the use of consultants and contractors by mining organizations indicate that they are usually used. The standard deviation for the use of consultants is 0.764 and the use of contractors is 0.710 indicating a narrow spread of data about the mean. This is also indicated by the mean and mode showing similar values. None of the respondents indicated that their organization does not use contractors or consultant. From the point of view of the consultants and contractors none of them indicated that they do not perform work for mining organizations.

Table 5.15: The use of contractors and consultants in the coal mining industry in South Africa

Variable	Sample	**Mean**	**Std Dev**	**Median**	**Mode**	**Skewness**
Use of consultants	27	4.259	0.764	4	4	-1.05
Use of contractors	22	4.136	0.710	4	4	-1.08

5.8 What are the delays experienced in the coal mining industry in South Africa?

In chapter 4 of this report the reposes received from the respondents were tabulated and presented. The first part of the listed delays is based on delays listed from previous research results. These delays were used as a baseline to determine if they were experienced in the coal mining industry. The results also answer the question of whether the delays in the coal mining industry are similar to the delays experienced in the construction industry. The delays listed from previous research results in the construction industry are grouped according to:

1) Delays due to labor
2) Delays due to materials
3) Delays due to equipment
4) Delays due to contractors
5) Delays due to the owners
6) Delays due to the consultants
7) Delays due to exogenous factors (weather)
8) Delays due to government regulation

From the results tabulated in Table 5.16 it is clear that none of the delays listed have never been experienced in the coal mining industry in South Africa. Due to the fact that the questionnaire used was a likert type and respondents have indicated according to the rigid scale options as shown in chapter 5 the mode results will be used as an indicator of the delay frequency. The mean will be used as the ranking mechanism to determine the top 10 delays experienced in the coal mining industry in South Africa.

Table 5.16: Delays experienced in the coal mining industry in South Africa similar to the construction industry

Number	**Variable**	**Mean**	**Std Dev**	**Median**	**Mode**	**Skewness**
	Labor (L)					
1	Shortage of manpower (skilled, semi-skilled, unskilled labor)	3.031	1.031	3	2	0.12

2	Labor disputes	2.188	0.965	2	2	0.52
	Material (M)					
3	Shortage of materials	2.5	0.718	2	2	0.56
4	Delay in materials delivery	2.781	0.792	3	2	0.42
5	Materials price fluctuations	2.406	0.946	2	2	1.02
6	Modifications in material specifications	2.594	0.756	2.5	2	0.38
	Equipment (E)					
7	Shortage of equipments	2.5	0.88	2	2	1.21
8	Failure of equipments	2.688	0.896	2.5	2	0.68
9	Insufficient equipments	2.625	0.833	2	2	0.47
	Contractor					
10	Lack of contractor's administrative personnel	2.594	0.979	3	3	-0.17
11	Shortage of technical professionals in the contractor's organization	3.031	0.999	3	2	0.14
12	Insufficient coordination among the parties by the contractor	3.188	0.931	3	3	-0.14
13	Delay in mobilization	3.25	0.88	3	3	0.08
14	Safety rules and regulations are not followed within the contractor's organization	3	0.95	3	3	0.24
15	Incompetent technical staff assigned to the project	2.813	0.738	3	3	-0.2
16	Improper technical study by the contractor during the bidding stage	2.906	0.893	3	3	0.19
17	Poor planning and scheduling of the	2.938	0.669	3	3	-0.62

	project by the contractor					
18	Improper handling of the project progress by the contractor	2.844	0.847	3	3	-0.37
19	Ineffective quality control by the contractor	3.094	0.928	3	4	-0.45
20	Use of unacceptable construction techniques by the contractor	2.625	0.942	2.5	2	0.11
21	Financial difficulties faced by the contractor	2.406	0.756	2	2	0.58
22	Delays in contractor's payments to subcontractors	2.313	0.78	2	2	0.68
	Owner					
23	Delays in site preparation	3	0.88	3	2	0
24	Delay in contractor's claims settlements	2.656	0.787	3	3	-0.13
25	Work suspension by the owner	2.344	0.787	2	2	0.98
26	Too many change orders from owner	3.031	1.092	3	2	0.41
27	Slow decision making from owner	3.344	0.937	3	3	0.24
28	Interference by the owner in the construction operations	2.781	0.941	2.5	2	0.96
29	Delay in progress payments by the owner	2.563	0.759	2	2	0.95
30	Financial constraints faced by the owner	2.031	0.74	2	2	0.97
31	Insufficient coordination among the parties by the Owner	2.938	0.84	3	2	0.12
	Consultant					

32	Ambiguities and mistakes in specifications and drawings	2.781	0.941	3	2	1.21
33	Poor qualification of consultant engineer's staff assigned to the project	2.406	1.103	2	2	1.1
34	Delay in the approval of contractor submissions by the engineer	2.75	0.95	2.5	2	1.26
35	Poor coordination by the consultant engineer with the parties involved	2.656	0.745	2.5	2	0.67
36	Slow response by the consultant engineer regarding testing and inspection	2.375	0.609	2	2	0.51
37	Slow response by the consultant engineer to contractor inquiries	2.5	0.718	2	2	0.56
	Exogenous factors (EF) Weather					
38	Severe weather conditions on the job site	3.125	1.008	3	2	0.34
	Government regulations					
39	**Difficulties in obtaining mining permission and other licenses**	3.5	1.078	3	3	-0.16
40	**Changes in Government regulations and laws**	2.719	0.958	2.5	2	0.85

Table 5.17 shows the statistical results of the potential delays listed in the questionnaire. The respondents were afforded the opportunity to rate these potential delays as actual delays that have taken place in the coal mining industry in South Africa. Focusing on the mode, the majority of the listed potential delays are considered potential delays. In chapter 4 Table 4.38 illustrates the respondent's opinion of these listed delays. The first listed delay in Table 5.17 is the reporting of exploration results which has a bimodal frequency of 2 and 4 which indicates that this potential delay was rated by the respondents as agreeing that it is a potential delay and also that they disagree that it is a potential delay. Looking at the mean of this data it is accepted that this potential delay can be considered in the list of delays in this study. In Table 5.18 this delay is rated as occurring seldom according to the mode (2) and the mean which is 2.438. Table 5.18 further illustrates the rating of the other delays listed by the respondents as those that have been experienced in the coal mining industry in South Africa. The highest occurring delay is the modeling inputs delay with a mode of 4 and a mean of 3.188.

