TITLE PAGE:

THE EFFECT OF USING MULTI-SKILLED WORKFORCE ON THE FLEXIBILITY OF PROJECT RESOURCE SCHEDULING AND PROJECT COSTS: ESKOM PTM CENTRAL GROUP PROJECT EXECUTION DEPARTMENT

By

Thulisile Manyi

Student number: 215080352

A dissertation submitted in partial fulfilment of the requirements for the degree of Masters of Business Administration

College of Law and Management Studies

Graduate School of Business and Leadership

Supervisor:

Dr Rosemary Sibanda

July 2017

SUPERVISORS APPROVAL TO SUBMIT

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

College of Law and Management Studies

Supervisors Permission to Submit Thesis/ Dissertation for Examination

Name: **Thulisile Manyi**	No: **215080352**	
Title: THE EFFECT OF USING MULTI-SKILLED WORKFORCE ON THE FLEXIBILITY OF PROJECT RESOURCE SCHEDULING AND PROJECT COSTS: ESKOM PTM CENTRAL GROUP PROJECT EXECUTION DEPARTMENT		
Qualification: MBA	School: GSB & L	
	Yes	No
To the best of my knowledge, the thesis/dissertation is primarily the student's own work and the student has acknowledged all reference sources	√	
The English language is of a suitable standard for examination without going for professional editing.	√	
Turnitin Report %	**4%**	
Comment if % is over 10%: N/A		
I agree to the submission of this thesis/dissertation for examination	√	
Supervisors Name: **Dr Rosemary Sibanda**		
Supervisors Signature:		
Date:		
Co- Supervisors Name: N/A		
Co- Supervisors Signature: N/A		
Date: N/A		

DECLARATION

I, Thulisile Manyi, declare that:

- The research reported in this thesis, except where otherwise indicated is my original work.
- This thesis has not been submitted for any degree or examination at any other university.
- This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
- This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
  a) Their words have been re-written but the general information attributed to them has been referenced;
  b) Where their exact words have been used, their writing has been placed inside quotation marks, and referenced.
  c) Where I have reproduced a publication of which I am author, co-author or editor, I have indicated in detail which part of the publication was actually written by myself alone and have fully referenced such publications.
  d) This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the thesis and in the References sections.

Signed:_____ Date: / /

ACKNOWLEDGEMENT

First and foremost, I thank God for the success of this project. My sincere appreciation and gratitude extends to all great minds that encouraged, guided and supported this project to the end. In particular, the following individuals:

- To my supervisor, Dr Rosemary Sibanda, thank you for your encouragement, guidance and support from the beginning of this project to its completion.
- My employer, Eskom PTM; for affording me time away from work (all the exams and study leaves), from the beginning to completion of MBA degree.
- Once more, many thanks to Eskom PTM Central Group manager; Etienne Diener, for granting me permission to conduct the research, and the respondents, my colleagues, for their time and co-operation in completing the questionnaire.
- To Hemalyn Bhadersein, this journey started with your letter of motivation to UKZN GSB & L, during MBA degree application to study phase, thank you.
- To the GSB & L staff, for admin support and guidance
- To my MBA colleagues and friends; David Mavukani, Kagiso Gabonewe and Chris Chizondo for encouragement, support and dedication to hard work.
- To Philani Shabalala (GSB&L 2017 MBA graduate), thank you for your big brotherly support.
- To my friends, Ntuthuko Kubheka, Bantu Qikani and Lucille Govender.
- To my life coach, Brian Sanele Shabalala, thank you so much.
- To my family thank you so much for your understanding and support.
- Lastly, a special gesture of gratitude goes to my soon to be wife, Nolubabalo Sohaba, for all the support and motivation over the past two and half years. Thank you for being a my pillar of strength and a wonderful mother to our two year old son Kayone Manyi, our new source of courage to achieve more, thank you.

