

KEY CHALLENGES FACED BY MAIN CONTRACTORS IN COORDINATING THE
WORKS OF THEIR SUBCONTRACTORS- A CASE STUDY OF KUSILE POWER
STATION PROJECT

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TABLE OF CONTENTS

LIST OF TABLES	3
LIST OF FIGURES	3
ACKNOWLEDGEMENTS	4
DECLARATION	5
ABSTRACT.....	6
DEFINITION OF KEY TERMS	7
CHAPTER 1	8
INTRODUCTION	8
BACKGROUND TO THE STUDY	9
PROBLEM STATEMENT	9
RESEARCH AIM	10
OBJECTIVES OF THE STUDY	10
RESEARCH QUESTIONS	11
RESEARCH METHODOLOGY	11
SCOPE OF THE STUDY	11
STRUCTURE OF THE STUDY	12
CHAPTER 2	15
LITERATURE REVIEW	15
SUBCONTRACTING IN CONSTRUCTION	15
CONTRACTOR-SUBCONTRACTOR CONTRACTUAL RELATIONSHIP	18
CONTRACTOR-SUBCONTRACTOR WORKING RELATIONSHIP	20
COORDINATION OF SUBCONTRACTORS' WORKS	22
HOW CONTRACTORS COORDINATE THEIR SUBCONTRACTORS' WORKS	23
CHALLENGES IN COORDINATING SUBCONTRACTORS' WORKS.....	26
SUMMARY OF LITERATURE	28
CHAPTER 3	30
RESEARCH METHODOLOGY.....	30
KUSILE POWER STATION PROJECT OVERVIEW	30
RESEARCH DESIGN AND METHODS	30

CASE STUDY STRATEGY- STRATEGY TO BE ADOPTED FOR THIS STUDY	31
RESEARCH METHODS	32
SAMPLING TECHNIQUE	32
RESEARCH INSTRUMENT	33
DATA COLLECTION	33
DATA ANALYSIS.....	35
RESEARCH ETHICS.....	35
RELIABILITY AND VALIDITY	35
CHAPTER 4	37
DATA PRESENTATION AND ANALYSIS	37
DATA PRESENTATION FOR EACH MAIN CONTRACTOR	37
MAIN CONTRACTOR 1	37
MAIN CONTRACTOR 2	41
MAIN CONTRACTOR 3	45
MAIN CONTRACTOR 4	47
COMBINED RESULTS / SUMMARY OF RESULTS.....	51
GENERAL OVERVIEW.....	51
CONSOLIDATED LIST PER STUDY OBJECTIVE	53
CHAPTER 5	65
DISCUSSION OF RESULTS.....	65
CHAPTER 6	71
CONCLUSION AND RECOMMENDATION.....	71
REFERENCES	73
APPENDIX 1- LIST OF COORDINATION ACTIVITIES by Saram & Ahmed (2001).....	75
APPENDIX 2- LIST OF COORDINATION ACTIVITIES by Jha & Misra (2007)	79
APPENDIX 3- INTERVIEW WITH MAIN CONTRACTOR NO. 1.....	83
APPENDIX 4- INTERVIEW WITH MAIN CONTRACTOR NO. 2.....	91
APPENDIX 5- INTERVIEW WITH MAIN CONTRACTOR NO. 3.....	97
APPENDIX 6- INTERVIEW WITH MAIN CONTRACTOR NO. 4.....	103

LIST OF TABLES

TABLE 1- ADVANTAGES AND DISADVANTAGES OF SUBCONTRACTING.....	17
TABLE 2- COORDINATION METHODS.....	26
TABLE 3- INTERVIEW DETAILS.....	34
TABLE 4.1- MAIN CONTRACTOR 1.....	38
TABLE 4.2- MAIN CONTRACTOR 2.....	42
TABLE 4.3- MAIN CONTRACTOR 3.....	45
TABLE 4.4- MAIN CONTRACTOR 4.....	48
TABLE 4.5- SUBCONTRACTOR INFORMATION.....	52
TABLE 4.6- CONSOLIDATED DATA.....	53
TABLE 4.7- SUMMARY OF COORDINATION ACTIVITIES.....	56
TABLE 4.8- GROUPED CHALLENGES.....	62

LIST OF FIGURES

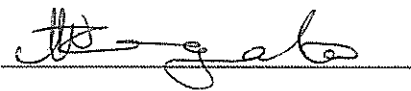
FIGURE 1- BARRIERS TO COORDINATION.....	27
FIGURE 3.1- POPULATION STRUCTURE.....	34
FIGURE 4.1- GENERAL OVERVIEW OF 4 MAIN CONTRACTORS.....	51
FIGURE 4.2- MAIN CONTRACTORS' CHALLENGES.....	61

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DECLARATION

I Abongile Noganta, declare that the content contained in this submission is my work and has never been submitted before at any learning institution. Where any of the content presented is the result of input or data from a related research, this is duly acknowledged in the text.

Signature 

Date 16-10-2019

ABSTRACT

Coordination is a crucial function in the management process of interdependent parties and their activities. In major construction projects, where there are manifold participants; the contractor is faced with the challenge of coordinating the interdependent subcontractors' tasks and subtasks in ensuring that quality standards, time and cost requirements are met and ultimately project success is achieved. Lack of coordination of subcontractors' works by the main contractors is one of the causes of deviations from project goals such as delivering a quality project within time and cost. This research is directed at identifying the key challenges that main contractors face when coordinating the subcontractors' works in major construction projects and how they overcome these challenges. Kusile Power Station was chosen as a case study for this research because it is a large project whereby the problem was observed by the researcher. This case was strategically selected because of the numerous contractors (at different levels) working at the peak stage of the project. In-depth interviews were held with four main contractors' representatives dealing with coordination at the Kusile Power Station Project. These four main contractors were selected based on the scope they are contracted to do, size of the company, and the number of subcontractors they manage and were responsible for. The four main contractors interviewed had 46, 8, 9 and 6 subcontractors respectively. 32 challenges were identified and grouped into 7 seven distinct groups. The key conclusions from the research data analysis was that resource handling (issues), clashes/ changes in designs/ drawings, and access issues are the three key coordination challenges faced by main contractors at the Kusile Power Station Project. To overcome these major challenges, the contractors perform & make use of resource scheduling, two/ three week look ahead, and site walks. It is recommended that a similar study be done in another major project to uncover other means of dealing specifically, with the three key challenges.

DEFINITION OF KEY TERMS

Coordination - the act of making all the people/ subcontractors involved in a plan/ program work together in an organized way

Challenge - is what gives difficulty in obtaining, performing or achieving a certain predetermined goal.

Multilayer subcontracting- is the further subcontracting by subcontractors with or without the knowledge or consent of the main contractor. (Yoke-Lian, Hassim, Muniandry & Teik-Hua, 2012)

Large/complex/mega project – is a temporary undertaking that is characterized by: large investment commitment, massive complexity (especially in organizational, technical and human terms), and long-lasting impact on the economy, the environment, society, and budget.

Subcontractor - is a construction firm that contracts with the main contractor to perform some aspect of the main contractor's work. (Arditi and Chotibhongs, 2005)

Transactions - refers to a transfer of resources between two or more firms/ companies. Kale and Arditi (2001)

CHAPTER 1

INTRODUCTION

Subsequent to contract award by the client to the main contractor, the contractor categorizes the entire scope of work into smaller, identifiable work packages which will be subcontracted to subcontractors. (Chau & Walker, 1994)

In mega projects, there would be multiple main contractors for different work packages/systems who will then have numerous subcontractors contracted and working under each of them.

Each main contractor is responsible for managing and coordinating the subcontractors' work that the contractor employs. (Chau & Walker, 1994; Olsson, 1997). In managing the subcontractors, the main contractor has to collaborate, communicate, integrate and coordinate the subcontractor's works and practices. (Chau & Walker, 1994; Olsson, 1997).

There are a lot of management strategies such as partnering, total quality management, etc. and these according to Hai, Yusof, Ismail & Wei (2012), originated from industries other than the construction industry. Furthermore due to the nature of the construction industry, adopting these strategies is considered challenging. Be it as it may, and for whichever strategy; Hai, Yusof, Ismail & Wei (2012) stressed that coordination should be developed and managed in construction to ensure project success.

In the present study, in-depth interviews will be used to obtain the main contractor's views on the key barriers/ challenges the main contractors face when coordinating subcontractors' works at the Kusile Power Station Project, in the context of the South African Construction Industry. This power station was chosen due to its size and progress at the time of the research, as it was at its peak of construction. The only other mega power station under construction in the country was Medupi Power Station Project, but was not considered for this research as it was far ahead in terms of construction.

Kusile Power Station Project is an Eskom new build project being built in Emalahleni, Mpumalanga next to the existing Kendal Power Station. This mega project has employed, at some stage, more than fifteen thousand employees. Kusile Power Station will comprise six units, each rated at an 800 MW installed capacity for a total capacity of 4 800 MW. Upon completion, Kusile will be the fourth-largest coal-fired power station in the world.

BACKGROUND TO THE STUDY

Revealed in the literature was that, coordinating subcontractors' works is the main contractor's responsibility and should be performed effectively to ensure the success of a project. Considering the benefits of subcontracting, amongst which are staff and cost related; the contractor subcontracts a certain percentage of the works to the different types of subcontractors. Contractual and other working relationships exist between the contracting parties. These relationships must always be considered by the main contractor in managing the subcontractor.

Hai, Yusof, Ismail & Wei (2012) in a conceptual study in Malaysia, on barriers to coordination; found and categorized the key challenges into 5 categories which are: the nature of construction, traditional contractual arrangement, construction participants, construction management approach and characteristic of organization. Coordination activities were also revealed in literature and were used as a guideline for data collection. The challenges and activities are linked. All the literature reported was from projects/ research done all over the world and a South African context/ background could not be obtained; and in this study the focus will be on a South African project. It is this link, additional coordination activities and additional challenges that will be investigated through empirical research.

PROBLEM STATEMENT

Construction of complex projects involving myriad of interrelated activities; interdependency between the project participants, and interdependency between activities increases as the project progresses. (Olsson, 1997; Iyer and Jha 2003; Cheng and Shen 2014; Hai et al 2012).

As a project reaches the crucial/ peak stage, a lot of work is executed by different levels of numerous subcontractors around the same area and at the same time. With this, the level of interrelation and interdependency between participants and activities escalates.

Therefore the main contractor's problem would arise when the subcontractors' work was not properly coordinated between one another and between other contractor's subcontractors. This becomes a problem when multiple contractors with manifold subcontractors under each of them, were working on a project, in the same area, and at the same time. Their works

needed to be planned, coordinated and integrated so that the overall project goals were realized. The planning and coordination was crucial in the sense that all subcontractors knew which activity needs to be done and when, which other subcontractors were working at the same time as him, which are the predecessor and successor subcontractors, how the works interface with that of other subcontractors.

Lack of coordination was observed by the researcher where an employer's supervisor would always be assisting the main contractor in resolving coordination issues faced by the main contractor, such as access issues. This raised questions from the researcher as to what other coordination challenges are faced by the main contractor and how these coordination challenges are overcome by the main contractor. Whenever these coordination challenges persisted, the progress of the works in a particular area would be slow such that the delays caused would adversely affect the schedule, completion time and project cost.

The main contractor's responsibility of managing the subcontractors' works became difficult most especially for works interface coordination, coordination of the manifold project participants (working at the same time in the same area), and coordination of the works. This is a crucial factor towards the success of a project. (Olsson, 1997; Iyer and Jha 2003; Chang and Shen 2014; Hai et al 2012).

RESEARCH AIM

The aim of the study was to identify key coordination challenges faced by main contractors in coordinating subcontractors' works, and develop recommendations for dealing with these challenges

OBJECTIVES OF THE STUDY

The specific objectives of the study are given below:

1. To determine how contractors coordinate subcontractors' works, and what activities do they perform when coordinating.
2. To examine the challenges faced by contractors in coordinating their subcontractors' works.
3. To ascertain how contractors deal with the challenges.

RESEARCH QUESTIONS

1. How do contractors coordinate their subcontractors' works, and what activities do they perform?
2. What are the key challenges faced by contractors in coordinating their subcontractors' works?
3. How do contractors deal with the subcontractor coordination challenges?

RESEARCH METHODOLOGY

The researcher used a case study to fulfill the study objectives. Firstly, related theories and studies were reviewed and lists of coordination activities together with coordination barriers were presented in the literature. In depth interviews were held with contractor representatives on site, to ensure that the respondents are given enough freedom to express their views on the topic while keeping within the boundaries of the study. These interviews were held with five representatives of four different main contractors.

SCOPE OF THE STUDY

Management is very broad and therefore the focus in this study was only on coordination of subcontractors' works by the main contractor. This is coordination while each subcontractor was working, making sure that access issues are sorted out and that no subcontractor delays/ disturbs/ interrupts the other subcontractor.

The research was solely aimed at main contractors and therefore data was collected from main contractors and not subcontractors, getting the contractor's perspective. All types of main contractors were considered regardless of the sector in which the contractor operates within the construction industry.

This research was done at Kusile Power Station, Mpumalanga Province in South Africa, therefore looked only at the South African construction industry. Kusile was chosen due to being a mega project in the execution phase at the time of research.

STRUCTURE OF THE STUDY

The structure of the study is as follows:

Abstract

- a short summary of the complete content of the project report

Definitions of key terms

- key definitions pertaining to this study are provided in this section

Chapter One

Introduction

- an introduction to coordination in the construction industry, and provided is a brief about the study

Background to the study

- gives a background to the study and its underlying concepts revealed through literature review on coordination activities performed by main contractors and the key coordination challenges that are faced by the main contractors

Problem statement

- gives in detail, the problem being investigated in the research

Research aim

- the aim of the study is stated in this section

Specific objective

- three specific objectives of the study are outlined

Research questions

- three research questions resulting from the objectives are listed in this section

Brief overview of the research methodology

- A brief of the methodology is outlined in this section. It addresses how the study will be done by the researcher through literature review and thereafter data collection using in-depth interviews with main contractors' representatives responsible for coordination of subcontractors' works

Scope of the study

- the full extent of the scope of the study is defined in this section

Chapter Two

Literature review

- this section starts by giving an overview of subcontracting in construction
- contractor-subcontractor contractual relationship is discussed
- contractor-subcontractor working relationship is explored
- coordination and challenges in coordination are discussed
- summary of the literature review

Chapter Three

Research methodology

- an overview of Kusile Power station is provided
- research strategy, method of data collection and analysis thereof are discussed
- a brief discussion on research ethics is given
- data collected through in-depth interviews with four main contractors

Chapter Four

Data presentation, analysis and results

- data is presented for the four main contractors individually before combined results are presented and analysed
- this data is presented and analysed for each study objective

Chapter Five

Discussion of results

- results are discussed per study objective and answering the research questions

Chapter Six

Conclusions and recommendations

- gives conclusions and recommendations to the research, pointing out the key coordination challenges faced by main contractors and giving suggestions as to how these challenges can be overcome

CHAPTER 2

LITERATURE REVIEW

SUBCONTRACTING IN CONSTRUCTION

Subcontracting is a business strategy used by main contractors to deal with uncertainty in the construction market and transfer risk (CIDB, 2013). While another definition is that subcontracting is a commercial arrangement in which a firm or individual carries out obligations and responsibilities on behalf of another company or individual (Laryea and Lubbock, 2013). By giving work to others, the main contractor transfers some risks associated with the project and the construction market/ industry.

Projects encompass numerous activities to be executed in order to finish the scope of works and these activities can vary from excavation, brickwork, electrification, plumbing, central building management system, etc. The main contractor is no specialist in all of the listed items and as such will subcontract some of the items to other contractors, known as subcontractors. These subcontractors are hired to execute specific tasks in a project and these are generally predetermined prior a contract is entered into by the parties.

These subcontractors in turn sublet parts of the works to other subcontractors and therefore creating a lower level subcontracting. This concept known as multilayer subcontracting and these levels are referred to as tiers. To realize the subcontracting benefits such as minimizing cost; the first tier (usually specialist) subcontractor sublets certain trades to other subcontractors and therefore creating a second tier subcontract. The second tier subcontractor may further sublet parts of the works to other smaller subcontractors even to individual workers.

Due to the wide range in the nature of activities in construction projects, studies by the CIDB (2013) and Mbachu (2008) categorized the types of subcontractors into three main categories: specialist subcontractors- those who undertake specialist services such as HVAC, electrical; trade subcontractors – specialize in general trades/ works such as brickwork, painting; and labour only subcontractors- skilled tradesman providing labour-only services.