Table 5.17: Potential coal mining industry delays in South Africa

Variable	**Mean**	**Std Dev**	**Median**	**Mode**	**Skewness**
The reporting of exploration results	3.063	0.948	3	2 /4	0.11
Geological interpretation	3.5	0.916	4	4	-0.4
Database integrity	3.406	0.798	4	4	-0.49
Modeling techniques	3.438	0.84	4	4	-0.31
Modeling inputs	3.469	0.842	4	4	-0.76
Ground conditions	3.813	1.061	4	4	-0.99
Running too may scenarios	3.75	0.916	4	4	-0.81
Up front planning	3.5	1.107	4	4	-0.38
Lowest bidder tender process	4.469	0.621	5	5	-0.74

Table 5.18: Delays related to the coal mining industry in South Africa

Number	Variable	Mean	Std Dev	Median	Mode	Skewness
41	**The reporting of exploration results**	2.438	0.801	2	2	0.22
42	**Geological interpretation**	2.625	0.751	2	2	0.76
43	**Database integrity**	2.719	0.729	3	3	-0.03
44	**Modeling techniques**	2.625	0.66	3	2	0.58
45	**Modeling inputs**	3.188	0.78	3	4	-0.35
46	**Ground conditions**	3.063	0.84	3	3	0.23
47	**Running too may scenarios**	2.938	0.878	3	2	0.43
48	**Up front planning**	2.875	1.04	3	2	0.63
49	**Lowest bidder tender process**	3.375	0.907	3	4	-0.02

From the listed delays the final ranked delays from the mean highest frequency of occurrence to the mean lowest frequency of occurrence is listed in Table 5.19. The top ten delays are therefore:

1) Difficulties in obtaining mining permission and other licenses
2) Lowest bidder tender process
3) Slow decision making from owner
4) Delay in mobilization by contractor
5) Insufficient coordination among the parties by the contractor
6) Modeling inputs in the resource and reserve determination process
7) Severe weather conditions on the job site
8) Ineffective quality control by the contractor

9) Ground conditions

10) Shortage of manpower (skilled, semi-skilled, unskilled labor)

Table 5.19: Ranked delays: highest mean frequency to lowest mean frequency

Number	Variable	Mean	Std Dev	Median	Mode	Skewness
39	Difficulties in obtaining mining permission and other licenses	3.5	1.078	3	3	-0.16
49	Lowest bidder tender process	3.375	0.907	3	4	-0.02
27	Slow decision making from owner	3.344	0.937	3	3	0.24
13	Delay in mobilization	3.25	0.88	3	3	0.08
12	Insufficient coordination among the parties by the contractor	3.188	0.931	3	3	-0.14
45	Modeling inputs	3.188	0.78	3	4	-0.35
38	Severe weather conditions on the job site	3.125	1.008	3	2	0.34
19	Ineffective quality control by the contractor	3.094	0.928	3	4	-0.45
46	Ground conditions	3.063	0.84	3	3	0.23
1	Shortage of manpower (skilled, semi-skilled, unskilled labor)	3.031	1.031	3	2	0.12
11	Shortage of technical professionals in the contractor’s organization	3.031	0.999	3	2	0.14
26	Too many change orders from owner	3.031	1.092	3	2	0.41
14	Safety rules and regulations are not followed within the contractor’s organization	3	0.95	3	3	0.24
23	Delays in site preparation	3	0.88	3	2	0
17	Poor planning and scheduling of the project by the contractor	2.938	0.669	3	3	-0.62
31	Insufficient coordination among the parties by the Owner	2.938	0.84	3	2	0.12

47	Running too may scenarios	2.938	0.878	3	2	0.43
16	Improper technical study by the contractor during the bidding stage	2.906	0.893	3	3	0.19
48	Up front planning	2.875	1.04	3	2	0.63
18	Improper handling of the project progress by the contractor	2.844	0.847	3	3	-0.37
15	Incompetent technical staff assigned to the project	2.813	0.738	3	3	-0.2
4	Delay in materials delivery	2.781	0.792	3	2	0.42
28	Interference by the owner in the construction operations	2.781	0.941	2.5	2	0.96
32	Ambiguities and mistakes in specifications and drawings	2.781	0.941	3	2	1.21
34	Delay in the approval of contractor submissions by the engineer	2.75	0.95	2.5	2	1.26
40	Changes in Government regulations and laws	2.719	0.958	2.5	2	0.85
43	Database integrity	2.719	0.729	3	3	-0.03
8	Failure of equipments	2.688	0.896	2.5	2	0.68
24	Delay in contractor's claims settlements	2.656	0.787	3	3	-0.13
35	Poor coordination by the consultant engineer with the parties involved	2.656	0.745	2.5	2	0.67
9	Insufficient equipments	2.625	0.833	2	2	0.47
20	Use of unacceptable construction techniques by the contractor	2.625	0.942	2.5	2	0.11
42	Geological interpretation	2.625	0.751	2	2	0.76
44	Modeling techniques	2.625	0.66	3	2	0.58
6	Modifications in material specifications	2.594	0.756	2.5	2	0.38
10	Lack of contractor's administrative personnel	2.594	0.979	3	3	-0.17
29	Delay in progress payments by the owner	2.563	0.759	2	2	0.95
3	Shortage of materials	2.5	0.718	2	2	0.56

7	Shortage of equipments	2.5	0.88	2	2	1.21
37	Slow response by the consultant engineer to contractor inquiries	2.5	0.718	2	2	0.56
41	The reporting of exploration results	2.438	0.801	2	2	0.22
5	Materials price fluctuations	2.406	0.946	2	2	1.02
21	Financial difficulties faced by the contractor	2.406	0.756	2	2	0.58
33	Poor qualification of consultant engineer's staff assigned to the project	2.406	1.103	2	2	1.1
36	Slow response by the consultant engineer regarding testing and inspection	2.375	0.609	2	2	0.51
25	Work suspension by the owner	2.344	0.787	2	2	0.98
22	Delays in contractor's payments to subcontractors	2.313	0.78	2	2	0.68
2	Labor disputes	2.188	0.965	2	2	0.52
30	Financial constraints faced by the owner	2.031	0.74	2	2	0.97

5.9 What are the effects of delays experienced in the coal mining industry in South Africa?

In section 4.5.6 the data collected from the questionnaire on the effects of the delays in the coal mining industry are tabulated. In Table 5.20 the effects of delays are listed. None of the effects have a mode or mean value lower than 2 which indicates that the effects of the delays listed have been experienced. Therefore none of the effects have never been experienced in the coal mining industry in South Africa. The timing effect shows a bimodal frequency of 4 and 5. The mean is 3.75, which indicates that the timing effects are usually experienced.