ABSTRACT

The introduction of multi-skilling within organisations is normally conducted with the aim of improving efficiency, quality, production and cost effectiveness. The study addressed the effect of using multi-skilled workforce in the execution of project activities by studying the changes in project execution resource scheduling flexibility and project costs in response to workforce multi-skilling strategy. A quantitative research design was used, to test the concept of workforce multi-skilling to predict its influence on project resource scheduling, project cost saving, project duration, effect on optimal utilization of project technicians and members if adopted at Eskom PTM Central Group department. An electronic questionnaire was distributed to collect data and statistical analysis of data was conducted. The hypothesis testing performed concluded as follows; there is evidence that the use of multi-skilled workforce provides for flexible project resource scheduling as much as 3.3 times. However, there is probably no positive relationship between multi-skilled workforce and project costs. Further results indicated that using multi-skilling has 3.3 times negative significant impact on project duration. On the other hand, the use of multi-skilling could have as much as 3.8 times positive significant impact on job redesign. And lastly, the use of multi-skilling could have up to 3.5 times positive significant impact on multi skills adoption rate. It is recommended that for Eskom PTM Central Group to realize full benefits of multi-skilling strategy in project execution there must be an action to fast-track cross-skilling initiatives with the aim of reducing time taken to complete a task and ultimately improve the influence of multi-skilling on project duration and costs. This research contributes to knowledge of engineering project management staffing of teams and effective management of operations. The arrangement of research objectives was a carefully thought out exercise to allow for research results to be quantified and generalized to the research site, to enhance business decision making.

Key words:

Multi-skilling, flexible project scheduling, project costs, project duration, job redesign, multi skills adoption.

TABLE OF CONTENTS

LIST OF FIGURES:

Number **Description** **Page**

LIST OF TABLES:

Number **Description** **Page**

LIST OF ABBREVIATIONS:

CoE	CENTRE of EXCELLENCE
CPM	CRITICAL PATH METHOD
DC	DIRECT CURRENT
DIFF	DIFFENCE
ECSA	ENGINEERING COUNSEL of SOUTH AFRICA
EEF	ENGINEERING EMPLOYERS FEDERATION
H_0	NULL HYPOTHESIS
H_1	ALTERNATE HYPOTHESIS
HRD	HUMAN RESOURCE DEVELOPMENT
PCA	PRINCIPAL COMPONENT ANALYSIS
PEM	PROJECT ENGINEERING MANAGER
PERT	PROJECT EVALUATION and REVIEW TECHNIQUE
S&M BAND	SPECIALIST & MANAGEMENT BAND
T11	TECHNICAL GRADE 11
T12	TECHNICAL GRADE 12
T13	TECHNICAL GRADE 13

SUMMARY OF CONTENTS:

1. **CHAPTER ONE**: INTRODUCTION AND OUTLINE OF THE RESEARCH PROJECT
2. **CHAPTER TWO:** LITERATURE REVIEW
3. **CHAPTER THREE:** RESEARCH METHODOLOGY
4. **CHAPTER FOUR:** ANALYSIS AND INTEPRETATION
5. **CHAPTER FIVE:** DISCUSSION
6. **CHAPTER SIX**: CONCLUSION AND RECOMMENDATIONS
7. **REFERENCES**
8. **APPENDICES**

1 CHAPTER ONE: INTRODUCTION AND OUTLINE OF THE RESEARCH PROJECT

1.1 INTRODUCTION

Nowadays, business peak level performance greatly relies on continuous development of human resource policies. For this reason, most organizations consider human resource labour as the most important aspect of production, as well as the most indispensable form of capital, a main source of competitive advantage and vital to normal operations of the organization. Accordingly, the most effective advancements to attaining competitive superiority in the current business environment are in the improvement of employee proficiency (Saravani & Abbasi, 2013).

It is only in developed countries that multi-skilling has been recorded as successful in carpentry and piping; crane operation and truck driving as model to improve project labour cost, control project duration and reduce idle times between activities (Attia, Duquenne & Le-Lann, 2013). The increasing need for production companies to rapidly respond to market volatility is however consequential because it creates a strong demand for flexibility in the operational processes of business (Attia, et al., 2013). The concept of multi-skilling promises to bring about flexibility in operational processes in a win-win approach where the company reduces its overall labour costs and on the other hand the multi-skilled employee income increases (Saravani & Abbasi, 2013). An effective well targeted training aimed at multi-skilling of workforce in production services can be a powerful force in addressing current skills shortages in manufacturing (Puttick, 2008).