From a contractual perspective, subcontractors can be:

- selected from a list of subcontractors recommended by the client at tender stage;
- nominated by the client and
- domestic, which the main contractor chooses by himself

The contractor divides the works according to the categories above and when awarding work to subcontractors considers the ability of the subcontractor to perform and deliver within time and desired quality standards. Factors affecting the number of subcontractors in a project will vary depending on items including but not limited to:

- the value of work to be subcontracted relative to the contract value
- contractual terms and conditions stipulating employment of local labour
- market conditions

CIDB (2013) specifies that in South Africa, about 55-80% of the project value is subcontracted out. Arditi and Chotibhongs (2005) and Mbachu (2008) give a higher percentage of between 80 to 90% of works that are subcontracted in building projects. This shows that a high value is usually subcontracted by contractors and on average about 75% of the project value is subcontracted.

Risk sharing is one of the reasons why contractors choose to subcontract, but it may also bring its own risks. Mbachu (2008) reveals that quality is a critical issue with subcontracting and the cost of remedial works can be as much as 12% of the contract value. A contractor is contracted to deliver a project within a set of predetermined project goals amongst which are time, quality and cost deliverables. Subcontracting may hinder the contractor in achieving these goals due to delays, poor quality and non-completion of works by the subcontractor. (CIDB, 2013). The main contractor then has to efficiently manage and coordinate the subcontractors' work during construction to ensure that all risks are managed and mitigated, and the project is delivered successfully as per the contract.

Mbachu (2008) states that traditionally, the contractor is responsible for the management and coordination of the subcontractors' works in order to achieve the project goals and targets. An argument made is that where the value of the subcontractor's work is more than that of the contractor, the contractor is exposed to more risk; as the contractor may not be in control of the works' quality and progress unless efficient management techniques are employed.

The advantages and disadvantages to the main contractor for subcontracting stated in studies by CIDB (2013), Mbachu (2008), Arditi and Chotibhongs (2005) and Yoke-Lian et al (2012) are tabulated below:

Table 1-Advantages and Disadvantages of Subcontracting

ADVANTAGES	DISADVANTAGES
Contractor's margin and costs are known from the onset.	Due to the required quality standards, the contractor might have to employ personnel for management and supervision of the subcontractors' work.
Give work to contractors who are best competent to perform it.	The contractor might have to bear the legal compliance costs for the works performed by subcontractors.
Ensures high quality of works since subcontractors are specialists in their trades.	Contributes to project delays due to lack of subcontractors' skills.
Work performed quicker and at a lower cost than contractor.	Negatively affects construction labour productivity.
Reduction of overheads and staff requirements.	
Risk and responsibilities of redeployment and hiring is passed on to the subcontractor.	
Can't sufficiently provide employment of skilled labour for all trades.	

Subcontracting is beneficial to the contractor, but as a relationship poses its own problems. Some of the problems between the contractor and subcontractor result from issues relating to payment, quality, errors and delay in issuing of drawings and approval thereof, conflicts amongst subcontractors, etc. (Laryea and Lubbock, 2013).

While contractors decide to subcontract, subcontractors on the other hand also decide whether to tender for subcontract work or not. Factors guiding a subcontractor on his decision include contractor's credit history, contractor's leadership and managing skills, previous relationship with the contractor, the subcontractor's capacity (financially and resources), and the prospect of future business relationships (Laryea and Lubbock, 2013). These are factors

which also determine the quality of the contractor-subcontractor relationship. If the subcontractor feels that the contractor is not punctual in making payments, frequent disputes, and subcontractor can barely survive; the subcontractor would even opt to end business. This relationship is governed by means of a contract which becomes a formal agreement between the transacting companies and this is discussed in the following section.

CONTRACTOR-SUBCONTRACTOR CONTRACTUAL RELATIONSHIP

As part of the contributions to a successful project, the suitable subcontractors should be employed for the right job. As it is the main contractor's responsibility to manage, coordinate and deliver a project within the set goals; it is in the main contractor's best interest to employ subcontractors suitable for the specific trade, who know how to do the work and are reliable. Hartmann, Ling and Tan (2009) in their study investigating the trade-offs main contractors are expected to make amongst various criteria when selecting subcontractors in Singapore; focused on four criteria, namely: price, technical know-how, quality and cooperation. These are not the only criteria available for main contractors in the subcontractor selection process and more will be uncovered in this research.

Price is one of the important criteria due to main contractors looking to make profit and minimizing costs; and the only way is to award a tender to the lowest bidder.

Technical know-how is a critical criterion as well in the evaluation and selection process. The contractor would prefer a subcontractor who has the knowledge and understanding of effectively fulfilling his duties and as such enhances the development of his competence level, expertise and consequently the use of correct working methods.

Quality is the extent to which subcontractors deliver products or services that meet project requirements (Hartmann et al., 2009). Furthermore, four aspects were identified which contribute in determining the quality of the final product; and are:

- Technical quality- quality of the building at a technical level (quality of materials, fittings, etc.)
- Functional quality- fitness for purpose
- Workmanship quality- standard of workmanship in completed building, and
- Architectural quality- quality of a building in architectural and aesthetic terms.

Cooperation is in the operational stage (both operational and managerial levels) and it is imperative for a main contractor to select a subcontractor that will cooperate, fulfill his duties, be relatively easy to manage by being less problematic and efficient; and having a positive attitude, etc.

In all this, the main contractor has to make use of the tender processes available to invite, evaluate, select and appoint tenderers to execute the works.

An open tender bidding process is generally pursued for tendering new jobs. The evaluation criteria used in this procurement route is wide and can be tailored for a specific project, but emphasis is greatly given to the lowest tenderer/ price/ amount. The gatekeepers for each tender are allocated weightings. As stated by Yoke et al (2012), significance should not only be placed on price but also a combination of financial health status of the tenderer, quality of work done on previous jobs, company size, etc. The second part of coordinating and monitoring of subcontractors is the contractor's responsibility and a crucial success factor.

The contractor will rely on subcontractors' submissions for price, financial well-being of the company; historical information obtained from references, reputation and previous experience to verify subcontractors' previous work details.

Subcontracting versions of main contract forms are used when concluding a contract between a main contractor and subcontractor worldwide. These contract forms are the FIDIC suite of contracts, General Conditions of Contract GCC, New Engineering Contract NEC and JBCC. A revelation in the study by the CIDB (2013) is that even though contracts are available for use, they are seldom used. With the preference rather given to less sophisticated documentation to govern the contractual relationship. The contract normally stipulates the rights, roles and responsibilities of either contracting party and furthermore, clauses outlining payment terms, retention, risk sharing and dispute resolution methods form the core of the contract. (CIDB, 2013).

A study done in Malaysia, by Yoke-Lian, Hassim, Muniandy, and Teik-Hua (2012) on the review of subcontracting practice in the construction industry, reviewed the literature on the subcontracting, with focus given to types and problems generated by subcontractors. As part of the conclusion, effective subcontractor selection during the bidding stage and monitoring during construction can determine the success of construction companies. Yoke et al (2012)

further state that selecting the right subcontractor, on its own does not guarantee the success of a construction project. Coordination and monitoring of subcontracted work, by the main contractor, during the construction stage is essential.

CONTRACTOR-SUBCONTRACTOR WORKING RELATIONSHIP

As stated above, the main contractor subcontracts parts of the works to multiple subcontractors. Other than contractual relationships, other working relationships exist between the contractor and subcontractors.

The main contractor in any project doesn't work alone but rather works with other firms which include subcontractors, suppliers, equipment dealers, etc. This means that there is somewhat a working relationship between the parties working together at any given point in time. Kale and Arditi (2001) state that a central block guiding operations in all industries is transactions and this approach can be used to study a firm's relationship with another. The term transaction is said to refer to a transfer of resources between two or more firms/companies. Miller, Packham and Thomas (2001) concur that the contractor-subcontractor relationship has always been a transactional relationship in nature. Relationships are guided by these transactions which in turn are coordinated by a single mechanism: price; and for a long time this was the sole mechanism. A main contractor transacts with several companies including subcontractors, suppliers, etc. during the execution of a project. An argument made by Kale and Arditi (2001) is that, it is not entirely correct to consider price as the primary mechanism for coordinating transactions while ignoring the social aspect of the industries. A concept of social embeddedness proposed that companies that have ongoing transactions with each other, are socially embedded and this has two distinct implications.

These are:

- It promotes the dispersion of information about the qualities of prospective transaction partners. These qualities include reliability, competence, ethicalness, trustfulness, etc. This information would normally be shared by companies with whom they have worked and this would serve as some guideline as to which company should be avoided or preferred.
- Social embeddedness, due to continuity (inter-organisational learning) augments the coordination between the transacting companies. This continuity works on an already existing

level of trust, norms and values establish routines, promotes alignment in companies' deliverables and expectations.

Kale and Ardit (2001), mention that; transactions involving a high level of uncertainty and high asset specificity become difficult to establish and most importantly to sustain. This is attributed to two human factors, which are opportunism and bounded rationality. Malome and Crowston (1994), suggest that actors performing interdependent activities may have conflicting interests. These conflicting interests may arise from opportunism from either party. Asset specificity refers to the degree to which an asset is specific to a given transaction, to the extent that it can't be easily redeployed for use in another context without appreciable loss in its productive value (Kale and Ardit, 2001). Three types of asset specificity have been identified:

- Site specificity- the usefulness of the asset is directly related to its location
- Physical asset specificity- relates to customizing assets for specific transactions
- Human asset specification- knowledge accumulated from previous transactions

One of the human factors stated above, opportunism, is based on the assumption that humans are self-centered. Also humans intend to be rational, hence the bounded rationality factor. Opportunism is the greatest risk to any transaction and this risk should be dealt with when dealing with these transactions. As companies seek to engage in transactions, they should find ways to manage against the risk of opportunism and one of the ways is to enter into a contract with each other. It must be noted that contracts don't highlight the behavior of potential transacting companies prior the agreement and therefore, a company might have to rely on previous experience with that company and referrals from others. Such that contractors would opt to build, keep and properly manage relationships with subcontractors with whom they have fruitfully worked with before and executed and delivered quality works on time in a trustworthy manner. Subcontractors on the other hand, would elect to keep relationships with contractors that are fair with an important factor being timeliness of payment for work done. Seemingly, for both parties to benefit; mutual cooperation can ensure the fulfillment of those benefits. (Miller et al 2001).

Even though the study by Kale and Ardit (2001) was one-sided in the sense that data was collected from the contractors only; it was proved that keeping good relationships through effective coordination, is strongly linked to the main contractor's economic performance.

COORDINATION OF SUBCONTRACTORS' WORKS

The complex nature of the construction industry coupled with the myriad of activities requires a number of different companies and people to execute the work and achieve project goals. It is an important task and yet it becomes a challenge to coordinate this variety of people and activities in construction. Coordination between parties in a project is crucial on all project stages and most especially design and execution, where coordination and integration are vital amongst the project team.

Effective coordination is a critical success factor in construction projects (Chaudhari & Bhangale, (2015); Shen & Cheng (2011); Jha & Iyer (2006) and Saram & Ahmed (2001)). Studies have been done looking at coordination activities in relation to time consumption/ frequency of each activity and whether it affects performance or not. Saram & Ahmed (2001) in a study on construction coordination activities, specifically focusing on what is important and what takes time, among building contractors in Hong Kong and Singapore, concluded that the time consuming activities are not necessarily the important activities.

Malone and Crowston (1994) view coordination as a process of managing dependencies among activities linking together different parts of an organization to accomplish a collective set of tasks/ goals. Chandhari & Bhangale (2015), in a study examining coordination goals for major projects in India, concluded that:

- Both oral and written communication should be used together,
- Meetings alone do not ensure coordination effectiveness, and
- Most coordination methods have numerous goals. Meetings tend out to have fewer goals and site visits & contract documents can be used for many purposes.

Olsson (1997), Jha and Iyer (2003), and Chang and Shen (2014), conclude that in complex projects, when the number of participants and interdependency is on the rise; interface coordination together with coordination among project participants becomes the most important factor that has maximum influence on successful cost performance.

More significance is linked to coordination in another study by Jha and Iyer (2006), stating that coordination is becoming the most pursued attribute in managing mega projects involving manifold participants and that lack of coordination with internal and external parties may overshoot the cost of the project.

Olsson (1997), in a study conducted in Sweden examining subcontract coordination in construction, reveals that managing subcontractors' works is usually the contractor's responsibility. Additionally, the need for coordination is related to the degree of interdependence between different subtasks. Hossain (2009) in a study on communication and coordination in construction projects, states that managing task / subtask dependencies is key in the coordination process. The contractor is then faced with this massive task of managing the interdependencies in complex projects comprising of a manifold of subcontractors.

HOW CONTRACTORS COORDINATE THEIR SUBCONTRACTORS' WORKS

Coordination is an everyday task for a project coordinator in a project and as such one would need to understand how and what activities are performed when coordinating project activities.

A lot of activities may be performed in coordinating subcontractors' works and studies by Saram & Ahmed (2001) and Jha & Misra (2007) give extensive lists of 64 and 59 coordination activities respectively. Below, the two studies will be briefly discussed to highlight the aim, data collected, analysis and conclusions drawn by the authors.

Study number 1

Briefly, Saram and Ahmed (2001) divide the activities into 5 groups, namely: provision of leadership, facilitating, controlling, communicating and recording; as shown in Appendix 1. This study examines what construction project managers perform to achieve coordination in a building project, what activities they consider important and what the time consuming activities are. The study was conducted in Hong Kong & Singapore where Project Managers were the targeted sample and out of 244 questionnaires that were distributed, 33 were returned and served as data for this study.

An array of issues were identified and refined to arrive at a list of 64 coordination activities. A questionnaire was then developed and sent to construction project managers and coordinators to enable them to identify activities of high, mid, or low importance and N/A for those considered not applicable. Space was also provided to allow respondents to add any

other activities not covered in the list. The second part was for the respondents to indicate whether the time consumed for each activity was high, mid, or low. On both categories (importance & time consumed), the activities were allocated a percentage on the options (high, mid, low, N/A) and the number of responses were indicated. The list of activities was arranged in the order of importance, from most to least important. This then provided a consolidated picture of what important and consumes time.

Among key results was that a few respondents selected the N/A option on some of the questions, meaning that the respondents view these as not having an impact on coordination. These include maintaining records of price escalation, controlling project finances, interfacing with other departments, etc. The most important activity was identifying strategic activities and potential delays. One respondent even went on to mention that he personally performs the activity himself using his vast knowledge and experience through site walks and observations on site, which he reckons are very important. Additionally, knowing which activities will have a huge impact on the coordination process is crucial. Overall 12 activities, from the list, were ranked high in importance and highly time consuming.

Study number 2

From the study above by Saram & Ahmed (2001), Jha & Misra (2007) attempted to categorize the activities. Jha & Misra (2007), in this study conducted in India, rank and classify the coordination activities; as shown in Appendix 2. Firstly, four performance criteria were formulated, namely cost, schedule, quality, and no-dispute criteria. Four broad groups were devised and the activities, obtained in study number one, were grouped according to the following: resource handling, team building, contract implementation, and planning. Resource handling is stated as the most important of them all and also revealed by Hossain (2009), that managing shared resources is one of the key activities in the coordination process.

The sample for the study was senior construction professionals in large civil engineering projects. Questionnaires were used to collect data, exploring the impact the coordination activities have on schedule, cost, quality, and no-dispute thereby leaving out criteria such as safety, client satisfaction, etc.

The findings of this study are quoted below:

- *“Regular monitoring of critical path activities for adhering to schedule; monitoring the budget on all activities and taking corrective action; application of good technical practices; implementation of all contractual commitments are the most important coordination activities corresponding to schedule, cost, quality, and no-dispute performance criteria respectively.*
- *The intensity of a given coordination activity clearly varies depending upon the performance criteria being used. Further, the overall intensity can be thought of as the sum of the product of weight and the intensity of the different performance criteria.*
- *Different aspects of coordination related to resource handling, team building, contract implementation and planning are required to ensure proper coordination leading to a successful project.*
- *Resource handling is the most critical factor in achieving project coordination.”*

These two studies have informed the current study and the two lists, even though some activities are duplicated, are used as a guideline for the current research. Finding out activities performed by the contractors was the first step. Then establishing what challenges are faced by the contractors when coordinating/ performing these activities and how they overcome the challenges.