Table 5.20: Effects of delays related to the coal mining industry in South Africa

Number	Variable	Mean	Std Dev	Median	Mode	Skewness
1	**Cost effect**	3.5	1.047	4	4	-0.63
2	**Talent and skills effect**	2.719	0.772	3	3	0.1
3	**Environmental effect**	2.25	0.95	2	2	1.14
4	**Corporate image effect**	2.344	1.125	2	2	1
5	**Safety effect**	2.656	1.096	2.5	2	0.44
6	**Timing effects**	3.75	1.107	4	4/5	-0.38

Table 5.21 shows the ranked effects of delays using the mean as the ranking variable. The most experienced effect is timing effects with a mean of 3.75 followed closely by cost effects with a mean of 3.5. Talent and skills effects, with a mean of 2.719, are ranked third closely followed by safety effects with a mean of 2.656. Corporate effects are ranked fifth with a mean value of 2.344 and environmental effects are ranked sixth with a mean value of 2.25.

Table 5.21: Ranked effects of delays related to the coal mining industry in South Africa

Number	Variable	Mean	Std Dev	Median	Mode	Skewness
6	**Measuring timing effects**	3.75	1.107	4	4/5	-0.38
1	**Cost effect**	3.5	1.047	4	4	-0.63
2	**Talent and skills**	2.719	0.772	3	3	0.1

	effect					
5	**Safety effect**	2.656	1.096	2.5	2	0.44
4	**Corporate image effect**	2.344	1.125	2	2	1
3	**Environmental effect**	2.25	0.95	2	2	1.14

5.10 Summary of analysis and hypothesis testing

The null hypothesis testing was performed at a significance level of 0.05 to determine accept or reject outcomes. The first null hypothesis (H_o1) tested was that there are no delays in coal mining projects in South Africa. This hypothesis was rejected and the alternative hypothesis (H_11) accepted which is, that there are delays in coal mining projects in South Africa.

The second null hypothesis (H_o2) tested was that the delays experienced in projects in the coal mining industry are not measured effectively. The testing resulted in the rejection of the null hypothesis and acceptance of the alternative hypothesis (H_12) which states that the delays experienced in projects in the coal mining industry are measured effectively.

The third null hypothesis (H_o3) tested was that the effects of delays in projects in the coal mining industry in South Africa are not measured effectively. The testing resulted in the rejection of the null hypothesis and acceptance of the alternative hypothesis (H_13) which is that the effects of delays in projects in the coal mining industry in South Africa are measured effectively.

The forth null hypothesis (H_o4) tested was that the majority of delays experienced are not during the planning phase of the project process. The testing resulted in the acceptance of the null hypothesis.

The fifth null hypothesis (H_o5) tested was that the majority of delays experienced are not during the execution phase of the project process. The testing resulted in the rejection of the null hypothesis and acceptance of the alternative hypothesis (H_15) which is that the majority of delays experienced are during the execution phase of the project process. It was further determined that consultants and contractors are used in the coal mining industry.

The potential delays experienced in the coal mining industry in South Africa listed in the measuring instrument were analyzed according to the data received from the respondents. The delays are listed in order of the most experienced delay first to the least experienced delay last in Table 5.19. The potential effects of delays experienced in the coal mining industry in South Africa were analyzed and listed from the most experienced effect to the least experienced effect in Table 5.21.

5.11 Conclusion

In this chapter the hypotheses were tested and the various research questions answered based on the analysis of the data. In chapter six the research conclusions and recommendations will be presented.

Chapter 6: Conclusion and Recommendations

6.1 Introduction

In Chapter 5 the hypotheses were tested, the research questions answered and a list of delays and their effects tabulated. In this chapter conclusions will be drawn on the findings presented in this study as well as present recommendations. Areas for future research will be proposed to ensure continuity in this area of project management.

6.2 Conclusions

6.2.1 *Project management personnel in the South African coal mining industry*

The majority of the personnel involved in projects in the South African coal mining industry are predominantly male. The average age of the personnel is between 30 and 40 years with the majority having more than 10 years professional experience in project management. The results from this research are therefore mainly based on the perception of persons that have had many years of experience. The number of projects they have been involved in was not clarified, but for those having more that 10 years experience in coal mining related projects it can be assumed that it is more than one. This demonstrates that the coal mining industry uses experienced people in their project management teams.

The use of consultants and contractors does take place in the coal mining industry in South Africa. The analysis showed a strong affinity to the use of contractors and consultants. The use of these professionals probably takes place at various stages in the project management life cycle. The use of consultants could mostly take place during the conception, selection, planning, evaluation and termination phases and the use of contractors more in the execution phase. This was, however, not formally tested in this research.

6.2.2 *Delay occurrence in the South African coal mining industry*

The occurrence of delays in projects in the coal mining industry is experienced. The perceived frequency of these delays varies with a majority indication that delays occur at a high frequency. In other industries such as the construction industry it seems evident that delays will more than likely occur in projects. The issue is whether it will affect the project in a way that causes a critical effect to that project.

6.2.3 *Measuring delays in the South African coal mining industry*

The recording and measuring of delays are important in the sense that it enables the organization to determine that a delay occurred and that it can be classified in terms of a scale of severity. The technique used to classify delays is based on whether the delays are; critical and noncritical, excusable and non-excusable, compensable or non-compensable, and concurrent and non- concurrent. The use of this method is done by the majority of organizations to some degree. This includes mining organizations, consultants and contractors. It may be that they use a different method of classifying delay. The majority of the delays experienced are seldom classified as critical and noncritical, non-excusable and non-compensable. The remaining delays were mostly classified as excusable, compensable, and concurrent and non- concurrent.

6.2.4 *Delays during the project life cycle*

Delays are experienced during various phases of the project life cycle. The two phases most likely to experience delays are the planning and execution phases. The execution phase is the phase to mostly encounter delays in projects in the coal mining industry in South Africa. The planning phase is the next area of expected delays. The remaining phases; conception, selection, evaluation and termination, are expected to seldom experience delays.