This research study aims to examine the effect of using multi-skilled workforce in the execution of project activities by studying the changes in project execution resource scheduling flexibility and project costs in response to workforce multi-skilling strategy and the use of job redesign to facilitate multi-skilling. The knowledge gaps identified in the literature review informs the purpose, research objectives, hypothesis and significance of the study.

The major sources of information for this study range from published books', peer reviewed published journals, conference publications, periodic articles as well as

newspaper articles. The database sources that were used were EBSCOhost, Google Scholar, Science Direct and Emerald Insight. The selection of sources was based on relevance of information to the topic under research, credibility of the sources and year of publication.

1.2 BACKGROUND TO THE STUDY

The rising complexities in operational performance of companies to adapt to changing environment, the effect of globalization on production performance, national economies and trading, have posed a question to the South African Human Resource Development plan. According to Human Resource Development report, HRD-SA (2009), economic competitiveness is not only measured by total workforce skills nationally, but by capacity of flexible workforce that can adjust quickly to the rapid advancement in technology, productivity, trading and industry. Consequently, poor capacity to react to these challenges with effective speed and proficiency leads to loss of competitive advantage. As a result, during the 2008 world economic recession companies were forced to shed jobs to sustain operational costs and in that companies realized the need for adaptive workforce that can competently perform duties beyond their job description, thus a new breed of workforce with the ability to take on multiple project roles (Testa, 2010).

The increasing moves made by South Africa within the sphere of international markets is noteworthy, but also notable is the general lack of skills acting as contributing stumbling block to the country's on-going growth and development (Dickson, 2003). The mining industry in particular amongst other engineering industries in South Africa is faced with endless human resource challenges resulting from increased global competition, production demands, shortages of scarce skills and high turnover rates (Motsoeneng, Schultz & Bezuidenhout, 2013). South Africa is faced with engineering skills shortage, considering the latest Engineering Counsel of South Africa (ECSA) results, in the country there is only a total of 15 000 engineers and one engineer approximately services 2666 people meanwhile overseas one engineer services 40 people (Tancott, 2014).

The ageing engineering workforce is a global phenomenon; the problem is that South Africa is likely to continue being a destination for skill poaching by developed countries (Makholwa, 2010). The skills shortage in South Africa stems

from inadequate investment in skills development, education, the rise of migrating highly skilled professionals, increasing demand in production, the country's incapacity to utilize and retain human resource skills (Mateus, Allen-Ile, & Iwu, 2014).

The increasing competition in the engineering industry is reactive means to survive international market rivalry and a potential solution that promises yield to competitive advantage within the engineering industry is the workforce multi-skilling strategy with adaptive work organization to allow for use of combined skill sets (Dickson, 2003). Similarly, Singh and Shah (2014), the most difficult challenges confronting the engineering industry are the limitations in the availability of skilled workforce and the increasing demand for production and cost efficacy. The solution some companies use to overcome such challenges is the workforce multi-skilling strategy as reactive means to improve production levels and reduce operating costs. This shift in thinking led many companies to the adoption of workforce labour multi-skilling, allowing workers to work across multiple disciplines (Lee & Nam, 2013).

1.3 RESEARCH SITE BACKGROUND

Eskom PTM is a division of Eskom Group Technology; a mandated critical technical service provider to predominantly Eskom Generation, as well as project associated technical services to Eskom Group Capital, Transmission and Distribution. This business unit also offers engineering support services, commissioning and maintenance of Power Electronics, Electrical Protection, Automatic Voltage Regulators, Supervisory Control and Security Systems, Specialised Electrical Tests on Power Transformers, Electrical Calibration Services, Metering and Measurements, Industrial Air-conditioning and Electronic Card Repairs. In essence, Eskom PTM business unit is involved on all critical paths of major projects; refurbishment work and green field build projects that involve the above competencies within the Generation environment.

Eskom PTM has offices in Johannesburg, Durban, Cape Town, Bloemfontein, Klerksdorp and Witbank.