It is important to understand how the coordination process is performed by contractors. A study by Kubicki, Bignon, Halin and Humbert (2006) breaks coordination into two parts/ actions as follows: drafting coordination activities which determine the basic construction tasks together with their sequence; and planning, which takes resources and technical constraints into account. Informal coordination, also called mutual adjustment is viewed as a compulsory process to adjust activities into project plans and major phases of a project.

Two coordination methods are given and are summarised in the table below:

Table 2- Coordination Methods

ORAL COORDINATION	ATIFACTS-BASED COORDINATION
Based on a knowledge background shared by the actors involved in coordination activity	Complex projects
Mostly used in relatively “simple” fields	Tasks with high variability, numerous actors
Suitable for repetitive and clearly defined tasks	

These two methods are adopted in construction projects and shown in the above table is that the choice of method to be used is dependent on the complexity of the task. In cases where there are many interdependent tasks, simple or complex; a question should be asked as to which method the contractor should rely on using? The interdependency brings a tricky challenge in coordinating.

CHALLENGES IN COORDINATING SUBCONTRACTORS’ WORKS

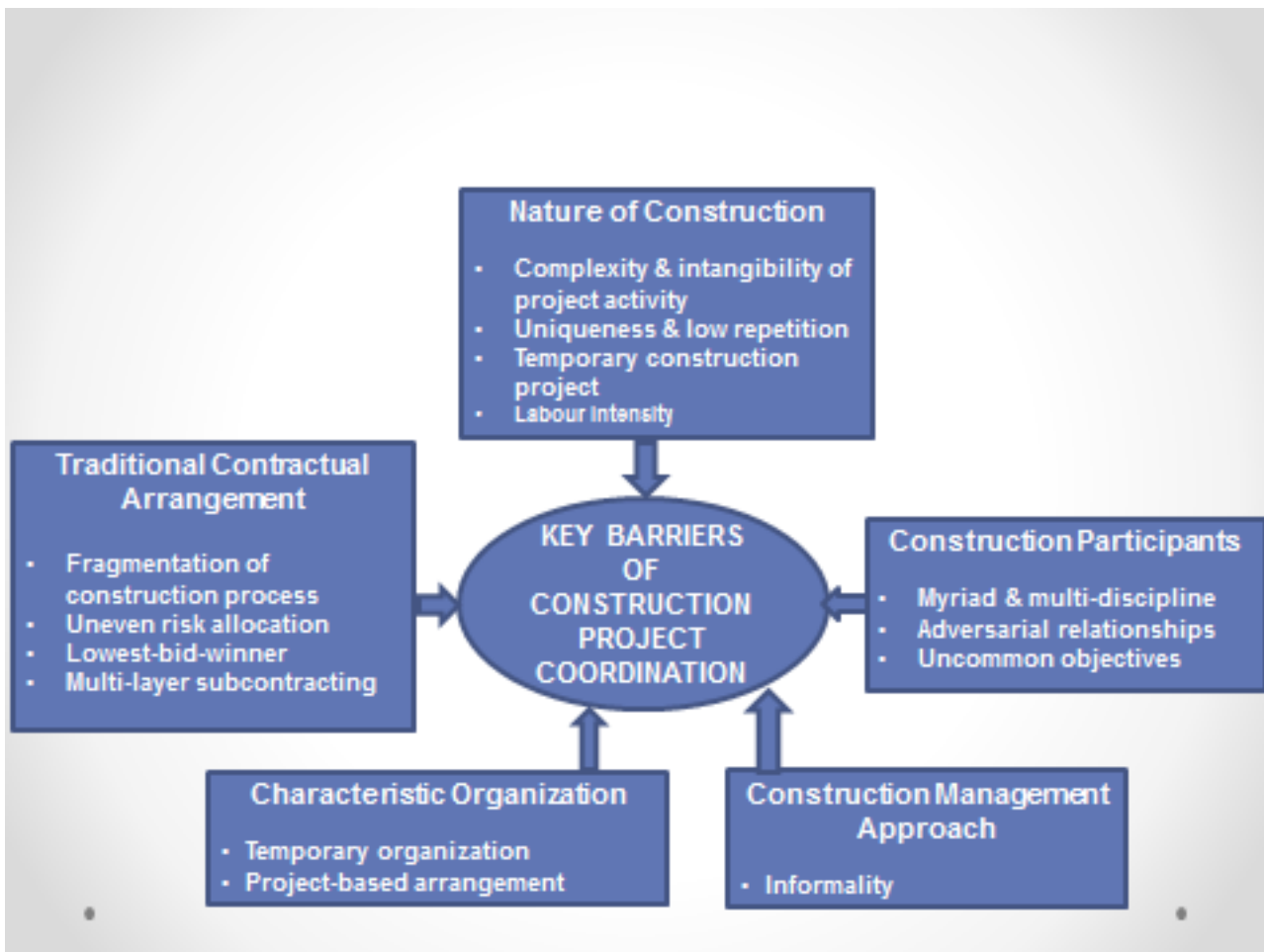
Additional to statements made earlier; Hai, Yusof, Ismail & Wei (2012) & Jha and Iyer (2006) agree that coordination is significant and that it reduces error and discrepancies throughout the construction process. With all the cons of coordination in construction, there seems to be insufficient coordination in construction projects, and reasons for this need to be examined.

Hai et al (2012), in a conceptual study of key barriers in construction project coordination, established five key barrier categories in construction project coordination, as shown the figure below. The five categories are the nature of construction, traditional contractual arrangement, characteristic of organization, construction management approach and construction participants.

Coordination improves communication, integration and team work through cooperation. A question arising from the study by Hai et al (2012), is, “how effective and efficient is coordination when adopted in the hostile nature and characteristic of construction?”

As much as there are five categories of barriers identified by Hai et al (2012), this was only a conceptual study and therefore the need for an empirical study is evident in a quest to prove/ disprove and examine other challenges not covered in this study.

Figure 1- Barriers to Coordinating



SUMMARY OF LITERATURE

- The main contractor is no specialist in all trades and as such subcontracts some of the works to companies with the expertise to do the job, known as subcontractors.
- Main contractors subcontract, on average 75% of work to subcontractors, who further subcontract to other subcontractors; a process known as multilayered subcontracting. Among advantages of subcontracting is to realize profit and lower cost of performing the work by subcontractors; and a major disadvantage is that it contributes greatly to project delays.
- Many reasons exist as to why contractors subcontract work and one of the main reasons is risk sharing. In as much as the contractor shares the risk; he is still accountable to deliver the project within predetermined goals. The subcontractor then has to efficiently manage & coordinate the subcontractors' work during construction.
- There are contract forms used in concluding contracts between the main contractor and subcontractors, and between the subcontractors themselves. There has been hesitancy in adopting these contracts between the parties and that formal agreements are the preferred choice. These agreements are back-to-back in nature and the smaller party may not even be aware of the conditions of the agreement such that problems relating to payment arise during the course of the project.
- Effective coordination has been singled out as a critical success factor in complex construction projects, and as such needs to be properly managed/ performed by the main contractor as it is his responsibility. A key factor in the coordination process is managing task dependencies. The contractor is then faced with a big task of managing manifold interdependencies in complex projects having manifold subcontractors.
- Both oral & written (informal & formal) coordination methods should be applied in junction. Meetings alone do not ensure coordination effectiveness.
- A study was done examining what project managers perform to achieve coordination in a building project and what activities take time. A total of 64 activities were identified from questionnaires in the study conducted in Hong Kong & Singapore. Site walks & observations are a very important task/ activity and another crucial exercise is to know which activities will have a huge impact on the coordination process & manage accordingly. 12 activities are ranked high in importance and highly time consuming.

- In a second study, Jha and Misra (2007) categorized the 64 activities where they rank and classify the activities based on cost, schedule, quality, and n-dispute criteria. A conclusion was that resource handling is the most critical activity in coordination.
- Hai et al (2012), in a conceptual study of key barriers in construction project coordination, established five key barrier categories in construction project coordination namely: the nature of construction, traditional contractual arrangement, characteristic of organization, construction management approach and construction participants.

CHAPTER 3

RESEARCH METHODOLOGY

KUSILE POWER STATION PROJECT OVERVIEW

The Kusile Power Station, situated in the Mpumalanga province outside of Witbank, is a multi-billion rand power station currently under construction. This mega project was the largest project in South Africa at this moment and once completed, would be one of the largest coal-fired power stations in the world.

The project was complex as it encompassed different sectors within the engineering and built environment such as civil, electrical, chemical, mechanical, instrumentation, etc. Due to the size of this project, there were many stakeholders not only from the Mpumalanga province but the country and the world. As in any project, stakeholder management is critical; it became highly challenging in a project of this magnitude where dynamics (i.e. financial, political, socio-economic, etc.) and challenges (job creation, service delivery, standard of living) faced by the country were at the center stage.

With all the dynamics and challenges in mind, at its peak; the project had employed well over 100 companies (as main contractors, subcontractors and suppliers). With the high number of companies employed, management of both the companies and the works became crucial in achieving the project goals. Management entailed integration, communication, coordination, etc. during all project stages ensuring that all project management knowledge areas were attended to. Coordination was seen as one of the major challenges that were encountered on the project and was the focal point of the research.

RESEARCH DESIGN AND METHODS

According to the Oxford English Dictionary, research is defined as “*a systematic investigation or inquiry aimed at contributing to knowledge of a theory, topic, etc., by careful consideration, observation, or study of a subject*”.

From the definition above, one can conclude that research is done in a systematic manner and its aim is to either contribute to existing or create new knowledge using methods and procedures to answer pre-determined questions and set objectives.

The aim was to conduct an intense enquiry into the crucial challenges/ barriers impeding the main contractor from coordinating subcontractors' works. A comprehensive review of subcontracting and coordinating was performed in order to establish the types and levels of subcontractors, type and value of subcontracted work; and the coordination methods employed, challenges met in coordinating and strategies used to overcome the challenges. Personnel employed by the main contractor to coordinate subcontractors' work (subcontracts manager, construction manager, construction coordinator, project manager) formed part of the population since they dealt directly with the core of this study as a similar approach was deemed suitable by Laryea and Hughes (2008).

CASE STUDY STRATEGY- STRATEGY TO BE ADOPTED FOR THIS STUDY

This, according to Welman, Kruger, Mitchell, (2005); pertains to a research where a limited number of units of analysis are studied intensively. Saunders, Lewis & Thornhill (2009) and Proverbs & Gameson (2008) concur that this is a strategy used in conducting an empirical investigation investigating a phenomenon within its real life context usually with the use of several data collection methods.

The Case Study Project

The case was the new build Kusile Power Station Project, situated in Witbank in the Mpumalanga Province of South Africa. This was one of the two mega projects that are being constructed in the country at that moment. This project was strategically selected because, firstly, there are numerous contractors (at different levels) working, at the peak stage of the project. Secondly, this complex project consisted of new technologies, large amounts of construction materials and resources employed to deliver the much awaited power plant on time. A multi-contracting strategy was adopted by the client, where the works were split into different sections and systems of the plant. It was possible to have multiple main contractors; of which some were explored in this study. All major contractors then subcontracted portions of the works to smaller contractors either specializing in the smaller fields/ trades of work or for any other industry and site related reasons. These first tier subcontractors also sublet parts of their works to other subcontractors (second tier), resulting in multilayer subcontracting.

The population of the study comprises of the main contractors working at the Kusile Project, since the main objective of the study was to ascertain key challenges faced by the main contractors in coordinating subcontractors' works.

According to Welman et al (2005), the objective of any case study is usually to investigate the dynamics of a single bounded system. A single case was used to collect data.

RESEARCH METHODS

In meeting the study objectives, the researcher collected primary data from the population selected for the research. The following distinction was made by Farrell (2011) on the two different data forms.

- Primary data, which is the original data created by the efforts of the researcher.
- Secondary data, which is the existing data.

Furthermore there was a matter of objectivity and subjectivity of the data. The qualitative approach is subjective in nature and quantitative on the other hand, is objective. Subjectivity, according to Farrell (2011) was reported as the soft data or a person's views. The two data forms may be used in isolation and/or together (i.e. qualitative data converted and analyzed as quantitative/ hard data) as the case may be depending on a study and nature of its objectives.

Permission to conduct this research at the Kusile Power Station Project was requested and obtained by the researcher prior commencement of data collection. Ethics clearance was also applied for and obtained.

SAMPLING TECHNIQUE

The population, main contractors at the Kusile Power Station, was assessed and out of all the main contractors, four main contractors were identified and selected as a sample for the study. These four main contractors were selected based on the scope they are contracted to do, size of the company, and the number of subcontractors they manage and are responsible for. Out of the four main contractors, two were construction project management companies/ firms and the other two were contractors (performing the actual work on site). Furthermore,

two were mechanical, one was civil and the last one was a building contractor. This split did not form part of the selection criteria mentioned above.

RESEARCH INSTRUMENT

The study was focused on investigating the crucial challenges/ barriers impeding the main contractor from coordinating manifold subcontractors' works in complex projects through in-depth interviews conducted at Kusile Power Station Project.

Questions that formed the basis of the semi-structured interviews in trying to obtain the necessary data to fulfill the research objectives are listed below. This was an outline of the interview and the respondents were afforded an opportunity to give as much detail as possible. It was imperative to categorize the questions and were categorized into three main categories: general, contracting and coordination; as shown in appendix 3.

The general section related to the type of subcontractor, the kind of work the subcontractor was contracted to perform, etc.

The contracting section dealt with the types of contracts used and the value of subcontracted work relative to the main contract work.

The coordination section focused on the activities done when coordinating, challenges faced in each activity and mitigating factors/ strategies used to overcome the challenges.

DATA COLLECTION

Data collection was done through in-depth interviews which were a suitable choice as well used by Baiden, Price and Dainty (2005) while investigating the extent of team integration within construction projects. Comparison and reference was made to this study because in the study by Baiden et al (2005) and the current study, soft properties of management (i.e. integration and coordination) were being investigated.

The in-depth interviews were designed to be as flexible and informal as possible to allow the interviewees to be in control and supply as much information as possible since they have the knowledge and expertise pertaining to key coordination challenges. The interviews were all designed and scheduled to take between 15 to 20 minutes each, using a set framework of

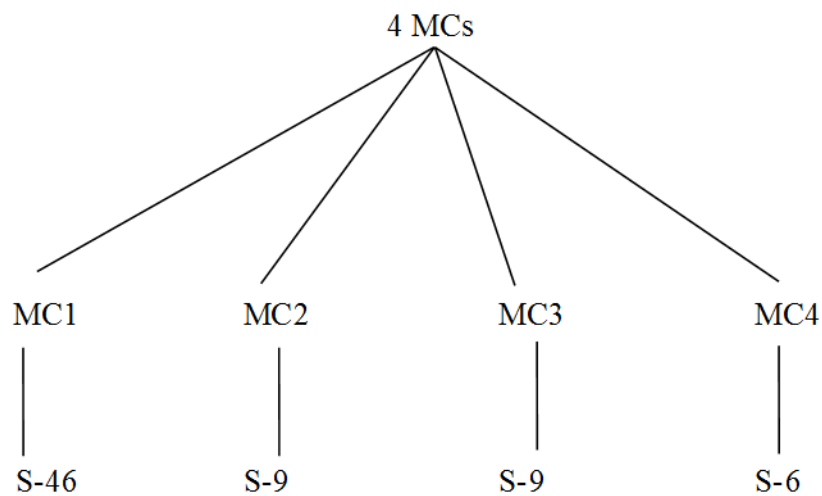
questions outlined below. However, due to a number of factors, the planned duration was not precisely achieved on all interviews held, as shown in table 3 below:

Table 3--Interview details

MC No.	No. of Interviews	Job Description	Duration
MC 1	2	Site Engineer	20 min
		Supervisor	35 min
MC 2	1	Site Engineer	60 min
MC 3	1	Construction Manager	40 min
MC 4	1	Project Planner	35 min

Figure 3.1 below shows the structure of the population, where MC stands for main contractor and S stands for subcontractor. Under each MC, the number of subcontractors is provided, as obtained from the interviewees.

Figure 3.1- Population Structure



DATA ANALYSIS

For each main contractor, data for each objective was presented and analysed in detail. At the end the data was consolidated for all 4 main contractors per study objective. This gave a clear picture and a good comparison could be drawn from this presentation.