6.2.5 *The possible delays expected in coal mining projects in South Africa*

The delays that can be experienced in the coal mining industry are grouped as:

a) Labor related delays include the shortage of manpower and events of labor disputes.

b) Material related delays include; shortage of materials, delay in materials delivery, materials price fluctuations and modifications in materials specifications.

c) Equipment related delays include; shortage of equipments, failure of equipments and insufficient equipments

d) Contractor related delays include; lack of contractor's administrative personnel, insufficient coordination among the parties by the contractor, shortage of technical professionals in the contractor's organization, delay in mobilization, safety rules and regulations are not followed within the contractor’s organization, incompetent technical staff assigned to the project, improper technical study by the contractor during the bidding stage, poor planning and scheduling of the project by the contractor, improper handling of the project progress by the contractor, ineffective quality control by the contractor, use of unacceptable construction techniques by the contractor, financial difficulties faced by the contractor and delays in contractor’s payments to subcontractors.

e) Owner related delays include; delays in site preparation, delay in contractor’s claims settlements, work suspension by the owner, too many change orders from owner, slow decision making from owner, interference by the owner in the construction operations, delay in progress payments by the owner, financial constraints faced by the owner, insufficient coordination among the parties by the owner.

f) Consultant related delays include; ambiguities and mistakes in specifications and drawings, poor qualification of consultant engineer’s staff assigned to the project, delay in the approval of contractor submissions by the engineer, poor coordination by the consultant engineer with the parties’ involved, slow response by the consultant engineer regarding testing and inspection, slow response by the consultant engineer to contractor inquiries.

g) Exogenous factor related delays are severe weather conditions on the job site

h) Government legislation delays include; difficulties in obtaining mining permission and other licenses, changes in government regulations and laws.

i) Reserve determination, mine planning and process related delays include; the reporting of exploration results. geological interpretation, database integrity, modeling techniques, modeling inputs (plant and equipment, cut- off grades or parameters, mining factors or assumptions and volume and capacity estimates for processing), ground conditions, running too may scenarios, up front planning, lowest bidder tender process.

The delays listed from a) to h) were also found to be delays in the construction industry. The ranking of the delays are obviously different. This confirms that the coal mining industry and the construction industry experience similar delays. This conclusion is due to the fact that construction forms a part of a coal mining project. The types of projects were limited to the establishment of a green fields (new mining area) operation or a brown fields (expansion of current mining) operation. Given the extensive list of delays the majority of the listed delays are seldom experienced.

The top ten delays are:

1) The South African mining industry is governed by the Department of Mineral Resources. As stated by the South African government services (2011) an applicant for a mining permit must follow application steps to obtain the permit. These steps are:

    1. Submit an application form accompanied by a fee.
    2. Submit an environmental management plan
    3. Consult the land owner or legal occupier of the land as well as any other affected party and submit the outcome of this process within 30 days of completion.

    The process of compiling the environmental management plan involves the Department of Water Affairs (DWA) and the Department of Economic Development, Environment and Tourism (DEDET). Each department has its own legal requirements and timelines. It is possible that this process can cause delays in obtaining mining permission for coal mining in South Africa. It is recommended that the process is driven by knowledgeable people so that the organization does not fall victim to the process.

2) The lowest bidder tender process is used as a cost saving drive by many companies. This may cause problems due to the work quality and delivery time. This process should be carefully managed to ensure that it does not become a risk to the organization.

3) Slow decision making by the owner can be perceived due to internal processes used for decision making. These processes should be understood when drawing up the work schedule to ensure that the correct time is allocated to the activity.

4) The delay in mobilization, 5) insufficient coordination and 8) ineffective quality control among parties by the contractors can be caused by an ineffective supply chain and many other issues. The contractors need to be committed in terms of resources and availability from the initiation of the project to ensure a reduction in delays.

6) Modeling inputs are from information gathered during exercises such are core drilling and sampling activities. If the data are bias or poorly representative the modeling outputs will be flawed.

7) Severe weather conditions are unpredictable. Construction and surface mining is extremely difficult if high rainfall is experienced. Lightning is a safety hazard that can be avoided by removing personnel from possible exposure. High temperatures can cause heat exhaustion which is also a potential safety risk.

9) Ground conditions vary based on the geological area to be mined. The conditions can be affected by geological features such as faults, slips and dykes. Areas affected by poor ground conditions will take longer to mine.

10) A shortage of manpower will differ depending on the location of the mining site. Traditionally the mining organizations provide accommodation for the required labor as not all skills are available from local communities. The supply of unskilled manpower will probably be easier to recruit compared to semi skilled and skilled labor.

The ranking of the delays was done in terms of frequency of occurrence. The effects of these specific individual delays on timing and cost would introduce a third dimension to this research indicating the criticality of each type of delay on a coal mining project.

6.2.6 *The possible effects of delays expected in coal mining projects in South Africa*

The effects only total six in number. The two effects ranked first and second are:

1) Timing effects
2) Cost effects

The other effects can almost be classified as subsets of these two effects. The other listed effects:

3) Talent and skills effects
4) Safety effects
5) Corporate image effects
6) Environmental effects

As with other industries, the timing and cost are the major effects experienced from delays in the coal mining industry. These effects due to delays in coal mining projects mostly result in the negative timing and cost aspects. These effects can be considered the secondary effects of project delays. The other delays listed can be considered the primary effects of the project delays. These effects will eventually lead to the increase of costs or the increase in the delivery timing of the project.

To illustrate this by example the cost of a major safety incident will be based on a number of factors. The number of hours or days that the project is stalled to assess and correct the initial procedures to avoid a reoccurrence of a similar event can severely effect costs. This may lead further to the payment of standing time to various contractors and consultants. Compensation payment to the worker or family due to the incident, depending on the severity thereof, may incur further costs. The timing effects of this incident will be based on the number of hours or days in which no activity takes place. Some mining organizations stop an entire mine if a major safety event occurs and this may be for several days in which time they investigate the incident and council all personnel working on that mine to prevent a reoccurrence of the incident or similar incident. The timing effect may differ if a project site only decides to stop a section of the project versus the total project. By stopping only a portion the effect may not be on the critical path compared to stopping the entire site which would.

The environmental effects can be caused due to failure of equipments for example. This could be due to a pump failing which has to pump contaminated water from a pollution control dam to prevent overflow into the receiving environment. This can cause varying levels of river pollution depending on the quality and quantity of the contaminated water entering the river. The environmental can effect lead to further cost effects in the form of a fine from the Department of Water Affairs, the cost to replace or repair the pump and any compensation to other parties due to work stoppages or compensation to communities outside the mining area. This contamination can lead to further corporate image effects. The eventual result of a corporate image effect can be cost related as the situation will require remedial action. Standing time may also be a cost effect. This will depend on whether the delays are compensable or non-compensable.

The effects of delays are obviously the subsequent damage that the project suffers due to events that cause the project process or a portion of the process to cease for a period of time. Therefore the fundamental effect of delays in the coal mining industry in South Africa is timing. This conclusion has emerged from the ranking. Recommendations

6.3 Recommendations

6.3.1 *Measuring of delays*

The measuring of delays entails the recognition of a delay according to an act or event that extends the time required to perform tasks under a contract. Further, the classification of this delay will ensure that the project management team can determine the possible effects as well as prevent future similar occurrences from taking place. Therefore it is vital that the project management teams measure the delays as they occur. This should be done by all parties involved, not just the main project management team. The contractor and consulting firms should measure the delays so that the determination of whether the delays are critical and noncritical, excusable and non-excusable, compensable or non-compensable, and concurrent and non- concurrent can be negotiated between the owner, consultant and/ or the contractor.