1.4 FOCUS OF THE STUDY

The study seeks to evaluate the effect of using multi-skilled workforce in the execution of project activities by studying the changes in project execution resource scheduling flexibility, project cost savings and duration of projects in response to workforce multi-skilling strategy and the use of job redesign to facilitate multi-skilling at Eskom PTM Central Group department.

1.5 PROBLEM STATEMENT

Eskom PTM delivers critical project execution services, commissioning and maintenance support of electrical engineering systems for Eskom Generation, Transmission, Group Capital and Distribution. This business unit is located in Johannesburg, Durban, Cape Town, Bloemfontein, Klerksdorp and Witbank.

Eskom PTM Central Group department consists of a mix of electrical engineering disciplines; Telecontrol, Protection, Metering, DC Power Sources and Air Conditioning. However, technician training and development is restricted to one of the disciplines mentioned above and as a result technicians focus only on one part of project execution scope of work. Being that, projects usually carry idle time labour costs, experience endless problems when it comes to project scheduling of teams and project duration overruns due current use of single skill specialization and thereby limiting technician utilisation and productivity.

1.6 PURPOSE OF STUDY

The study examines the effect of using multi-skilled workforce in the execution of project activities by studying the changes in project execution resource scheduling flexibility, project labour costs and duration of projects in response to workforce multi-skilling and the use of job redesign as strategy to facilitate adoption of multi-skilling. A quantitative research design was used, to test the concept of workforce multi-skilling to predict that its adoption influences project resource scheduling, project cost savings, project duration and leads to optimal utilization of project technicians and members at Eskom PTM Central Group department. An electronic questionnaire instrument was used to distribute, collect and analyze data using statistical analysis tools.

1.6.1 Specific Objectives

The objectives indicate goals of a research study (Creswell, 2014). With that in mind, the objectives of this study are as follows:

- To measure the influence of multi-skilling on flexibility of project scheduling
- To evaluate the relationship between multi-skilling and project labour costs
- To study the effect of multi-skilling on the duration of the project
- To evaluating multi-skilling and adoption of multi skills
- To evaluate the use of job redesign to facilitate workforce multi-skilling

1.6.2 Research Hypothesis

Hypothesis statements are predictions made by the researcher about expected results findings (Creswell, 2014). Therefore, following are research hypothesis statements:

$H_1$1: The use of multi-skilling provides for flexible project resource scheduling

$H_1$2: Multi-skilling has positive effect on the project cost savings

$H_0$3: The use of multi-skilling has no significant impact on project duration

$H_1$4(i): There is a positive relationship between multi-skilling and job redesign

$H_1$4(ii): Multi-skilling has a positive impact on adoption of multi skills.

1.7 SIGNIFICANCE OF THE STUDY

The strategy of multi-skilling is commonly found in the manufacturing and process industries where some of the labour force is trained to be multi-skilled (Abotaleb, Moussa & Hussain, 2014). Although multi-skilled labour scheduling and optimization is discussed in literature as early as the 1990s, there is limited literature available on the topic of job redesign and rotation of roles as means to facilitate multi-skilling and influence project resource scheduling, duration of projects and reduce project costs. But, recent research reveals that the use of multi-skilling in the construction industry leads to increased productivity, flexibility, and work continuity (Liu & Wang, 2012). Therefore, this study proposes to investigate the effect of job redesign as one of the tools that can be used to

facilitate workforce multi-skilling to influence project resource scheduling, reduce project costs and project duration.

1.8 DELIMITATIONS OF THE STUDY

The research topic only limits the scope of the study to the influence of workforce multi-skilling on project resource scheduling, project cost savings, project duration, and adoption of multi-skilling at Eskom PTM Central Group section. The participation of the study was limited to only Eskom PTM Central Group department employees.

1.9 EXPECTED OUTCOMES OF THE STUDY

According to Saravani and Abbasi (2013), the concept of multi-skilling purports a promise to solve increasing labour cost problems in a win-win manner, the company reduces its overall labour costs meanwhile multi-skilled worker income demand increases. Therefore workforce multi-skilling will prove to have a positive effect on the project costs. There will be a positive relationship between job redesign, job rotation and multi-skilling, Koike (1977) observed that typical Japanese companies offer their employees with more company specific skills by rotating them among interrelated jobs (Morita, 2005).