RESEARCH ETHICS

Ethics clearance was applied for and obtained from the university. Physical and continued access was requested from potential respondents with the purpose of the research, method of data collection used, time and resources utilized in completing the research. Matters of confidentiality and anonymity were explained and addressed from the beginning with the proposed respondents. The purpose and background to the study was explained to each interviewee prior the interview for awareness and for the interviewee to have insight prior the interview. Communication with all respondents was through phone calls, emails and sms in organizing the interviews. Professionalism was upheld at all times with respondents and the respondents' information supplied and working relationships.

RELIABILITY AND VALIDITY

The consent to participate form was explained to each respondent thoroughly prior the interview. Actions and steps to uphold confidentiality and anonymity were explained clearly and in detail to the respondents. With this assurance, it allowed the respondent to be free in answering the interview questions without fear or favour. The participants gave both positive and negative experiences without holding back. This informs the researcher of the little to none bias on the side of the respondents.

The best suitable times were chosen by each respondent based on his/ her availability. This meant that the interview was not going to be interrupted. All respondents were in no hurry, and this meant that an answer to each question was carefully thought through and extensively explained.

The researcher kept consistency in the manner in which questions were asked during the five different interviews with the four different main contractors.

The outcomes/ results of the research will, in no way, negatively or positively affect the respondents. In addition to the steps taken to uphold anonymity and confidentiality, this has ensured that the respondents give a true picture & not skew and bias data.

The different level of experiences of the respondents (at Kusile Power Station and other projects the respondents have worked at previously) and different formal designations of the respondents has ensured data validity in the sense that data was from objective and integrated data sources.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

In this section the researcher examined how the contractors at the Kusile Power Station Project coordinate works of their subcontractors, what challenges they face in this process and how they overcame these challenges.

DATA PRESENTATION FOR EACH MAIN CONTRACTOR

Data was presented for each main contractor separately, before a combined presentation and analysis was provided.

MAIN CONTRACTOR 1

Main contractor one is a Joint Venture between two big South African building companies. This contractor's scope of works covers the construction of miscellaneous buildings (i.e. substations, pump houses, offices) including HVAC, electrical & fire detection systems' supply and installation. A FIDIC RED Book has been adopted for this contract and the contract value of the works is R 3.7 Billion, where 80%-90% of the scope is subcontracted.

On average, there are about forty six subcontractors that are subcontracted to main contractor number one. The total number differs from time to time due to the fact that some subcontractors get demobilized and also new subcontractors get mobilized.

The contractor has a combination of domestic and labour only subcontractors as shown in table 4.1 below.

Table 4.1-Main Contractor No.1 Work Packages

No.	WORK PACKAGE	DOMESTIC	LABOUR ONLY
1	Earthworks	2	
2	Piling	1	
3	Concrete		
4	Formwork	2	
5	Reinforcement	3	
6	Plastering	1	2
7	Structural Steelwork	2	
8	Scaffolding	2	
9	Waterproofing	2	
10	Steel Fixing		5
11	Brickwork		4
12	Capentry		1
13	Painting		1
14	Ironmongery		1
15	Tiling		3
16	Cranage	2	
17	Fencing	1	
18	Electrical Work	1	
19	Plumbing	2	
20	Fireproofing & Detection	1	
21	Ceiling, Partitioning & Access Flooring	4	
22	HVAC	1	

Two respondents were interviewed from contractor one because of availability and that they were coordinating subcontractors' works on the buildings they worked on. Refer to Appendix 3, and below the study objectives are outlined based on the responses.

Study Objective 1: To ascertain how contractors coordinate their subcontractors' works

- A consolidated response from the two respondents is as follows:
- The coordination process is started by checking the programme for interfacing of works and for all the contractors on site. This also assists in confirming the limited access onsite.
- Upon the verification of the programme, the total resources that will be required are determined. These resources (time and labour) will be based on productivity also taking into consideration the season of the year it is.

- Priority is given to the activities that are on the critical path.
- Meetings are held with the relevant parties such as the site agent, site engineer and contract manager to discuss, plan and review possible challenges and obstacles, set reasonable targets & consequences of late finish, ways of compressing the schedule to create float between activities to allow for unknown delays might they arise. In these, all necessary documentation such as drawings, specifications, etc. are transmitted.
- When work has started, the contractor has to follow up and track the progress of the works.
- Another aspect was tracking of the procurement progress.

Study Objective 2: To determine activities the contractor does when coordinating subcontractors' works

- A startup meeting is held where the programme is discussed with the workers, using all drawings, schedule, pictures/graphics so that all team leads and workers are clearly aware of the work ahead, schedule, and output required.
- A tool box talk is held every morning to outline the plan for the day. This is done daily even though the overall programme has been discussed already because the workers might forget and it is always imperative that workers know what portion should be done on the day.
- A method statement is prepared, which includes a risk assessment for each activity. This is shared at the tool box talk with all workers, so that they are aware of the dangers pertinent to the works and how to work safely while performing each activity.
- Outline/ review Safety and Quality procedures and work according to these requirements.
- Continuously check on the works/ progress thereof.
- Monitor the works- to see if the workers are working according to the plan, safely and are not compromising the quality of the works because if not, there'll be reworks and this means quite a number of things such as demolition of what is done already, redoing the works, remedying the affected parts. This all ends up as additional costs to the contractor such as material costs, more wastage, more time, no progress and other contractors' claims if their works are affected. This assists in verifying whether are working where they've been assigned to work or not.

- Update the 3 week look-ahead programme which outlines the activities for the next three weeks.
- Send the 3 week look ahead to the subcontractors as well so that they know what they have to do.
- Follow up to check whether they are following the schedule.

Study Objective 3: To examine challenges faced by contractors in coordinating their subcontractors' works.

- The following challenges were outlined by the respondents:
- Clashes and changes in drawings
- Resources that don't arrive on time
- Weather related challenges
- Absenteeism of resources
- Strikes on site by other contractors
- Strikes in communities where the workers reside
- Sharing access with other packages/ contractors
- Competency and skill available
- Having more resources than required (affects quality, safety and progress)
- Delays in inspections
- Different timeframes for different jobs affecting your job resulting in pressure to finish
- Small subcontractors usually have a challenge with their suppliers in terms of financing of materials and getting materials to site.
- Subcontractors making unrealistic promises and as such, do not keep.

Study Objective 4: To ascertain how contractors deal with the challenges.

- Doing a 3 week look ahead of the schedule to make sure the impact on the programme is known at all times.
- Communication with site engineers, other supervisors, team leads and workers. This is a very important aspect of coordination. This is done by means of emails, holding meetings, calling and sending sms.
- Apply the code of conduct policy to deal with absenteeism
- Planning and following the critical
- Performing resource levelling (revising plans regularly)
- Promoting teamwork
- Timely scheduling of works and resources (identifying scope decrease/ increase on time and inform the affected subcontractor on time for him to mobilize or demobilize workers)
- Monitor, keep track on the programme and meet daily to check whether the subcontractors are following the programme and the status of the procurement of materials.

MAIN CONTRACTOR 2

Main contractor two is a Joint Venture between two big South African building companies. This contractor's scope of works covers the civil works on the Kusile site. A FIDIC RED Book was originally adopted for this contract at a contract value of R 9 Billion.

Subsequently, in 2015, the contract was changed from a re-measurable to a cost plus contract. This came with its benefits and challenges for both parties. One major issue is with the management of labour resources with regards to work / availability of access to work areas.

On average, there are about nine subcontractors that are subcontracted to main contractor number two. The total number differs from time to time due to the fact that some subcontractors get demobilized and also new subcontractors get mobilized. Moreover, with the adoption of the cost plus pricing option, this mobilization and demobilization process happens more often than before as there is no stability and control over who gets affected by access issues.

The contractor's subcontractors are as shown in table 4.2 below and according to the work packages.

Table 4.2 – Main Contractor No. 2 Work Packages

No.	WORK PACKAGE	NUMBER OF SUBCONTRACTORS
1	Scaffolding & Formwork	1
2	Reinforcement	3
3	Scaffolding only	2
4	Waterproofing	1
5	Grouting	1
6	Steelwork	1

One respondent was interviewed from contractor two. Refer to Appendix 4, and below the study objectives are outlined based on the responses.

Study Objective 1: To ascertain how contractors coordinate their subcontractors' works

As shown in the respondent's answer to question 9a of Appendix 4; the original contract was not unitized meaning that work was planned to be done from unit to unit. Now the Employer, in 2015, decided to unitize the project. This meant that now work has to be done on multiple units at the same time with different unit managers. Different managers work differently therefore forcing the contractor not to have a uniform way of coordinating works.

The respondent further provided two methods of working where in Units 5&6 coordination takes place and in Units 2, 3 & 4; there is no coordination. This objective was then addressed in terms of Units 5&6 only, and the response is highlighted below.

The contractor:

- Holds coordination meetings where he looks at the priority activities of the unit. All main contractors working on the unit are present at this meeting. The employer's unit manager is also present.
- Then there's a meeting with all the contractor's subcontractors, to align them with the schedule.

- Prioritizes works on the critical path.

Study Objective 2: To determine activities the contractor does when coordinating subcontractors' works

Activities provided by the contractor, under question 9b of Appendix 4 are provided below:

- The contractor provides a 2 week look ahead for works (based on schedule) and access (looking only at his readiness to start working at an area).
- A 7 O'clock daily meeting is held with the subcontractors- discuss and outline the plan for the day.
- An 8 O'clock coordination meeting is held with Employer and subcontractors (supervisors) to discuss the plans and address challenges faced.
- Communicate with the subcontractors during the day via emails, sms, calls, and via a WhatsApp group.
- Track and monitor progress during the day.
- Hold adhoc meetings with supervisors during the day. Solving identified issues, improvising due to changes encountered on the day.
- Receive and review subcontractors' weekly programme.

Study Objective 3: To examine challenges faced by contractors in coordinating their subcontractors' works.

- According to the respondent, under question 10 on the appendix;
- Due to coordination & proper and timely planning, there are fewer challenges that are faced by this contractor in units 5 & 6. And these are:
- Minor Access issues
- Urgent requests' disruptions
- Unforeseen circumstances

In units 2, 3 & 4 the contractor reported that he works very difficult in these units because there's no planning and coordination therefore timely availability of resources is the only

challenge they must fix themselves. Because this is now a cost plus contract, they also do not carry the risk of having resources on site when there's no work for them.

Access is a major issue / challenge for the contractor in these units.

Study Objective 4: To ascertain how contractors deal with the challenges.

Answers to question 10 of Appendix 4 provide detail to this objective.

In units 5 & 6:

- Proactive working assists the contractor in avoiding challenges, dealing with/ solving them before they arise.
- The contractor works on programs with the whole team (planner, procurement, construction, commercial, engineering) to get a consolidated working plan.
- Track the procurement progress of long lead items to avoid logistics and delivery issues/ challenges.
- Monitoring and updating of the procurement tracking sheet which have the following fields:
 - Area at which the equipment will be used
 - Has it been ordered (Y/N?)
 - Priority
 - Supplier date
 - Delivery status

Due to planning and coordination, the contractor is well informed of what he'll need and when. This reduces and mitigates any procurement risks.

In units 2, 3 & 4:

The contractor reports back to the Employer for him to fix all access issues and any other challenges they face due to the impromptu setup of unit managers in these units.

MAIN CONTRACTOR 3

This contractor is an International Mechanical Project Management contractor responsible for the procurement and construction of the Turbine machine. The contract type used is a FIDIC YELLOW Book, Design and Build. The contract value is R 16 Billion with about 80% of works subcontracted.

The main contractor is responsible for the main Turbine Plant itself and the smaller/ supporting components and works have been subcontracted. The numbers of subcontractors according to the different work packages/ scope are tabulated below.

Table 4.3-Main Contractor No.3 Work Packages

Work Package	Number
Mechanical Piping	1
Mechanical Structural	1
Painting	1
Recycle Pumps Installation	1
HVAC	1
Insulation	1
Electrical, Control & Instrumentation	1
Laminations	1
Structural Steel Erection	1

One respondent was interviewed from contractor three and responses are outlined below. Refer to Appendix 5.

Study Objective 1: To ascertain how contractors coordinate their subcontractors' works

The respondent's detailed response to question 9a, as shown on Appendix 5, has been reported below.

- Through site organization i.e. there is a construction manager and supervisor for each subcontractor, concentrating and managing the specific subcontractor.
- Receive and review a master schedule from the client, detailing all works and interfacing for project activities and project critical path.
- Hold a weekly integration and coordination meeting with the client, where the contractor aligns his schedule to the project schedule. In this meeting, the schedule is/

may be revised to meet client required dates for access to other site contractors. The contractor also updates his schedule for dates on which access is expected to be available for him and informs the client of these dates so that the client can go monitor and manage his other contractors' works to meet our scheduled access dates.

- Monitor subcontractors' resources in line with planned work by requesting histograms from the subcontractors.
- Hold daily coordination meetings where the client, all subcontractors and the main contractor are in attendance. In this meeting planned activities and objectives are outlined; understand the scope of other subcontractors and issues arising so that these are resolved at once.
- Execution of crucial and complex activities requires daily meetings to plan, monitor progress and making sure that materials are available, the area is ready, quality and safety requirements are taken care of before commencement of the works, etc. For example, the contractor meets one of our major piping subcontractors every morning to discuss the activities and plan for the day.

Study Objective 2: To determine activities the contractor does when coordinating subcontractors' works

Three activities were provided by the respondent on question 9b of the appendix, and below are the activities:

- Communication via the supervisors (calls, emails, sms)
- Follow up on subcontractors for required information including progress
- Close supervision

Study Objective 3: To examine challenges faced by contractors in coordinating their subcontractors' works.

Through the coordination process, the respondent's answer to question 10 of the appendix highlighted the following as challenges he faces:

- Complying with the schedule due to slippages by subcontractors.

- Delays due to material supply.
- As an offshore company with mostly foreign management employees, language barrier with locals becomes a challenge.
- Access delays due to lots of subcontractors in one area (main contractors' and other contractors' subcontractors)
- Internal access issues where it is the main contractor's fault.

Study Objective 4: To ascertain how contractors deal with the challenges.

Shown under question 11 of the appendix are strategies employed by the respondent to overcome these coordination challenges, and below are the details.

The respondent:

- Holds meetings to resolve delay issues and discuss mitigation strategies. These are held between relevant parties between the contractor, subcontractor and employer. Sometimes the employer would liaise with his other contractors if they are affected.
- Employs local supervisors to enhance communication with local labour
- For issues that need the client, it is easy for us because we are sitting in the same area with some employer representatives.
- The contractor has an offsite procurement department comprising of expeditors and quality personnel for the workshop fabrication works.
- The supply chain department manages logistics and delivery from suppliers both local and offshore.
- Communicates frequently to analyze and solve problems.

MAIN CONTRACTOR 4

This contractor is an International Mechanical Project Management contractor responsible for the procurement and construction of the Flue Gas Desulphurization (FGD) Plant. The

contract type used is a FIDIC YELLOW Book, Design and Build. The contract value is R 3.5 Billion with about 75% of the works subcontracted.

The main contractor is responsible for the main FGD plant itself and the smaller/ supporting components and works have been subcontracted. The number of subcontractors according to the different work packages/ scope is tabulated below.

Table 4.4-Main Contractor No.4 Work Packages

Work Package	Number
Painting	1
Mechanical	1
Insulation	1
Piping	1
Control & Instrumentation	1
Scaffolding	1

One respondent was interviewed from contractor four and is outlined below. Refer to Appendix 6 for the full interview.

Study Objective 1: To ascertain how contractors coordinate their subcontractors' works

The coordination process, as contractor number four stated in his response to question 9a; starts before contracts are awarded. A master Time Schedule is prepared through his planning office. This is then split into the different sections for tender purposes. A tendering schedule (showing the required start and end dates of the project) is issued; which the tenderer must populate into a detailed schedule with all interfaces.

Study Objective 2: To determine activities the contractor does when coordinating subcontractors' works

In answering this objective, the respondent's response to question 9b in the appendix covers the following:

- Do a three week look ahead to see what activities are coming up in the next three weeks.

- Hold weekly interface meetings with subcontractors which have interfacing activities in a particular section.
- Hold a daily morning preparation meeting to outline plan for the day and implementation thereof.
- When behind schedule, the contractor holds weekly pull back meetings to pull back the schedule.
- Communicate through emails, sms and call the subcontractors.
- Arrange site walks with our subcontractor 'representatives'.