6.3.2 *The occurrence of delays*

The occurrence of delays in the coal mining industry is to be expected. It may be beneficial to establish some form of knowledge transfer to project teams embarking on a project in the coal mining industry. This may reduce the possibility of delays or reduce the negative effects that accompany delays. By developing partnerships with the consultants and contractors in the project management life cycle and sharing the knowledge gained may reduce the number of delays and the severity of negative effects.

These delays are definite risk factors that need to be considered prior to the kick off of a coal mining project. It will be neglectful to think that a coal mining project in South Africa will run from conception to termination without experiencing any delays or even any significant delays. The critical factor to consider is the effect that will be experienced.

6.3.3 *The effects of delays*

To avoid negative effects of delays in a coal mining project the project management team need to focus on the delays themselves. The effect of the delay is a consequence of the delay itself. Coal mining organizations, their consultants and contractors need to establish some form of partnership in the management of a project to prevent delays and minimize the effects. Subsequently, they need to introduce a knowledge management program to ensure the transfer of knowledge to other project management teams to reduce and even completely eradicate delays and their effects in coal mining projects in South Africa. With this knowledge management system it may be easier to develop pre determine mitigation actions to reduce the effects of the delays to a certain extent.

6.4 Recommendations for future research

6.4.1 *Delays during the project life cycle*

The delays and their effects that occur in coal mining projects in South Africa can be linked to the various life cycle phases of project management. From this research report it is evident that delays are mostly experienced during the planning and execution phases. By enabling a link between which delays usually occur in those phases and other phases will improve the ability of the project management teams to avoid these delays by introducing mitigation measures.

6.4.2 *Knowledge management in coal mining projects*

Research can be undertaken to access if the use of knowledge management occurs in coal mining projects and whether the introduction of a knowledge management system in coal mining projects will reduce the occurrence of delays and the effects of delays.

6.4.3 *Mitigation methods for reducing delays in projects in coal mining projects*

Research should be undertaken to access the various methods of mitigation used in coal mining projects to reduce or eliminate delays. Project management is applied in novel ways in various coal mining organizations by introducing extra steps to ensure governance. This may similarly be exercised in the mitigation of the delays and their effects in various projects.

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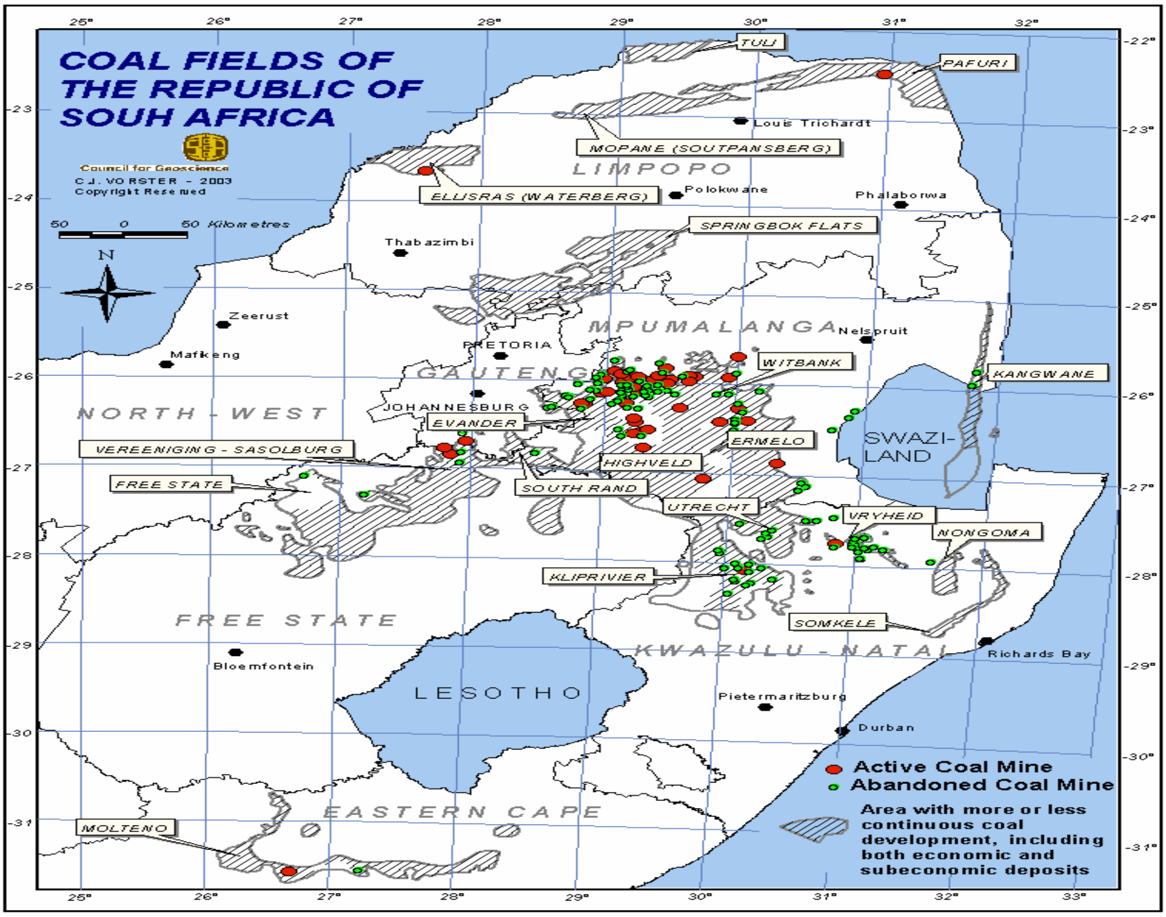
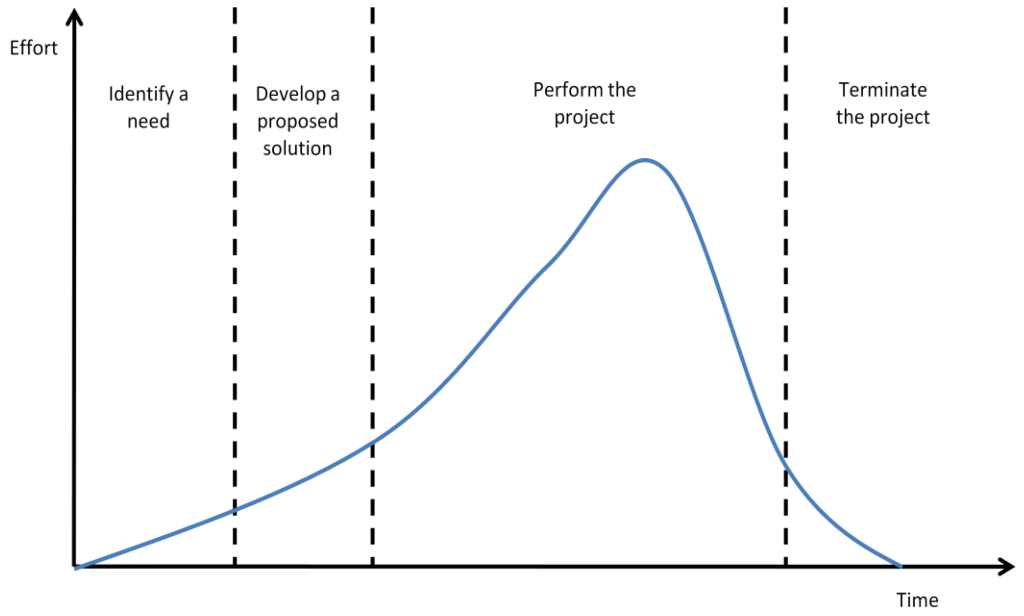
Annexures