1.10 DEFINITION OF TERMS

1.10.1 Multi-Skilling

Multi-skilling as defined by Engineering Employers Federation (EEF) is the attainment of additional skills, complementing those previously acquired in a given job. While, multi-skilling is defined as a means of removing traditional divisions separating disciplines in work areas and giving responsibility to individuals well trained for a range of different types of activities and three dimensions of multi-skilling are; vertical, horizontal and depth multi-skilling (Singh & Shah, 2014). Multiskilling is a labour force strategy that shows to decrease indirect labour costs, increase productivity, and reduce staff turnover. Multi-skilled labour force are workers who possess a range of skills that allow for participation in more than one work process (Gomar, Haas & Morton, 2012).

1.10.2 Vertical Multi-Skilling

The employee takes on supervisory/administrative tasks such as overseeing/leading a self-managed team (Singh & Shah, 2014).

1.10.3 Horizontal Multi-Skilling

The employee takes on a different task at the same level of his/her normal tasks (Singh & Shah, 2014).

1.10.4 Depth Multi-Skilling

The employee takes on a set of complex skills acquired within the same job grade in order to offer a better overall service (Singh & Shah, 2014)

1.10.5 Training

Training is the process of developing a worker's skills, learning new concepts, rules or attitudes in order to increase effectiveness on a particular job (Abomeh & Peace, 2015).

1.10.6 Kaizen Concept

Kaizen refers to continuous improvement involving everybody in the organization from top management to functional level workers (Singh & Shah, 2014).

1.11 ASSUMPTIONS

The assumption under the study based on review of literature in chapter is that Multi-skilling leads to increased operational performance and reduction in labour cost regardless of industry or application as long as the idea and change management systems are landed properly.

1.12 DISSERTATION STRUCTURE

Chapter one of this research offers perspective from both world and local view stand points, chapter two is the review of literature, chapter three is the research methodology, chapter four is the analysis and interpretation of results, chapter five is the discussion of results and chapter six concludes the study.

1.13 CHAPTER SUMMARY

This chapter presented the background of the study together with the research site, problem statement, purpose of the research, main objectives of the study and the hypothesis statements. Also the significance of the study, delimitations and the expected outcomes of the study were provided in this chapter.

In the next chapter, the literature pertaining to the effect of using multi-skilling on project labour resource scheduling, project cost savings, project duration, job redesign and the prospects of multi-skilling adoption was reviewed and discussed in-line with research objectives and hypothetical statements. Chapter three, provides the research methodology for the study, then chapter four presents the results findings of the study while chapter five discusses the results findings in detail. And lastly, chapter six concludes the research study and answers the main research problem and also provides recommendations.

2 CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

The introduction of workforce multi-skilling within organisations is typically carried out with the aim of improving efficiency, production, quality and costs reduction. Recent research reports that the majority of case study companies had used multi-skilling as part of their process of reorganisation (Horbury & Wright, 2010). In a like manner, the quest by businesses and leaders to find ways to improve productivity and cost effectiveness has led many companies to the adoption of labour multi-skilling practice, where workers can work across traditional occupational boundaries (Adamu, Nensok & Aka, 2012).

This study seeks to examine the effect of using multi-skilled engineering workforce in the execution of project activities by studying the changes in project execution resource scheduling, labour cost savings and project duration in response to the workforce multi-skilling strategy and use of job redesign to facilitate workforce multi-skilling at Eskom PTM Central Group. As part of study investigation the four hypothesis statements were developed based on conducted critical literature review; $H_1$1: The use of multi-skilling provides for flexible project resource scheduling, $H_1$2: Multi-skilling has positive effect on the project cost savings, $H_0$3: The use of multi-skilling has no significant impact on project duration, $H4_1$(i): There is a positive relationship between multi-skilling and job redesign, and $H_1$4(ii): Multi-skilling has a positive impact on adoption of multi skills.