Study Objective 3: To examine challenges faced by contractors in coordinating their subcontractors' works.

Challenges faced by main contractor four, detailed in his answer to question 10 of the appendix are provided below:

- Subcontractor's representatives not delivering on their promises/ deliverables. This delays the contractor's overall work/schedule and delays other contractors as well.
- The workers mentality in the sense that, seemingly they don't want the project to finish, as this would mean they would be out of jobs. According to the respondent, due to the Project Labour Agreements (PLA) in place, the workers are too comfortable in this project and this makes them want to stay for as long as possible and the project to keep on open for longer. This PLA has made provision for benefits such as bonuses, incentives and allowances. The PLA also provides long weekends whereby workers are entitled to leave and not be at work, this then means that there are a few workers available to work through volunteering.
- Labour Union involvement with how workers work i.e. workers being on a go-slow without any sense of urgency.
- HR related issues such as sick leaves and unplanned leave application.
- Access issues in areas where works are to be executed.

Study Objective 4: To ascertain how contractors deal with the challenges.

Question 11 in the appendix details the response detailing strategies employed by the contractor to address the coordination challenges.

- The contractor has, through past experience, decided to lock interface dates and have enough detail on new contracts.
- The contractor has learnt from the way in which he worked on the preceding Unit or Units, from the way they managed subcontractors, the way in which the schedule and execution activities was done, sequencing of activities, dealing with paperwork and processes.
- Try by all means to find amicable solutions at all times. The contractor always looks at resolving issues without involving contractual/ commercial processes. This is because once this route is initiated, the work might standstill on site/ there might be reluctance to work by subcontractor/ these processes might end in a bad way for the subcontractor which can lead to contract termination.
- The contractor indicated that site walks are the most effective.

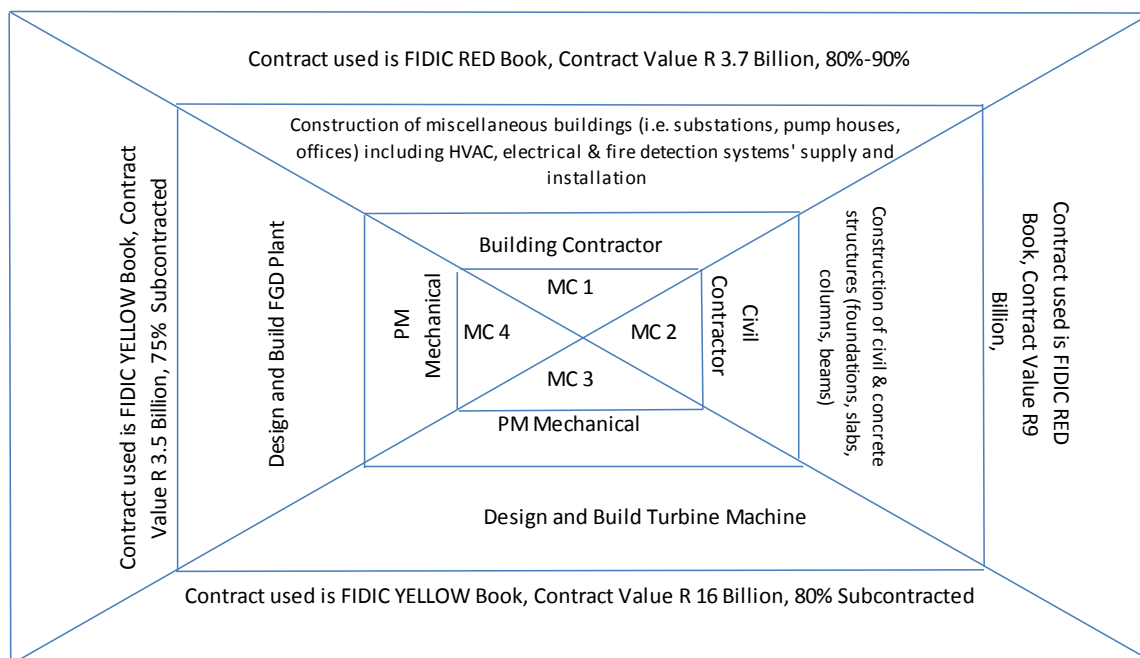
“When there are access issues on site; I go to site with the subcontractors individually, we discuss the problem causing delay and mitigating plans. Then I met with all subcontractors involved, we discuss the problem, effects and come up with the best solution for all parties. I then draft detailed minutes outlining responsibilities, accountable people, and dates for each action item and send to the subcontractors. This assists in making sure that all parties are held accountable and deliver on time. I don't like emails because this method is slow; I might not read all my emails or miss urgent/ important emails.”

COMBINED RESULTS / SUMMARY OF RESULTS

GENERAL OVERVIEW

The four contractors are responsible for different sections within the plant viz., civil, building and mechanical works. The types of contracts used are all from the FIDIC suite of contracts and these are the Yellow Book for mechanical scope where the contractor designs and builds (MC 3 & MC 4) and Red Book for the civil and building scopes where the client designs and the contractor constructs (MC 1 & MC 2). The contract values range between R 3.5 Billion to R 16 Billion, with all contracts showing similar values for subcontracted work ranging between 75% and 85%. All this is shown in figure 4.1 below.

Figure 4.1- General overview of the 4 main contractors



The number of subcontractors and the trades per main contractor has been tabulated under table 4.5 below.

Table 4.5- Subcontractor information (numbers)

WORK PACKAGE	DOMESTIC	LABOUR ONLY	WORK PACKAGE	NUMBER
MC 1			MC 2	
Earthworks	2		Steelwork	1
Piling	1		Reinforcement	3
Formwork	2		Scaffolding only	1
Reinforcement	3		Waterproofing	1
Plastering	1	2	Grouting	1
Structural Steelwork	2		Scaffolding & Formwork	1
Scaffolding	2		MC 3	
Waterproofing	2		Mechanical Piping	1
Steel Fixing		5	Mechanical Structural	1
Brickwork		4	Painting	1
Plastering		2	Recycle Pumps Installation	1
Carpentry		1	HVAC	1
Painting		1	Insulation	1
Ironmongery		1	Electrical, Control & Instrumentation	1
Tiling		3	Laminations	1
Cranage	2		Structural Steel Erection	1
Fencing	1		MC 4	
Electrical Work	1		Painting	1
Plumbing	2		Mechanical	1
Fireproofing & Detection	1		Insulation	1
Ceiling, Partition & Access flooring	4		Piping	1
HVAC	1		Control & Instrumentation	1
			Scaffolding	1

CONSOLIDATED LIST PER STUDY OBJECTIVE

STUDY OBJECTIVE 1- TO ASCERTAIN HOW CONTRACTORS COORDINATE THEIR SUBCONTRACTORS' WORKS

Table 4.6- Consolidated data on how contractors coordinate their subcontractors' works

MC NO.1	MC NO.3	MC NO.4
Check the programme for interfacing of the works and the contractors on site	Through site organization i.e. we've got a construction manager and supervisor for each subcontractor, concentrating and managing the specific subcontractor.	Prepare a master schedule
Confirm the limited access onsite.	Receive and review a master schedule from the client, detailing all works and interfacing for project activities and project critical path.	Split schedule into the different work sections for tender purposes
Determine the total resources that will be required.	Hold a weekly integration and coordination meeting with the client, where we align our schedule to the project schedule.	Issue tender schedule
Prioritize activities based on/ aligned to the critical path	Monitor subcontractor resources in line with planned work by requesting histograms from the subcontractors.	
Perform resource levelling exercise so that no one is idle on site.	Hold daily coordination meetings where we have the client, all subcontractors and the main contractor in attendance.	

Attend meeting with the site agent, site engineer and contract manager to discuss, plan and review possible challenges and obstacles, set reasonable targets & consequences of late finish, ways of compressing the schedule to create float between activities to allow for unknown delays might they arise	Hold daily meetings for the execution of critical/ crucial and complex activities	
Follow up with my subcontractors		
Transmit all necessary documentation such as drawings, programme.		
Schedule and hold daily and weekly meetings with the subcontractor		
Monitor the work progress		
Track the procurement progress/ status		
Check if they have people with the necessary skills on site		

Main contractor number 2 indicated that due to the change in the original work execution methodology by the employer, work is now unitized and different unit managers work differently. This is explained in the discussion after this consolidated list below.

Below is a consolidated list of activities from all interviewees except Main Contractor No.2.

1. Prepare a master schedule
2. Split schedule into the different work sections for tender purposes
3. Issue tender schedule
4. Allocate designated construction manager, supervisor managing each subcontractor
5. Receive and review a master schedule from the client, detailing all works and interfacing for project activities and project critical path.
6. Check the programme for interfacing of the works and the contractors on site
7. Perform resource planning & levelling
8. Prioritise critical path activities
9. Confirm the limited access onsite.
10. Monitor the work progress
11. Track the procurement progress/ status
12. Check if people employed have the necessary skills on site
13. Arrange and attend integration, coordination, planning meetings with main contractor's personnel only
14. Attend the above mentioned meetings with main contractor & subcontractors
15. Attend the above mentioned meetings with main contractor, subcontractors & client
16. Transmit the necessary documentation such as drawings, program to subcontractors

On all four contractors interviewed, it has been revealed that the coordination process begins with a schedule. Two contractors (MC 3 & 4) indicated that they prepare a master schedule at the beginning of a project and work from it by dissecting it into smaller schedules for different scopes/ areas/ sections of work. When subcontracting, each tender goes with the relevant section schedule for the tenderers to work on. Upon tender award, the subcontractor schedule is then rolled up to the master schedule. These two contractors together with MC 1, further from the master schedule, devise a programme where the works and activities are outlined in detail. This shows all interfaces (both internal & external to main contractor).

One main contractor, MC 2, has different dynamics and coordination is handled quite differently. This package was awarded based on a FIDIC Red Book and a Bill of Quantity

option was adopted. Later in the project, due to the Employer changing the sequence of construction from the original sequence, a Cost Plus option was then introduced and agreed to by both parties. This meant that all the remaining units were to be constructed concurrently and each unit has its own delivery manager from the Employer's side. These unit managers work differently and the contractor is forced to work according to the unit manager's principles. On units 5 & 6, the contractor indicated that there is a well-established coordination process unlike in units 2, 3 & 4 where the work is not well coordinated.

Main contractor number 3 indicated an imperative action which it takes by employing a construction manager and a supervisor for each subcontractor; concentrating and managing the specific subcontractor. The other main contractors, on the other hand, have different personnel, including a supervisor, site agent, foremen; responsible for sections/ trades and not necessarily a certain subcontractor.

STUDY OBJECTIVE 2- TO DETERMINE ACTIVITIES THE CONTRACTOR DOES WHEN COORDINATING SUBCONTRACTORS' WORKS

Table 4.7- Summary of coordination activities by contractors

MC NO.1	MC NO.2	MC NO.3	MC NO.4
Hold a start-up meeting to discuss the programme with the workers, we bring all drawings, schedule, pictures/graphics so that all team leads and workers are clearly aware of the work ahead, schedule, and output required	We do a 2 week look ahead for works (based on schedule) and access (looking only at my readiness to start working at an area).	Communication via the supervisors (calls, emails, sms)	We do a three week look ahead to see what activities are coming up in the next three weeks.
Hold tool box talk every morning to outline the plan for the day.	Hold a daily 7 O'clock meeting with the subcontractors-	Follow up on subcontractors for required information	We hold weekly interface meetings with subcontractors which have interfacing activities in a

	discuss and outline the plan for the day.	including progress	particular section.
Prepare a method statement which includes a risk assessment for each activity.	8 O'clock coordination meeting with Employer and subcontractors (supervisors). Discuss the plan, lay address challenges.	Close supervision	We hold a daily morning preparation meeting to outline plan for the day and implementation thereof.
Outline/ review Safety and Quality procedures and work according to them	Communication with the subcontractors during the day via emails, sms, calls and our WhatsApp group.		When we are behind schedule, we hold weekly pull back meetings to pull back the schedule.
Continuously checking on the works/ progress thereof.	Tracking and monitoring progress during the day.		We communicate through emails, sms and call the subcontractors
Monitor the works	Hold adhoc meetings with supervisors during the day. Solving identified issues, improvising due to changes.		We arrange site walks with our subcontractor 'representatives
Attend meetings	We receive a weekly programme from the subcontractor, which we discuss and amend accordingly.		

Update the programme, prepare a 3 week look ahead and share with subcontractors			
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Below is a consolidated list of activities from all interviewees.

1. We hold a startup meeting
2. Hold tool box talk every morning to outline the plan for the day.
3. Hold a daily 7 O'clock meeting with the subcontractors- discuss and outline the plan for the day.
4. Hold an 8 O'clock coordination meeting with Employer and subcontractors (supervisors). Discuss the plan, lay & address challenges.
5. Hold Ad hoc meetings with supervisors during the day. Solving identified issues, improvising due to changes.
6. Hold weekly interface meetings with subcontractors which have interfacing activities in a particular section.
7. Hold a daily morning preparation meeting to outline plan for the day and implementation thereof.
8. When we are behind schedule, we hold weekly pull back meetings to pull back the schedule.
9. Prepare a method statement which includes a risk assessment for each activity.
10. Outline/ review Safety and Quality procedures and work according to them
11. Track and monitor progress during the day.
12. Do a three week look ahead to see what activities are coming up in the next three weeks.
13. Do 2 weeks look ahead for works (based on schedule) and access (looking only at my readiness to start working at an area).
14. Update the 3 week look ahead programme,
15. Send the 3 week look ahead to the subcontractors so that they know what they have to do.
16. Follow up to check whether subcontractors are following the schedule
17. We receive a weekly programme from the subcontractor, which we discuss and amend accordingly.

18. Communicate with the subcontractors during the day via emails, sms, calls and our WhatsApp group.
19. Communicate via the supervisors (calls, emails, sms)
20. Follow up on subcontractors for required information including progress
21. Close supervision
22. We arrange & hold site walks with our subcontractor's representatives.

STUDY OBJECTIVE 3- TO EXAMINE CHALLENGES FACED BY CONTRACTORS IN COORDINATING THEIR SUBCONTRACTORS' WORKS

The main contractors reported that they face a number of challenges with their individual subcontractors and these are shown in the table below.

Main Contractor 1

This contractor reported some challenges which are out of his control such as strikes and weather conditions. Most of the challenges are in the contractor's control and he can or should be able to manage these challenges. Key challenges faced by this contractor are access sharing, competency of labourers, procurement issues with small subcontractors and clashing of drawings.

Access becomes a problem where access is not granted or released at the time that has been agreed to by all parties involved. This causes delays to the schedule and affects progress if not managed properly.

Due to Skills Development requirements, contractors must employ local labour from the surrounding communities and small companies within the region. At times, these local companies and labour are not competent enough for the works to be executed. The small companies also experience cash flow problems and this also affects the procurement of material.

Clashing and changes in drawings is a big issue even though it can be effectively managed at times. There are times where the management of this challenge becomes difficult and delays

the contractor's progress, require reworks and becomes the root of contractor claims. Sometimes this can be resolved within a short space of time, such as a few hours to a day; but some take longer due to the type of change and what it affects. The contractor reported that some areas are shut down and remain that way due to discussions taking a long time (weeks/ months). In this situation the contractor is then forced to reallocate his workers to other areas.

Main Contractor 2

Due to the different dynamics and changing of original sequence of works, as explained in the previous section, coordination is performed differently in different units. Where there is coordination, minor access challenges are experienced by the contractor. Urgent requests and disruptions by the employer is another challenge faced by the contractor on a daily basis. Due to the Cost Plus option being used, the employer attempts to manage the contractor's labour count by instructing the contractor to reduce/ increase the labour as and when he foresees an incline or decline in work or access. This is a huge challenge to the contractor because he has to demobilize and hire labour more frequently than he would if this was not the case. The contractor ends up losing competent workforce due to this process.

In units with no coordination, the contractor experiences major access challenges and clashing in works with other contractors.

Main Contractor 3

The contractor's main challenges are delays caused by late supply of material and access delays on site. Other challenges include slippages by subcontractors and language barrier due to the contractor being a foreign company with foreign management personnel.