Annexure A: Coal Fields in South Africa



Annexure B: Project life cycle (Gido and Clements, 1999)



Annexure C: Possible construction project delays

	Yang, Yang and Kao (2009)			**Assaf and Al-Hejji (2006)**	
Number	**Stage in Project**	**Delay Cause**		**Delay**	**Sources of Delay Group**
1	Feasibility study and preliminary plan	Model selection for PPP		Original contract duration is too short	Project
2		Law and regulation change		Legal disputes b/w various parts	Project
3		Shortage of professional service fee		Inadequate definition of substantial completion	Project

4		Limitation of land use regulation		Ineffective delay penalties	Project
5		Urban plan change		Type of construction contract (Turnkey, construction only,.)	Project
6		Selection of professional consultant		Type of project bidding and award (negotiation, lowest bidder,.)	Project
7		Lack of determination of entitled government		Delay in progress payments by owner	Owner
8		Implementation schedule change		Delay to furnish and deliver the site to the contractor by the owner	Owner
9	Announcement and submission of application	Announcement content change		Change orders by owner during construction	Owner
10		Low enthusiasm of private investment		Late in revising and approving design documents by owner	Owner
11		Improper announcement content		Delay in approving shop drawings and sample materials	Owner
12		Law and regulation change	Duplicate	Poor communication and coordination by owner and other parties	Owner
13		Urban plan change	Duplicate	Slowness in decision making process by owner	Owner
14		Low self liquidating ratio		Conflicts between joint-ownership of the project	Owner
15		Lack of incentive for private		Unavailability of incentives for contractor for finishing ahead of schedule	Owner

		investment			
16		Trivial administrative procedures		Suspension of work by owner	Owner
17		Rigid investment content		Difficulties in financing project by contractor	Contractor
18		No investment consultant		Conflicts in sub-contractors schedule in execution of project	Contractor
19		Short tendering period		Rework due to errors during construction	Contractor
20		Impractical financial feasibility		Conflicts b/w contractor and other parties (consultant and owner)	Contractor
21	Evaluation and selection	Evaluation and selection committee change		Poor site management and supervision by contractor	Contractor
22		Hard to define objective evaluation rule		Poor communication and coordination by contractor with other parties	Contractor
23		Improper evaluation and selection procedure		Ineffective planning and scheduling of project by contractor	Contractor
24		No bidder		Improper construction methods implemented by contractor	Contractor
25		Divergent results by evaluation and selection committee		Delays in sub-contractors work	Contractor
26		No qualified bidder		Inadequate contractor’s work	Contractor

27	Negotiation and signing of concession agreement	Design change		Frequent change of sub-contractors because of their inefficient work	Contractor
28		Law and regulation change	Duplicate	Poor qualification of the contractor's technical staff	Contractor
29		Schedule delay by administrative procedure		Delay in site mobilization	Contractor
30		Project debt collateral		Delay in performing inspection and testing by consultant	Consultant
31		Mechanism for forced transfer		Delay in approving major changes in the scope of work by consultant	Consultant
32		Role conflict in negotiation		Inflexibility (rigidity) of consultant	Consultant
33		Urban plan change	Duplicate	Poor communication/coordination between consultant and other parties	Consultant
34		Uncertainty on political issues and government-finished items		Late in reviewing and approving design documents by consultant	Consultant
35		Unclear definition of changeable and unchangeable items		Conflicts between consultant and design engineer	Consultant
36		Land rental fee		Inadequate experience of consultant	Consultant
37		Debt problem		Mistakes and discrepancies in design documents	Design

38		Rigid land rental fee		Delays in producing design documents	Design
39		Divergence in negotiation and contract signing		Unclear and inadequate details in drawings	Design
40		Improper timing for negotiations		Complexity of project design	Design
41		Dispute on operation duration		Insufficient data collection and survey before design	Design
42		Dispute on land usage		Misunderstanding of owner's requirements by design engineer	Design
43		Delayed land liberation schedule		Inadequate design-team experience	Design
44		Improper contract planning		Un-use of advanced engineering design software	Design
45	Design	Demand change on the client		Shortage of construction materials in market	Materials
46		Wrong clients demand recognized by the project team		Changes in material types and specifications during construction	Materials
47		Inexperienced project team		Delay in material delivery	Materials
48		Improper planning and schedule developed by project team		Damage of sorted material while they are needed urgently	Materials
49		Improper design caused	Duplicate	Delay in manufacturing	Materials

		by law and regulation change		special building materials	
50		Trivial administrative procedures	Duplicate	Late procurement of materials	Materials
51		Improper selection of designer and consultant		Late in selection of finishing materials due to availability of many types in market	Materials
52		Uncompleted client- finished items		Equipment breakdowns	Equipment
53	Construction	Change orders		Shortage of equipment	Equipment
54		Unexpected increased quantity		Low level of equipment-operator's skill	Equipment
55		Late site liberation by client		Low productivity and efficiency of equipment	Equipment
56		Shortage of construction budget		Lack of high-technology mechanical equipment	Equipment
57		Bad weather and disaster		Shortage of labors	Labors
58		Law and regulation change	Duplicate	Unqualified workforce	Labors
59		Fluctuation on resource price		Nationality of labors	Labors
60		Shortage of materials		Low productivity level of labors	Labors
61		Failed examination and inspection		Personal conflicts among labors	Labors

62		Failed final examination		Effects of subsurface conditions (e.g., soil, high water table, etc.)	External
63	Operation	Construction schedule delay		Delay in obtaining permits from municipality	External
64		Law and regulation change	Duplicate	Hot weather effect on construction activities	External
65		Unclear operation plan		Rain effect on construction activities	External
66		Shortage of operation manpower		Unavailability of utilities in site (such as, water, electricity, telephone, etc.)	External
67		Shortage of operation cash flow		Effect of social and cultural factors	External
68		Shortage of debt capital		Traffic control and restriction at job site	External
69		Inadequate personnel skills		Accident during construction	External
70		Bad weather and disaster		Differing site (ground) conditions	External
71		Operation disaster		Changes in government regulations and laws	External
72		Resistance by residents		Delay in providing services from utilities (such as water, electricity)	External
73	Transfer	No takeover entity		Delay in performing final inspection and certification by a third party	External
74		Incompletion of property transfer			

75		Unclear definition of compensable and non-compensable project items			
76		Indefinite property list			
77		Incomplete refunded project loan			
78		Insufficient document preparation			
79		Divergent transfer scope			
80		Incomplete duty from contract party			

Annexure D: Request to conduct research in respondent organization

Dear Sir/ Madam

I am currently in the third year of the Master of Business Leadership (MBL) course studying at the UNISA School of Business Leadership (SBL). In this final year it is required that I perform a research project. I have chosen to research the causes and effects of project delays in the coal mining industry.

I hereby request that you grant me permission to collect data from your organization to assist with this research. The data will mainly consist of a questionnaire which needs to be completed by the personnel in your organization working in the project management field.

The completed research findings will be shared with your organization on completion. All information regarding your organization will be treated in the strictest confidence. Your assistance in this regard is highly appreciated.

Yours sincerely

Clinton Lee

Cell no. 082 458 7746

Email: Clinton.lee@bhpbilliton.com

Annexure E: Request for the respondent to complete the questionnaire

Dear Sir/ Madam

I am currently in the third year of the Master of Business Leadership (MBL) course studying at the UNISA School of Business Leadership (SBL). In this final year it is required that I perform a research project. I have chosen to research the causes and effects of project delays in the coal mining industry.

I hereby request that you complete the attached questionnaire to assist with the collection of data for the research. The completion of the questionnaire is voluntary. The information will only be used in the stated research and nothing else.

The completed research findings will be shared with your organization on completion. All information regarding your organization will be treated in the strictest confidence.

Please return the completed questionnaire to the email address below by 20 September 2011. If there are any clarifying questions please do not hesitate to contact me.

Your assistance in this regard is highly appreciated.

Yours sincerely

Clinton Lee

Cell no. 082 458 7746

Email: Clinton.lee@bhpbilliton.com

Annexure F: Complete questionnaire

Section 1- Biographical questions							
1	**Gender**	**Male**	**Female**				
		☑	☐				
2	**Type of company in which you work**	**Mining**	**Consultant**	**Contractor**			
		☐	☐	☐			
3	**Project management role**	Junior Project manager	Project manager	Senior Project manager	Executive Project manager	Other (specify)	Remarks
		☐	☐	☐	☐	☐	
4	**Project management experience**	**0-1 year**	**1-<2 years**	**3-<5 years**	**6-<10 years**	**> 10 years**	
		☐	☐	☐	☐	☐	
5	**Age**	**<20 years**	**21-30 years**	**31-40 years**	**41-50 years**	**51- 65 years**	
		☐	☐	☐	☐	☐	
Note:	**Please select the appropriate checkbox and insert comments in the remarks box when applicable**						
When complete go to "General Questions" tab							

Section 2- Questions related to delays and their effects

	Question	Always	Usually	About half the time	Seldom	Never	Explanation
	Section 2.1						
1	Are delays experienced in projects your organization is involved in?	☐	☐	☐	☐	☐	
	Section 2.2						
2	The project management process is generally divided into life cycle sections. The basic sections are: a) Conception b) Selection c) Planning, scheduling, monitoring and control d) Evaluation and termination Based on the project life cycle, select the frequency of delays experienced in each section.						
2.1	Conception	☐	☐	☐	☐	☐	
2.2	Selection	☐	☐	☐	☐	☐	
2.3	Planning	☐	☐	☐	☐	☐	
2.4	Monitoring and control (Execution)	☐	☐	☐	☐	☐	
2.5	Evaluation	☐	☐	☐	☐	☐	
2.6	Termination	☐	☐	☐	☐	☐	
	Section 2.3						
3	Delays are measured in terms of the unintended increase in the time it takes to complete a project. Are the delays in projects measured in your organisation?	☐	☐	☐	☐	☐	
3.1	Delays can be classified into critical and non critical, excusable and non excusable, compensable and non- compensable, and concurrent and non- concurrent. Are projects in your organisation measured in this way?	☐	☐	☐	☐	☐	
3.2	Are the delays experienced						**Explanation**
	Critical?	☐	☐	☐	☐	☐	Critical delays are those that affect the project completion date or milestone dates
	Non- Critical?	☐	☐	☐	☐	☐	
	Excusable?	☐	☐	☐	☐	☐	Excusable delays are those that have taken place due to unforeseeable events beyond the control of the project executor
	Non- excusable?	☐	☐	☐	☐	☐	Non- excusable delays are events in the control of the project executor
	Compensable?	☐	☐	☐	☐	☐	A compensable delay is one that entitles the project executor to time extensions or additional compensation
	Non- Compensable?	☐	☐	☐	☐	☐	Non- compensable means that the project executor is not entitled to time extension or other compensation even if the delay is excusable.
	Concurrent?	☐	☐	☐	☐	☐	Delays occurring on separate paths that can cause a delay to the critical path are concurrent delays
	Non- Concurrent?	☐	☐	☐	☐	☐	
	Section 2.4						
4	Most literature, particularly post 2000 look at delays from the perspective of consultants, contractors and the owners of projects.						
4.1	If you are part of a mining organization; do you use the services of consultants in mining projects.	☐	☐	☐	☐	☐	
4.1.1	Do you use the services of contractors?	☐	☐	☐	☐	☐	
4.2	If you are part of a consulting firm; do you consult for mining organizations on projects?	☐	☐	☐	☐	☐	
4.3	If you are part of a contracting firm; do you do work for mining organizations on projects?	☐	☐	☐	☐	☐	
	Section 2.5						
5	The effects of delays are mainly listed as timing and cost impacts.						
5.1	Have the delays encountered by you in coal mining projects resulted in an increase in project delivery timing?	☐	☐	☐	☐	☐	
5.2	Have the delays encountered by you in coal mining projects resulted in an increase in project costs?	☐	☐	☐	☐	☐	
5.3	Are the effects of delays recorded as they occur during the project?	☐	☐	☐	☐	☐	
5.4	To measure delays effectively, the cause should be entered into the schedule program to determine the effect on the timing of the project and thus the cost. Has this method of measuring the delay effect been done in the coal mining projects you have been involved with.	☐	☐	☐	☐	☐	
5.5	Some large mining organisations rate risks based on cost, people, environment, corporate image and safety. Project delays in coal mining can have a negative effect on these elements listed. Please rate the frequency that you have experienced negative effects in these categories below.						
5.5.1	Cost of the project	☐	☐	☐	☐	☐	
5.5.2	Talent and skills management of the personnel	☐	☐	☐	☐	☐	
5.5.3	Effect on the environment	☐	☐	☐	☐	☐	
5.5.4	Effect on the organization's corporate image	☐	☐	☐	☐	☐	
5.5.5	The effects on the safety statistics of the organization	☐	☐	☐	☐	☐	