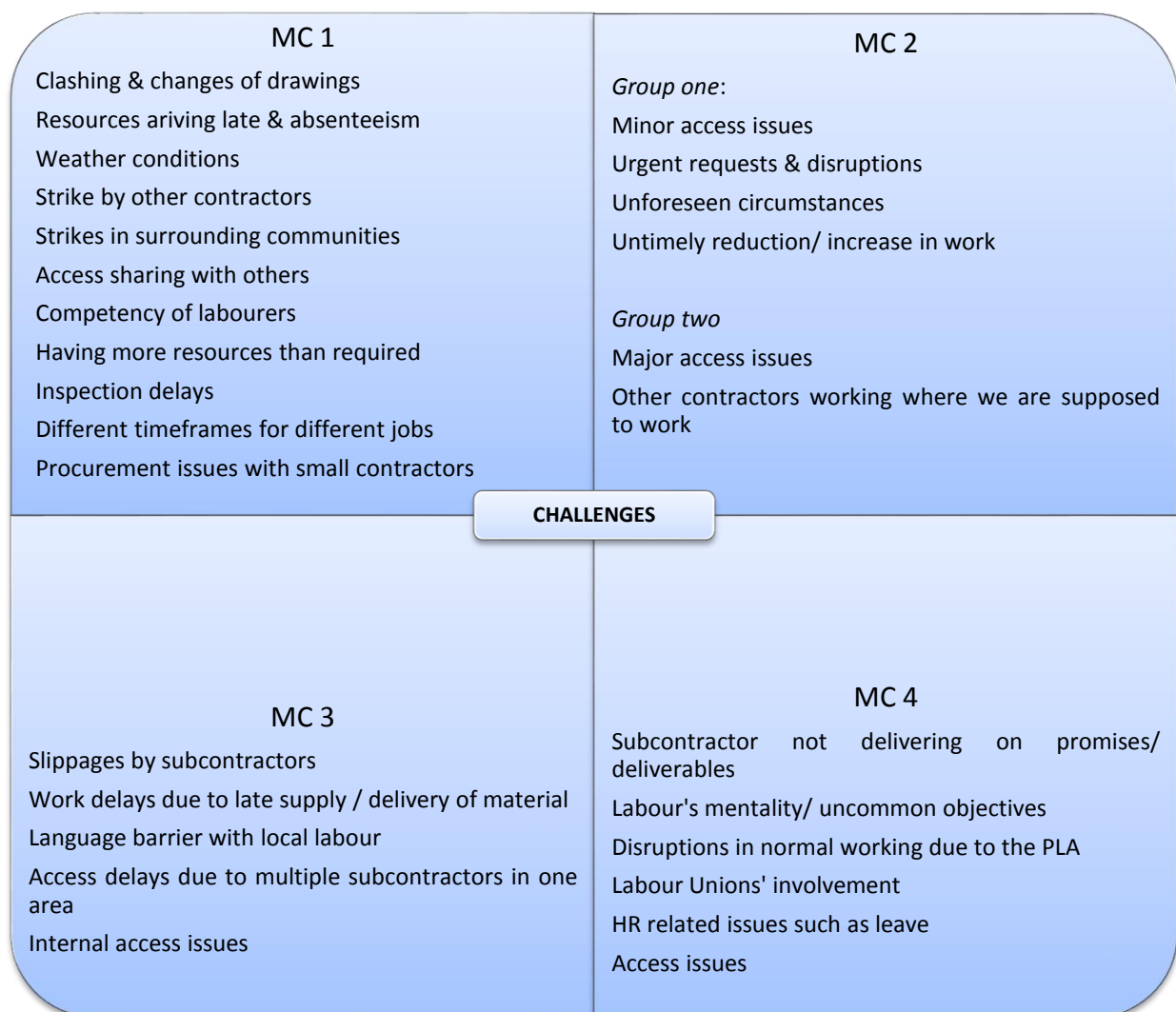
Main Contractor 4

The subcontractor challenges faced by this contractor include subcontractors not delivering on their deliverables on time and this in turn affects the schedule. Due to the implementation of the Project Labour Agreement (PLA) on site, normal/ standard working shifts and days are tailored for site and differ with the industry. The effect of this PLA is mostly experienced by

the contractor during PLA weekends and long weekends, whereby there is a site shutdown. This means no work happens as there are no workers on site and the contractor cannot continue with work and experiences disruptions. The contractor, being a foreign company, has difficulty in dealing with the Labour Unions on site. The contractor's view is that the subcontractors' labourers are overprotected.

Shown in figure 4.2 below is all the main contractors' coordination challenges.

Figure 4.2- Main contractors' coordination challenges



These challenges were then grouped for each main contractor and this has been tabulated in table 4.8 below.

Table 4.8- Grouped challenges

CHALLENGES	MC 1	MC 2	MC 3	MC 4
External Forces -Strikes by others, weather	X			
HR & PLA Related -Absenteeism, leave, late arrival	X			X
Engineering & Quality Related -Clashing & changes in drawings/ designs, CIRs, poor quality work on/ off site	X	X		
Procurement & Logistics	X	X	X	
Resource Related -Labour competency, more/ less resources than required, untimely reduction/ increase in work	X	X		
Working Arrangements -Access issues, inspection delays, work slippages by subcontractor, late achievement of targets, urgent requests, unforeseen circumstances, untimely reduction/ increase in work	X	X	X	X
Language Barrier			X	X

STUDY OBJECTIVE 4- TO ASCERTAIN HOW CONTRACTORS DEAL WITH THE CHALLENGES

Listed below is a comprehensive list obtained from the interviews:

1. Implementing the code of conduct policy
2. Monitor & track the procurement status
3. Monitor and update the procurement tracking sheet
4. Setting up an offsite procurement department that deals with procurement of materials. Having a supply chain department that manages logistics & delivery from both local and offshore suppliers
5. Promoting teamwork
6. Do a 2 or 3 week look ahead
7. Frequent communication via e-mails, sms, calls, WhatsApp messages, meetings
8. Resource scheduling/ levelling
9. Fix or lock interface dates
10. Have enough detail on new contracts
11. Using lessons learnt- Management of subcontractors
 - i. Manner in which we schedule & execute activities
 - ii. Sequencing of activities
 - iii. Dealing with paperwork & processes
12. Find amicable solutions to solve issues at all times
13. Resolve issues without involving contractual/ commercial processes
14. Hold site walks
15. When dealing with access issues-
 - i. Site walk with the affected subcontractors, individually
 - ii. Discuss the problem, cause of delay & come up with mitigating plan
 - iii. Hold a collective site walk with all parties involved; discuss the problem, effects and best solution for all parties

- iv. Draft detailed minutes outlining the way forward, responsibilities, dates and accountable persons for each action item

CHAPTER 5

DISCUSSION OF RESULTS

This study explored coordination challenges by assessing contractors' daily coordination methods & activities, as applied/ performed at the Kusile Power Station Project. This study was exploratory since a few studies have been done on this subject. The approach used in this study was a case study due to this approach being considered an appropriate methodology for developing theoretical frameworks. The number of case projects was not large and some of the research findings are valid only for their particular cases.

The following discussion will serve to further substantiate the results given above.

STUDY OBJECTIVE 1- TO DETERMINE HOW CONTRACTORS COORDINATE SUBCONTRACTORS' WORKS AND WHAT ACTIVITIES DO THEY PERFORM WHEN COORDINATING

Coordination, according to the respondents, starts with a schedule which also serves as a guide for resource planning and identification of critical path activities. The respondents basically/ generally follow a process even though they all do it differently, but this process is consolidated in the results shown above.

Only two out of the four contractors (both mechanical contractors), reported that they allocate a designated construction manager or supervisor to manage each subcontractor. This is a critical activity and this is evident due to the level of attention and detail that is given to the subcontractor. The supervisor is able to focus and zoom in on one subcontractor, while keeping in mind all interfaces and dependencies with other activities and subcontractors.

On the other hand, the other two contractors (civil and building contractors) do not necessarily focus on each subcontractor but rather split sections where one supervisor will be responsible for work to be done on the entire section. Both strategies are effective for works in which they are applied. In the mechanical field, scopes/ trades are separated i.e. piping, insulation; and there would be a supervisor for each subcontractor responsible for each trade. The only part, which is the integration/ interfacing, needs to be managed by the supervisors

and ensure that there is alignment in works according to the master schedule/ programme. In the second strategy, for civil and building contractors; the supervisor is responsible for a section/ area/ building and therefore will have to coordinate works done by different subcontractors interfacing in one area. For example coordinating concrete, formwork, reinforcement (steel fixing), and waterproofing subcontractors when constructing a concrete basement of a building. This is more of a consolidated approach to coordination due to the manner in which works are structured.

The second crucial step in the process, as reported by the respondents, is organizing, integration, coordination, planning, and meetings with the contractor's personnel only (i.e. planner, construction manager, commercial team, etc.). These meetings are also held with the subcontractors and together with the client; at different frequencies (weekly/ ad-hoc/ planned). This is where each aspect and detail of the works are discussed, timelines set and agreed upon. There are different attendees to different meetings so that only the relevant parties and decision makers are involved in discussions, for the meeting to be effective.

All discussions are recorded with actions, timelines, solutions, and way forward; then shared with the attendees and relevant personnel. Then follow up in ensuring that these meetings serve their purpose, is for people to do their part after the meeting. The project manager/ construction manager/ supervisor then need to be hands on to ensure that the responsible parties do what is required of them and are held accountable. They should also do follow ups on deliverables to check and track progress, which will have an effect on the achievement of the overall goals. Key activities, given emphasis by the respondents, are:

- Holding start up meetings, toolbox meetings, daily preparation meetings; to outline the plan and targets for the day and implementation thereof

Holding daily ad-hoc meetings with subcontractors during the course of day

Holding weekly interface meetings

- Preparing and working according to the method statements and Safety & Quality procedures which include risk assessments per activity
- Having site walks with the subcontractors, follow up and close supervision of the subcontractor

- Communicating with the subcontractor via methods such as emails, sms, calls, and WhatsApp.

STUDY OBJECTIVE 2 - TO EXAMINE THE CHALLENGES FACED BY CONTRACTORS IN COORDINATING THEIR SUBCONTRACTORS' WORKS

Challenges which are common amongst the four main contractors have been reported and grouped according to similarities in chapter four above. The following are the groups of challenges:

- Working arrangements
- External forces
- Resource related
- Procurement logistics
- Language barrier
- Engineering and quality related
- Human resource and PLA related

The key categories from the above are: working arrangements, resource related challenges, Engineering & quality related challenges, and language barriers. Challenges falling under these categories are significant towards achieving coordination at Kusile Power Station. Briefly, the categories and challenges together with methods/ how the contractors overcome the challenges; are discussed below.

- Engineering & Quality Related

Clashing & changes in drawings/ designs, Contractor Information Requests, poor quality work on/ off site

These challenges are significant because once the contractor encounter such, then coordination hits a stand still. At some point when the contractor encounters clashing in drawing/ designs, he should raise a Contractor Information Request (CIR) to the employer and has to wait for the response while he temporarily suspends the work. This affects the contractor's coordination plan.

The contractors, to overcome this challenge, prepare a 2 or 3 week look ahead whereby these design and quality challenges are dealt with and minimised. Meetings and communicating with the employer also assists in dealing with these challenges.

- Language Barrier

Two contractors, which are international companies, have foreign personnel in most senior management positions. The foreign personnel are not fluent in speaking English and this poses a difficulty when they deal/ have to be supervising and working with the local labour.

To overcome this, the contractor employs local supervisors and some construction managers to ensure that there is a language link/ flow and coordination and communication is enhanced for better coordination.

- Resource Related

Labour competency, more/ less resources than required

The competency of the labour force has been reported as a major concern and poses difficulty in coordinating works. This results from the subcontractors hiring incompetent labour or not adequately training the labour for the job. As work increases/ decreases in one area, resources have to be moved around to work in other areas which have work. Sometimes this exercise doesn't happen instantly and leaves workers idle or hinders progress due to slow production when a lot of resources work in the same area. Additionally Jha and Misra (2007) also infer that resource handling is the most critical factor in achieving project coordination.

To reduce/ deal with this, the contractors perform resource scheduling/ levelling exercise and also rely on the 2 week look ahead to schedule the resources. Trainings are provided to the labour force.

- Working Arrangements

Access issues, inspection delays, work slippages by subcontractor, urgent requests, unforeseen circumstances, untimely reduction/ increase in work

These challenges have a major impact on the coordination process and arise on a daily basis.

STUDY OBJECTIVE 3-. TO ASCERTAIN HOW CONTRACTORS DEAL WITH THE CHALLENGES

The contractors indicated a few ways and steps that they use to overcome these challenges. They use lessons learnt obtained since the project started and also obtained when working in the earlier units/ areas. These include and affect the manner in which the contractor schedules & executes activities, sequencing of activities, and dealing with paperwork & processes.

When there is an issue, the contractor prefers to find amicable solutions to solve issues at all times instead of always involving contractual/ commercial processes because once these processes are started they might cause more delays and even end up in claims and disputes.

Holding site walks has been said to be the most effective way in dealing with access issues. Saram and Ahmed (2001) also attest to this in their investigation of important and time consuming coordination activities in building projects. This process is what the contractor follows in ensuring that access issues are amicably resolved as soon as possible. This shows that to achieve effective coordination, both formal and informal methods should be pursued in combination, and below is a highlight of this process:

- Hold a site walk with the affected subcontractors, individually.
- Discuss the problem, cause of delay & come up with a mitigating plan
- Hold a collective site walk with all parties involved; discuss the problem, effects and best solution for all parties
- Draft detailed minutes outlining the way forward, responsibilities, dates and accountable persons for each action item
- Send minutes, via e-mail, to all subcontractors involved, this assists in making sure that all parties are held accountable & deliver on time
- Follow up e-mail with other forms of communication such as sms, meeting and calls

Hai et al (2012) in the conceptual study of barriers to coordination categorized the challenges into 5 categories. Revealed by the results of this current empirical study is that out of all the

challenges identified; can be linked to only two categories out of the five revealed in literature. These are Construction Participants and Characteristic of Organization.

Construction Participants

Contractor Information Requests are amongst other reasons, a result of lack of information and knowledge by the contractor of other contractors' work at interfacing areas. Hai et al (2012) indicated that due to complexities and multi-disciplinary nature of the participants causes a mismatch between the technical interdependence of the works and their organizational independence. Furthermore this is explained by the limited knowledge and expertise of a participant towards the other works, which are running over their boundaries.

Uncommon objectives exist in construction and are based on a win-lose arrangement, which hinders the coordination process. Hai et al (2012) further states that a common objective has seldom existed in construction. Revealed through interviews in the current study is that due to the working arrangements between the employer and organized labour; labour and labour representatives are perceived to be reluctant to finishing the project. This hinders work on site and also affecting close supervision and coordination of the works on site.

Characteristic of Organization

The temporary nature of construction where participants have less opportunity to develop long-term relations is reported as a coordination barrier by Hai et al (2012) in the literature review. As revealed in the interviews, having more/ less resources than required and untimely reduction/ increase in work due to working conditions, affects the resource coordination by the main contractor.

Hai et al (2012) infers that the traditional management approach has been done informally in the construction industry and this has led to difficulty in managing communication and coordination of construction participants.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

Effective coordination is a critical success factor in complex construction projects, and as such needs to be properly managed/ performed by the main contractor as it is his responsibility. A key factor in the coordination process is managing task dependencies. The contractor is then faced with a big task of managing manifold interdependencies in complex projects having manifold subcontractors. Revealed was that both oral & written (informal & formal) coordination methods should be applied in junction. Meetings alone do not ensure coordination effectiveness.

Research Aim

The study was carried out to address the main aim of the study which was:

To identify key coordination challenges faced by main contractors in coordinating subcontractors' works, and develop recommendations for dealing with these challenges.

The three study objectives were addressed as follows:

1. To determine how contractors coordinate subcontractors' works and what activities do they perform when coordinating

Key activities highlighted from the research findings were

- Holding meetings at regular intervals such as startup meetings, toolbox meetings, daily preparation meetings, interface meetings.)
- Having site walks with the subcontractors and applying close supervision.
- Communicating with the subcontractor regularly

2. To examine the challenges faced by contractors in coordinating their subcontractors' works

Resource handling (issues), clashes/ changes in designs/ drawings, and access issues are the three major coordination challenges faced by main contractors at the Kusile Power Station Project.

3. To ascertain how contractors deal with the challenges

To overcome resource related challenges, the contractors perform resource scheduling/ levelling exercise and also rely on the 2 week look ahead to schedule the resources based on the work.