Note: Please select the appropriate checkbox

When complete click here to continue to "Type of delays" tab

Section 3- Identifing delay types

Section 3.1

No	Category	Experiences				
	The following list of delays is based on areas found to be specific delay causes in the construction industry.Please rate the frquency of occurance in coal mining projects that you have been involved in.					
		Always	Usually	About half the time	Seldom	Never
	Labor (L)	1	2	3	4	5
1	Shortage of manpower (skilled, semi-skilled, unskilled labor)					
2	Labour disputes					
	Material (M)					
3	Shortage of materials					
4	Delay in materials delivery					
5	Materials price fluctuations					
6	Modifications in materials specifications					
	Equipment (E)					
7	Shortage of equipments					
8	Failure of equipments					
9	Insufficient equipments					
	Contractor					
10	Lack of contractor's administrative personnel					
11	Shortage of technical professionals in the contractor's organization					
12	Insufficient coordination among the parties by the contractor					
13	Delay in mobilization					
14	Safety rules and regulations are not followed within the contractor's organization					
15	Incompetent technical staff assigned to the project					
16	Improper technical study by the contractor during the bidding stage					
17	Poor planning and scheduling of the project by the contractor					
18	Improper handling of the project progress by the contractor					
19	Ineffective quality control by the contractor					
20	Use of unacceptable construction techniques by the contractor					
21	Financial difficulties faced by the contractor					
22	Delays in contractor's payments to subcontractors					

	Owner					
23	Delays in site preparation	☐	☐	☐	☐	☐
24	Delay in contractor's claims settlements	☐	☐	☐	☐	☐
25	Work suspension by the owner	☐	☐	☐	☐	☐
26	Too many change orders from owner	☐	☐	☐	☐	☐
27	Slow decision making from owner	☐	☐	☐	☐	☐
28	Interference by the owner in the construction operations	☐	☐	☐	☐	☐
29	Delay in progress payments by the owner	☐	☐	☐	☐	☐
30	Financial constraints faced by the owner	☐	☐	☐	☐	☐
31	Insufficient coordination among the parties by the Owner	☐	☐	☐	☐	☐
	Consultant					
32	Ambiguities and mistakes in specifications and drawings	☐	☐	☐	☐	☐
33	Poor qualification of consultant engineer's staff assigned to the project	☐	☐	☐	☐	☐
34	Delay in the approval of contractor submissions by the engineer	☐	☐	☐	☐	☐
35	Poor coordination by the consultant engineer with the parties involved	☐	☐	☐	☐	☐
36	Slow response by the consultant engineer regarding testing and inspection	☐	☐	☐	☐	☐
37	Slow response by the consultant engineer to contractor inquiries	☐	☐	☐	☐	☐
	Exogeneous factors (EF)					
	Weather					
38	Severe weather conditions on the job site	☐	☐	☐	☐	☐
	Government regulations					
39	Difficulties in obtaining mining permission and other licences	☐	☐	☐	☐	☐
40	Changes in Government regulations and laws	☐	☐	☐	☐	☐

Section 3.2

The literature reviewed does not list delays in coal mining or other projects. However, potential project risks and pitfalls are mentioned. These points are listed below. Rate these points on whether you consider them as delays in coal mining projects.

		Strongly Agree	Agree	Un-decided	Disagree	Strongly Disagree
1	In determining the mineral resource and reserves do you agree that the following are potential delays?					
1.1	The reporting of exploration results.	☐	☐	☐	☐	☐
1.2	Geological interpretation	☐	☐	☐	☐	☐
1.3	Database integrity	☐	☐	☐	☐	☐
1.4	Modeling techniques	☐	☐	☐	☐	☐
1.5	Modelling inputs such as plant and equipment, cut- off grades or parameters, mining factors or assumptions and volume and capacity estimates for processing	☐	☐	☐	☐	☐
2	Sources of uncertainty are prevalent in coal mining, of which ground conditions are a major issue. Would ground conditions result in project delays in coal mining?	☐	☐	☐	☐	☐
2.1	Can running too may scenarios cause delays in a coal mining project?	☐	☐	☐	☐	☐
3	Up front planning is critical to a mining project. Could this planning cause delays in a coal mining project?	☐	☐	☐	☐	☐
4	The tender process usually results in the selection of lowest bidder . Could this cause delays in a coal mining project?	☐	☐	☐	☐	☐

Section 3.3

Based on the rating given in Section 3.2 it may be that you have encountered these potential delays in a coal mining project. Please rate the frequency of the potential delays below.

		Always	Usually	About half the time	Seldom	Never
1	In determining the mineral resource and reserves.					
1.1	The reporting of exploration results.	☐	☐	☐	☐	☐
1.2	Geological interpretation	☐	☐	☐	☐	☐
1.3	Database integrity	☐	☐	☐	☐	☐
1.4	Modeling techniques	☐	☐	☐	☐	☐
1.5	Modelling inputs such as plant and equipment, cut- off grades or parameters, mining factors or assumptions and volume and capacity estimates for processing	☐	☐	☐	☐	☐
2	Ground conditions	☐	☐	☐	☐	☐
2.1	Running too may scenarios.	☐	☐	☐	☐	☐
3	Up front planning.	☐	☐	☐	☐	☐
4	Lowest bidder tender process	☐	☐	☐	☐	☐