They hold site walks with individual subcontractors and also collectively with all parties affected by the access issues and follow up these with minutes detailing way forward and responsible parties.

Limitation to the study was the number of main contractors available, who had multiple/ numerous subcontractors.

It would be worthwhile to examine coordination challenges faced by contractors on other mega projects in South Africa in the future to find out if different/ the same results will emerge and establish external validity of these findings. E.g. projects in a different industry/ sector, private vs public projects. A different perspective from subcontractors in complex projects will also add value in future research.

For future studies, the researcher also recommends that a similar study, focusing mainly on how the three challenges stated above are overcome by contractors; be done in another project to uncover more ways the challenges can be overcome.

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APPENDIX 1- LIST OF COORDINATION ACTIVITIES by Saram & Ahmed (2001)

1. Providing Leadership

- 1.1. Translating documents into task assignments
- 1.2. Identifying strategic activities and potential delays
- 1.3. Identifying technical and workforce requirements
- 1.4. Delegating the work
- 1.5. Following up the delegated work
- 1.6. Motivating
- 1.7. Developing a team spirit
- 1.8. Resolving differences/conflicts/confusions among participants
- 1.9. Maintaining proper relationships with client, consultants, and the contractor
- 1.10. Receiving constructive input from all participants in the project
- 1.11. Establishing and maintaining an effective organizational structure and communication channels
- 1.12. Interfacing with other departments/managers in your organization outside the project team

2. Facilitating

- 2.1. Identifying/gathering information on requirements of all parties and consolidating for use in planning
- 2.2. Providing an organized means for gathering information and compiling
- 2.3. Managing contractual issues
- 2.4. Interpreting all contractual commitments and documents
- 2.5. Interfacing/integrating the work on different subsystems

- 2.6. Agreeing on detail methods of construction
- 2.7. Improving/altering/eliminating activities and considering better alternatives that may efficiently meet the project objectives
- 2.8. Analysing the project performance on time, cost and quality, detecting variances from the schedule/ requirements, and dealing with their effects considering time and resource constraints
- 2.9. Estimating resource requirements
- 2.10. Coordinating and rescheduling the sequence of onsite work
- 2.11. Coordinating offsite fabrications and their delivery with the onsite work
- 2.12. Coordinating the purchases, delivery, and storage of material
- 2.13. Optimizing resource allocation and utilization
- 2.14. Supporting own men and subcontractors with tools, equipment, and resources
- 2.15. Explaining and supporting the work of subcontractors
- 2.16. Identifying or gathering information on defects, deficiencies, ambiguities, and conflicts in drawings and specifications and having them resolved
- 2.17. Obtaining further drawings, specifications, and technical details on time for execution
- 2.18. Identifying and gathering information on builders work requirements (grouting-in, openings, making good, etc.) of all relevant parties and coordinating the time and manner of their execution
- 2.19. Providing general attendance (storage space, testing facilities, scaffolding, plant, power, water, illumination, etc.) to other parties
- 2.20. Coordinating handover of work areas (service areas, plant rooms, service routes, etc.) to other parties
- 2.21. Caring for works of others by making staff and workmen aware, where relevant providing covers, where possible changing the sequence of work, etc.

2.22. In case of defect or damage, proposing remedial work methods and programs for executing

2.23. Arranging for compliance with site instructions/ directives from the engineer and revising programs/ ordering material accordingly

2.24. Arranging for timely carrying out of all tests or inspections and approval by the engineer

2.25. Submitting material for approval by the engineer

2.26. Applying good technical practices

2.27. Applying good administrative procedures

2.28. Facilitating payments to own employees and subcontractors

3. Controlling

3.1. Managing the quality of all work carried out

3.2. Ensuring the timeliness of all work carried out

3.3. Ensuring effective utilization of manpower, plant, and material

3.4. Managing the health, safety, and welfare of employees

3.5. Managing the maintenance and safety of plant and machinery

3.6. Ensuring proper and safe delivery, storage, and handling of material

3.7. Monitoring the budget on all activities and taking corrective action

3.8. Controlling project finances

3.9. Monitoring the overall functioning of each section and department of the project

3.10. Ensuring discipline among all employees.

4. Communicating

4.1. Acting as liaison with the client and the consultants

4.2. Acting as liaison with specialist consultants, specialist subcontractors, nominated subcontractors, etc.

4.3. Contacting outside authorities

4.4. Communicating project progress, financial/commercial status, plans, schedules, changes, documents, etc., to all relevant participants

4.5. Conducting regular meetings and project reviews

4.6. Communicating instances of poor quality, dangerous or adverse incidents/situations to relevant personnel

5. Recording

5.1. Maintaining records of all drawings, information, directives, verbal instructions, and documents received from the consultants and the client

5.2. Maintaining records of work done outside the contract, variations, day works, and all facts/data necessary to support claims

5.3. Maintaining records of quantities of work done and details required for as-built drawings; especially of the work that is to get covered up

5.4. Maintaining records of price escalations, where the contract provides extra payments

5.5. Maintaining records of principal deliveries to the site and general particulars of shortages

5.6. Maintaining records of labour and plant deployment, working conditions (such as adverse weather), plant breakdowns, accidents, etc.

5.7. Maintaining records of all tests and inspections

5.8. Publishing daily construction reports in the format required by the engineer

APPENDIX 2- LIST OF COORDINATION ACTIVITIES by Jha & Misra (2007)

1. Implementing all contractual commitments.
2. Arranging for timely carrying out of all tests for inspections and approval by the engineer and maintaining records of the same.
3. Arranging submission of samples of materials for approval by the engineer.
4. Reporting progress reports, resources deployment report, etc. as required by the engineer.
5. Providing storage space, testing facilities, scaffolding, plant, power, water, illumination, etc. to other agencies as envisaged by the contract.
6. Arranging for compliance with site instructions/directives from the engineer and revising programmes/ordering material accordingly.
7. Applying good technical practices.
8. Preparing a project quality plan in line with contract specification.
9. Communicating instances of poor quality, dangerous or adverse incidents/situations to relevant personnel.
10. Caring for works of others by making staff and workmen aware of their responsibilities in this regard.
11. Coordinating handover of work areas/service areas (such as plant rooms, service routes, etc.) to other parties.
12. Proposing remedial work methods and programmes for executing in case of defect or damage.
13. Identification of appropriate human resources, materials and equipment for the project.
14. Estimating the optimum resource requirements.
15. Proper assignment of task to the available human resources for the project.
16. Organizing resources (manpower, plant and material) for effective utilization.

17. Arranging technical and behavioural training of human resources.
18. Facilitating payments to own employees and subcontractors.
19. Managing the health, safety and welfare of employees.
20. Managing the maintenance and safety of plant and machinery.
21. Equipping own men and subcontractors with tools, equipment and resources.
22. Explaining and supporting the work of nominated subcontractors and specialist suppliers.
23. Delegation of responsibilities to appropriate project participant.
24. Regular follow-up of work delegated to project participant.
25. Ensuring discipline among all employees.
26. Resolving differences/conflicts/confusion among participants.
27. Motivating project participants.
28. Developing a team spirit and receiving constructive input from all participants in the project.
29. Identifying/gathering information on requirements of all parties and consolidating for use in planning.
30. Identification of activities on critical path.
31. Communicating project progress, financial and commercial status, plans, schedules, changes, documents, etc., to all relevant participants.
32. Regular monitoring of critical path activities for adhering to schedule.
33. Coordinating the purchase, delivery, storage and handling of materials.
34. Arranging for kick-off meeting and review with all departments asking for date-wise schedule for their area of activities.
35. Identifying or gathering information on defects, deficiencies, ambiguities and conflicts in drawings and specifications and having them resolved.

36. Improving/altering/eliminating activities and considering better alternatives that may efficiently meet the project objectives.
37. Arranging inputs like drawings, specifications and technical details on time for execution.
38. Providing an organized means for gathering information and compiling records.
39. Identifying and gathering information on project work requirements (grouting, openings, making good, etc.) of all relevant parties and coordinating the time and manner of their execution.
40. Preparing coordination drawings for freezing sequence of activities and giving a road map of responsibilities to all involved in the project.
41. Agreeing on detailed methods of construction with all the parties involved.
42. Coordinating and rescheduling the sequence of onsite work in case of changes in requirement from client side.
43. Interfacing/integrating the work on different subsystems.
44. Establishing and maintaining an effective organizational structure and communication channels.
45. Conducting regular meetings and project reviews.
46. Analysing the project performances on time, cost and quality, detecting variances from the schedule/requirements and dealing with their effects considering time and resource constraints.
47. Monitoring the budget on all activities and taking corrective action.
48. Monitoring the overall functioning of each section and department of the project.
49. Keeping joint records of all drawings, amendments to contract, directives, correspondences, verbal instructions and documents received from the project participants (consultants, clients and vendors, etc.).
50. Keeping joint records of quantities of work done especially of the work that is to be covered up.

51. Keeping joint records of price escalations where the contract has escalation clause.
52. Keeping joint records of owner-supplied materials along with their scheduled delivery dates and actual receipt date.
53. Keeping joint records of all input cost (viz. labour, material, plant, etc.) for non-tendered items.
54. Keeping joint records of adverse weather conditions, breakdown time of client-supplied equipment, etc.
55. Coordinating with offsite fabricators and their deliveries.
56. Acting as liaison with specialist consultants, specialist subcontractors, nominated subcontractors, etc.
57. Maintaining proper relationships with client, consultants and the subcontractor.
58. Acting as liaison with the client and the consultants.
59. Contacting outside authorities for testing, inspection and approval, etc.

APPENDIX 3- INTERVIEW WITH MAIN CONTRACTOR NO. 1

Respondent No. 1- QS/Claims Officer

General- Subcontracting

Q1. What do you take into consideration prior/ when subcontracting works?

A: Whether the subcontractor/ supplier has skilled personnel for performing the works.

Company profile which will show information relating to the company of the registration, tax information

Availability of resources for the job

Cash flow which will inform us whether the subcontractor will be able to pay the contractor or not. Due to the different payment methods and periods, the subcontractor might have to pay the workers before getting paid for work performed.

References for previous work done to check for positives, negatives, issues/ challenges faced by previous employers.

Safety file which will entail the appointment of personnel (managerial), qualifications thereof and quality plans.

Q2. What kind of subcontractors have you employed?

A: We hire domestic subcontractors, labour only subcontractors and supply only.

Domestic- they supply and fit, they bring their own resources, material. They price a lump sum value at the tender stage.

Labour only- supply labour; material is sourced by the main contractor. These are mostly small companies from the local communities/ municipalities around site. The Employer, in a quest to empower the locals, embedded clauses to this effect in the contract. When the main contractor is need of such a subcontractor, he would notify the Employer and the Employer will go his data base where a list is kept and maintained, and forward a list to the main contractor.

Supply only- these just supply us with material

Q3. What work or scope are the subcontractors employed to perform?

A: There are a lot of trades that the subcontractors are employed to execute. These include brickwork & plaster, tiling, painting, electrical works, mechanical works (HVAC), plumbing and drainage, structural steelwork, formwork, Earthing, soil poisoning, fire protection, steel fixing (reinforcement), waterproofing, CCTV, finishes (carpentry and joinery, ironmongery), and roof sheeting.

Q4. What is the size of each subcontractor? (Workforce, capacity, CIDB grading)

A: The sizes range from small to big, the scope of works being performed by the subcontractors varies in magnitude.

Q5. What level/ tier is each subcontractor? - Multilayer Subcontracting

A: Almost all subcontractors are tier one subcontractors. Only one big subcontractor has employed subcontractors of its own. Four second tier subcontractors.

Contracting

Q6. How do you enter into contracts with the subcontractors? (Selection)

A: Labour only- we submit a request to the Employer and the Employer, from the Project data base, selects companies which meet our requirements and we then have separate meetings/ interviews with them, there is no tendering involved. We outline prices/ rates for the works, and then we selected the most suitable based on reputation, workmanship and the financial status and overall wellbeing of the company.

Domestic- normal/ traditional tender process is followed

On all types, over and above what I've mentioned, we have to look at the reputation, cash flow, technical, quality, and safety profiles of the companies.

Q7. Which contract do you use and why?

A: FIDIC Short Form of Contract since the main contract is also FIDIC.

Q8.

a. What is the value of your contract? (The actual figure won't be used in the research but important for the follow-up questions)

A: Not available

b. What is the extent of the total subcontracted work?

c. How much work, in percentage, is each subcontractor contracted to perform?

A: The total subcontracted work ranges from 80% to 90% of the total scope of works

Respondent No. 2- Site Foreman

Coordination

Q9.

a. *How do you coordinate subcontractors' works?*

A: We check the programme for interfacing of the works and the contractors on site. By this we also try to confirm the limited access we have onsite.

We determine the total resources that will be required. These resources (time and labour) will be based on productivity and this is done for all activities.

We then prioritize activities based on/ aligned to the critical path

Perform resource levelling exercise so that no one is idle on site.

Take into consideration the season of the year it is, this affects the duration of the works

Have a meeting with the site agent, site engineer and contract manager to discuss, plan and review possible challenges and obstacles, set reasonable targets & consequences

of late finish, ways of compressing the schedule to create float between activities to allow for unknown delays might they arise

b. What activities do you do when coordinating subcontractors' works?

A: We hold a startup meeting discussing the programme with the workers, we bring all drawings, schedule, pictures/graphics so that all team leads and workers are clearly aware of the work ahead, schedule, and output required

Hold tool box talk every morning to outline the plan for the day. We do this daily even though we have done the overall programme because the workers might forget and we always want to make sure they know what portion should be done on the day

Prepare a method statement which includes a risk assessment for each activity. This is shared at the tool box talk with all workers, so that they are aware of the dangers pertinent to the works and how to work safely while performing each activity

Outline/ review Safety and Quality procedures and work according to them

Continuously checking on the works/ progress thereof.

Monitoring the works- to see if the workers are working according to the plan, safely and are not compromising the quality of the works because if not, there'll be reworks and this means quite a number of things such as demolition of what is done already, redoing the works, remedying the affected parts. This all ends up as additional costs to the contractor such as material costs, more wastage, more time, no progress and other contractors' claims if their works are affected. To also see whether workers are working where they've been assigned to work or not.

Q10. What challenges do you face in performing each of the coordination activities?

A: There are many challenges that I face and amongst them are:

1. Clashing of drawings
2. Changes in drawings
3. Resources that don't arrive on time
4. Weather

5. Absenteeism of resources
6. Strikes on site by other contractors
7. Strikes in communities where the workers reside
8. Sharing access with other packages/ contractors
9. Competency
10. Too many resources than required (affects quality, safety and progress)
11. Delays in inspections
12. Different timeframes for different jobs affecting your job resulting in pressure to finish

Q11. What strategies do you use to overcome the challenges?

A: The strategies include:

1. Every week I do a 3 week look ahead of the schedule to make sure I'm aware of how the programme is being impacted at all times.
2. Communication with site engineers, other supervisors, team leads and workers. This is a very important aspect of coordination and my daily job. I do this by means of emails, holding meetings, calling and sending sms.
3. Revisiting time for working
4. Scheduling resources for multi working
5. Apply the code of conduct policy to deal with absenteeism
6. Planning
7. Following the critical
8. Performing resource levelling (revising plans regularly)
9. Promoting teamwork

Q12. Number of subcontractors you've worked with at a point in time

A: Minimum 4, maximum 10

Q9.

a. How do you coordinate subcontractors' works?

A: On a daily basis:

1. I follow up with my subcontractors, how I do so is that, before any work starts; I transmit all necessary documentation such as drawings, programme.
2. I schedule daily and weekly meetings with the subcontractor
3. Track the work progress
4. Track the procurement progress on what they need to supply, e.g. an electrical subcontractor- I follow up if materials are on site, conduits, wiring is on site.
5. Check if they have people with the necessary skills on site

b. What activities do you do when coordinating subcontractors' works?

A: The activities that I do on a daily basis are:

1. Attending meetings
2. Update a programme, 3 week look ahead which outlines the activities for the next three weeks.
3. Send the 3 week look ahead to the subcontractors as well so that they know what they have to do.
4. Follow up to check whether they are following the schedule

Q10. What challenges do you face in performing each of the coordination activities?

A: The challenges that I face are:

1. Being with a small subcontractor, someone on a small scale, they have a challenge with their suppliers in terms of financing of materials, getting materials onto site. They usually don't have problems with their labour force
2. The other problem is that subcontractors will give you promises on the programme which they cannot meet so that's another one where you need to follow through and do proper planning in terms of your production rates on how they should perform. Those are the main challenges that I face.

3. Basically, with the system that we are running here at Kusile, we have a specific number of subcontractors who have to service plus minus ten to fifteen buildings at a time, the following challenges that we do have is that they don't have enough resources to perform on each and every building. This is where we need to now schedule when to start with what building and move on to the next until you finish off. Those are the basic challenges that we encounter with them on a daily basis.

Q11. What strategies do you use to overcome the challenges?

A:

1. Scheduling of works and resources
2. For an example, our earthworks subcontractor- when we realize that the scope of works in terms of his resource that he has on site and the scope of work are on a larger scale, we try to identify that at least a month in advance to issue them with a letter to mobilize more resources/ plant to fulfil their services and try to keep the people they have mobilized for the couple of months or so, so they don't have to deal with the cost of demobilize after a month as it would not make financial sense.
3. On the other guys we monitor, keep track on the programme and meet daily to check whether they are following the programme and the status and also on the procurement.

Q. You mentioned that some have problems with suppliers and finance, I believe lead time would fall under that, so how do you assist your subcontractors in order for them not delay your schedule as the main contractor?

A: What I would look at is, when a subcontractor comes forward and has a problem with finance in terms of delivery or their financial cash flow is not adequate, maybe due to that they've just started on the project, we do give them an advance payment, but we also schedule a retention at the end of the project to cover the cost paid to the subcontractor in advance.

Q. in terms of lead times, do you assist them in terms of looking for different suppliers?

A: Basically a subcontractor has his own suppliers, we give them what quality standards we want and they have their own supplier where they'll negotiate their own deals. So we don't necessarily find them alternatives unless it has been requested by the subcontractor due to unavailability of suppliers (i.e. not produced in South Africa), then we try to assist and get them the material but it still lies with them in terms of the payments.

Q. moving out of coordination, in terms of what you have done here at Kusile, Kusile is a big project and maybe you have never worked on a project as huge as this one, so what are the site specific challenges you have encountered with dealing with subcontractors?

A: it's basically the ASGISA system, where we need to appoint specific subcontractors from specific areas and you find that those subcontractors don't have the certain skills that we require and the certain qualifications, hence we have to train them. While we are training them, we're losing time, production and financially. If I had to do a project elsewhere, I would employ any subcontractor I want, with the necessary skill that will assist me as well. So the major challenge is the skills level, most of the guys do not have the required skills.

Q. What is the maximum number of subcontractors you have had to work with at one point in time?

A: I've had to work with about 8 subcontractors.

APPENDIX 4- INTERVIEW WITH MAIN CONTRACTOR NO. 2

Respondent - Site Engineer

General- Subcontracting

Q1. What do you take into consideration prior/ when subcontracting works?

A:

We look at the capacity of the company, whether it has adequate resources (manpower & equipment)

The conditions of contract, employer requirements and also the legislation states that the contractor shall upskill local companies and communities, e.g. use of specified subcontractors.

Look at the company's expertise and whether they have the skill or not. e.g. waterproofing works; remedied works would need a specialist subcontractor.

Look at the opportunity to transfer risk and warranties. If the job will require, to some extent, a warranty; then we subcontract and minimize our risk.

Due to the size of the site and magnitude of work, we share the scope.

Q2. What kind of subcontractors have you employed?

A:

We have labour only subcontractors- main contractor supplies materials and equipment for minor works.

Domestic subcontractors

In-house subcontractors

Q3. What work or scope are the subcontractors employed to perform?

A: They work in areas/ do work that needs guarantees/ licensing and therefore needs a specialist.

Minor concrete repairs and all other non-concrete work

Q4. What is the size of each subcontractor? (Workforce, capacity, CIDB grading)

A: Difficult to say due to the change to cost plus.

Q5. What level/ tier is each subcontractor? - Multilayer Subcontracting

A: Level one only

Contracting

Q6. How do you enter into contracts with the subcontractors? (Selection)

A: We go out on open tender.

There are also selected subcontractors and subcontractors nominated by employer.

There are also subcontractors required for BEE compliance.

Q7. Which contract do you use and why?

A: We use the FIDIC short contract for standardization purposes.

Q8.

a. What is the value of your contract? (The actual figure won't be used in the research but important for the follow-up questions)

A: The original contract scope was not clearly defined and input information such as drawings & specifications was not fully supplied.

Scope growth resulted in Site Instructions, Variation Orders, Engineer's Instructions, and claims.

The above makes it difficult for me to establish the value of this contract.

b. What is the extent of the total subcontracted work?

c. How much work, in percentage, is each subcontractor contracted to perform?

A: The challenges faced on this contract and the changes which have resulted make it difficult for me to determine the percentage split in the scope.

Coordination

Q9.

c. *How do you coordinate subcontractors' works?*

d. *What activities do you do when coordinating subcontractors' works?*

A: The original contract was not unitized meaning we had to work from unit to unit. Now the Employer, in 2015, decided to unitize the project. This means now we work on multiple units at the same time with different unit managers. Different managers work differently therefore forcing us not to have a uniform way of coordinating.

Units 5 & 6	Units 2, 3 & 4
a. Hold coordination meetings where we look at the priority activities of the unit. All main contractors working on the unit are present at this meeting. The employer's unit manager is also present. • I then hold a meeting with all my subcontractors, to align them with the schedule. • We prioritize works on the critical path.	a. • Work on instructions issued by the employer to work at an area.
b. • We do a 2 week look ahead for works (based on schedule) and access	b. • No coordination.

(looking only at my readiness to start working at an area). • Hold a daily 7 O'clock meeting with the subcontractors- discuss and outline the plan for the day. • 8 O'clock coordination meeting with Employer and subcontractors (supervisors). Discuss the plan, lay address challenges. • Communication with the subcontractors during the day via emails, sms, calls and our WhatsApp group. • Tracking and monitoring progress during the day. • Hold adhoc meetings with supervisors during the day. Solving identified issues, improvising due to changes. • We receive a weekly programme from the subcontractor, which we discuss and amend accordingly.	
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Q10. What challenges do you face in performing each of the coordination activities?

A:

Units 5 & 6	Units 2, 3 & 4
Due to coordination & proper and timely planning, there are fewer challenges that we face. A these are: • Minor Access issues • Urgent requests' disruptions • Unforeseen circumstances	• Due to the impromptu method of working, access is a major challenge. • We get to an area at which we're instructed to work and we find another contractor working. • No planning which makes the job difficult for us.

Q11. What strategies do you use to overcome the challenges?

A:

Units 5 & 6	Units 2, 3 & 4
Proactive working assists us in avoiding challenges, dealing with/ solving them before they arise. We work on programs with the whole team (planner, procurement, construction, commercial, engineering) to get a consolidated working plan. Track the procurement progress of long lead items to avoid logistics and delivery issues/ challenges. Monitoring and updating of the procurement tracking sheet which have the following fields:	We report back to the Employer for him to fix all access issues. We work very difficult in these units because there's no planning and coordination therefore timely availability of resources is the only challenge we must fix ourselves. Because this is now a cost plus contract, we do not carry the risk of having resources on site and there's no work for them.

• Area at which the equipment will be used • Has it been ordered (Y/N) • Priority • Supplier date • Delivery status Due to planning and coordination, we are well informed of what we'll need and when. This reduces and mitigates any procurement risks.	
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APPENDIX 5- INTERVIEW WITH MAIN CONTRACTOR NO. 3

Respondent – Construction Manager

General- Subcontracting

Q1. What do you take into consideration prior/ when subcontracting works?

A: We look at the capacity of the company

We look at our data base for companies that we know, have worked with before, and have good references.

We look at their compliance to ISO standards, Quality and Safety Regulations

Q2. What kind of subcontractors have you employed?

A: Local subcontractors- both domestic and labour only

Offshore subcontractors for specialized trades

Q3. What work or scope are the subcontractors employed to perform?

A: We have turnkey contracts, normal subcontractors where the main contractor supplies the material to the subcontractors.

The work that we subcontract includes mechanical works, electrical works, control and instrumentation and civil works.

Q4. What is the size of each subcontractor? (Workforce, capacity, CIDB grading)

A: The biggest that we have employs around 300 people each. We also have smaller ones.

Q5. What level/ tier is each subcontractor? - Multilayer Subcontracting

A: All our subcontractors are level one subcontractor except for a few which have been employed by our piping subcontractor.

Contracting

Q6. How do you enter into contracts with the subcontractors? (Selection)

A: We define the scope first

Go on open tender, Request for a Quotation (RFQ)

We must get a minimum of 3 quotations as per the company policies and processes

We then do a technical evaluation, commercial evaluation including pricing and have clarification meetings to make sure that all tenderers are on the same page.

We then recommend to the senior management of the successful tenderer.

Q7. Which contract do you use and why?

A: We use the FIDIC subcontract for uniformity since the main contract is also FIDIC.

We also use the turnkey contract as well

a. What is the value of your contract? (The actual figure won't be used in the research but important for the follow-up questions)

A: Not sure of the exact amount.

b. What is the extent of the total subcontracted work?

c. How much work, in percentage, is each subcontractor contracted to perform?

A: About 80% of the main/ original scope has been subcontracted.

Coordination

Q9.

a. How do you coordinate subcontractors' works?

A. *Through site organization i.e. we've got a construction manager and supervisor for each subcontractor, concentrating and managing the specific subcontractor.*

We receive and review a master schedule from the client, detailing all works and interfacing for project activities and project critical path.

Hold a weekly integration and coordination meeting with the client, where we align our schedule to the project schedule. In this meeting we revise our schedule to meet client required dates for access to other site contractors. We also update our schedule for dates on which access is expected to be available for us and inform the client of our dates so that he can go monitor and manage his other contractors'' works to meet our scheduled access dates.

We monitor subcontractor resources in line with planned work by requesting histograms from the subcontractors.

Hold daily coordination meetings where we have the client, all subcontractors and the main contractor in attendance. In this meeting we outline planned activities, objectives, understand the scope of other subcontractors and issues arising so that we resolve at once.

Execution of crucial and complex activities requires daily meetings to plan, monitor progress and making sure that materials are available, area is ready, quality and safety requirements are taken care of before commencement of the works, etc. For example, we meet one of our major piping subcontractors every morning to discuss the activities and plan for the day.

b. *What activities do you do when coordinating subcontractors' works?*

A: *Communication via the supervisors (calls, emails, sms)*

Follow up on subcontractors for required information including progress

Close supervision

Q10. What challenges do you face in performing each of the coordination activities?

A: We face a challenge of complying with the schedule, slippages by subcontractors

Delays due to material supply

As an offshore company with mostly foreign management employees, language barrier with locals becomes a challenge.

Access delays due to lots of subcontractors in one area (main contractors' and other contractors' subcontractors)

Internal access issues, main contractor's fault.

Q11. What strategies do you use to overcome the challenges?

A: Hold meetings to resolve delay issues and discussing mitigation strategies. These are held between relevant parties from contractor, subcontractor and employer. Sometimes the employer would liaise with his other contractors if they are affected.

We employ local supervisors to enhance communication with local labour

For issues that we need the client for, it is easy for us because we are sitting in the same area with some employer representatives

We have an offsite procurement department comprising of expeditors and quality personnel for our workshop fabrication works.

The supply chain department manages logistics and delivery from suppliers both local and offshore.

Communicate frequently to analyze and solve problems.

Q. What could the reasons for finding idle workers on site be?

A. it is rare to find idle workers on our site because as a construction manager I instruct all supervisors to distribute workers to other areas if there's no work where they were working. This boils down to management of resources and if there's nowhere where they can work, they must be taken to the site office instead of idling around site. We hardly get these situations which are usually for a short period between one to two days.

Q. How many subcontractors do you have?

A. During peak times (beginning of 2016) we had a total of 16 subcontractors

Currently we have 11 subcontractors

APPENDIX 6- INTERVIEW WITH MAIN CONTRACTOR NO. 4

Respondent – Project Planner

General- Subcontracting

Q1. What do you take into consideration prior/ when subcontracting works?

A: Internally, we look at the scope of work to be subcontracted. In deciding, we do not prefer splitting sections as this would lead to coordination struggles/ challenges during execution. You would end up spending too much time and money managing contractors instead of the works; and the lesser the subcontractors the more effective they are. We also look at the company's area of expertise, office structure including factory/ warehouse conditions, company history, company's pricing and capacity.

Q2. What kind of subcontractors have you employed?

A: We use labour only and domestic subcontractors

Q3. What work or scope are the subcontractors employed to perform?

A: We have subcontracted mechanical works, steel structure erection and cladding, electrical and C&I; together with the ACC section which includes supply and installation of mechanical fans, insulation, and painting of fans.

Q4. What is the size of each subcontractor? (Workforce, capacity, CIDB grading)

A: Not aware of this information.

Q5. What level/ tier is each subcontractor? - Multilayer Subcontracting

A:

Contracting

Q6. How do you enter into contracts with the subcontractors? (Selection)

A: We define the scope of works, and go through internal committee for approval. We then advertise on open tender, we give preference to companies that are already working/ have worked at the Kusile Project site as these will have understanding of

the work, social and political dynamics involved. We hold detailed clarification meetings with interested contractors. The tender closes and the evaluation process starts until the contract is awarded.

Q7. Which contract do you use and why?

A: We have used a Turnkey contract for the ACC section and the FIDIC subcontract for other sections/ scopes

a. What is the value of your contract? (The actual figure won't be used in the research but important for the follow-up questions)

A: I don't know.

b. What is the extent of the total subcontracted work?

c. How much work, in percentage, is each subcontractor contracted to perform?

A: Almost 75% to 80% has been subcontracted. We have only kept the supply, erect and commissioning of the Turbine as it requires specialized skill and expertise which is not found in South Africa.

Coordination

Q9.

e. How do you coordinate subcontractors' works?

A. *Firstly, the coordination process for us starts before contracts are awarded. A master Time Schedule is prepared through our planning office. This is then split into the different sections for tender purposes. A tendering schedule (showing the required start and end dates of the project) is issued; which the tenderer must populate into a detailed schedule with all interfaces.*

f. What activities do you do when coordinating subcontractors' works?

A: *We do a three week look ahead to see what activities are coming up in the next three weeks. We hold weekly interface meetings with subcontractors which have*

interfacing activities in a particular section. We hold a daily morning preparation meeting to outline plan for the day and implementation thereof. When we are behind schedule, we hold weekly pull back meetings to pull back the schedule. We communicate through emails, sms and call the subcontractors. We arrange site walks with our subcontractor' representatives.

Q10. What challenges do you face in performing each of the coordination activities?

A: Subcontractor's representatives not delivering on promises/ deliverables. This delays my overall scope and delays other contractors as well. The mentality of workers in that seemingly they don't want the project to finish, as this would mean they would be out of jobs. Due to Project Labour Agreements (PLA) in place, the workers are too comfortable in this project and this makes them want to stay for as long as possible and project to keep on open for longer. This PLA has made provision for benefits such as bonuses, incentives and allowances. The PLA also provides long weekends whereby workers are entitled to leave and not be at work, this then means that there are a few workers available to work through volunteering. Labour Union involvement with how workers work i.e. workers being on a go-slow without any sense of urgency. HR related issues such as sick leaves and unplanned leave application. Access issues in areas where works are to be executed.

Q11. What strategies do you use to overcome the challenges?

A: We have, through past experience, decided to lock interface dates and have enough detail on new contracts. Have learnt from the way in which we worked on the preceding Unit or Units, from the way we manage our subcontractors, the way in which we scheduled and executed activities, sequencing of activities, dealing with paperwork and processes. Try by all means to find amicable solutions at all times. We look at resolving issues without involving contractual/ commercial processes because once this route is initiated, the work might standstill on site/ there might be reluctance to work by subcontractor/ these processes might end in a bad way for the subcontractor which can lead to contract termination. Site walks are the most effective, e.g. when there are access issues on site; I go to site with the subcontractors individually, we discuss the problem causing delay and mitigating plans. Then I meet

with all subcontractors involved, we discuss the problem, effects and come up with the best solution for all parties. I then draft detailed minutes outlining responsibilities, accountable people, and dates for each action item and send to the subcontractors. This assists in making sure that all parties are held accountable and deliver on time. I don't like emails because this method is slow; I might not read all my emails or miss urgent/ important emails.