The major sources of information for this study range from books; peer reviewed published journals, conference publications, periodic articles as well as newspaper articles. The electronic database sources used were EBSCOhost, Google Scholar, Science Direct and Emerald Insight. The selection of sources was based on relevance of information to the topic under research, credibility of the sources and year of publication. The background gives an overview of the study and the body of the literature review focuses on the study variables to expose the gap in the knowledge of the study.

2.2 BACKGROUND TO THE NEED FOR MULTI-SKILLS

The concept of multi-skilling arguably traces back in time to when mega structures like the Egyptian pyramid and the Great Wall of China were built (Nwaogazie, Augustine & Henshaw, 2016). Presently, the world's financial system has undergone tremendous changes in recent years and the immense competition created has given rise to the three buzzwords in the business world that is; targets, deadlines and performance (Sushil, 2014). As a result, global trends suggest that skills shortage is a worldwide occurrence; hence countries, states and businesses all over the world continuously express unhappiness regarding the shortage of skilled professionals in various sectors of their economies (Mateus, Allen-Ile, & Iwu, 2014). The growing need for reaction to market volatility raises a strong demand for flexibility in organizational operations and call for businesses to develop strategies for short, medium and long term in order to preserve and develop their workforce skills (Attia, et al., 2013).

A fundamental question in job design is whether employers should have employees specialize in certain tasks or whether workers should be multi-skilled so that they are able to perform multiple tasks (DeVaro & Farnham, 2010). Adeyoyin, Agbeze-Unazi, Oyewunmi, Adegun and Ayodele (2015), refer employee specialization to individuals and organizations that only focus on the limited range of production tasks they perform best and this requires workers to give up performing other tasks at which they are not as skilled, leaving those jobs to other employees who only perform those tasks. However, multiple skills training has increased its importance in today's intense business environment of global competition and fast changes where jobs are complex and ambiguous (Kagona, Shukla & Oduor, 2015). In addition, DeVaro and Farnham (2010), points out the advantage of multi-skilling relative to specialization is in the flexibility of labour allocation and utilization, since multi-skilled workers are able to adjust from one task to another in response to changing production requirements. As a result, certain project management organizations realized the necessity to conduct training courses for their employees (Maylor, 2010).

2.3 THE CONCEPT OF MULTI-SKILLING

The most serious challenges confronting labour intense industries today is the limited access to skilled workforce; seeing the increasing need for cost effectiveness and productivity, some companies have already started using multi-skilling as potential solution (Singh & Shah, 2014). Also, the rise in competition levels across industries has made competence to be regarded critical for business to maintain long term competitive advantage. Subsequently, firms are forced to realize the need to develop innovative technical competency measures that warrants the use of multi-skilling; narrowly defined as utilization strategy where an employee possess a range of skills appropriate for more than one work process (Akinola, Ogunsemi & Dada, 2015). This means, organizations may introduce multi-skilling as support to business strategic changes aimed at improving efficiency, product quality, production rate and competitiveness, as well as cost effectiveness. The concept of multi-skilling allows firms the flexibility to reallocate labour resources in response to volatile industry demands (DeVaro & Farnham, 2010).

Multi-skilling as defined by Engineering Employers Federation (EEF) is the attainment of additional skills, complementing those previously acquired in a given job. In addition, multi-skilling is also referred to as means of removing traditional divisions separating disciplines in work areas and giving responsibility to individuals well trained for a range of different types of activities and multi-skilling has three dimensions; vertical, horizontal and depth multi-skilling, however in most situations a combination of all three is ideal (Singh & Shah, 2014). Similarly, multi-skilled labour force are workers who possess a range of skills that allow for participation in more than one work process (Gomar, et al., 2012).

The presence of multi-skilled human resource labour in a crew increases productivity through the reduction of inefficiencies, supervision requirements and through on job training help close skill gaps amongst employees (Ahmadian Fard Fini, Rashidi, Akbarnezhad & Waller, 2016). Furthermore, literature from recent research view adoption of multi-skilled workforce as strategy to increase productivity, decrease indirect labour costs, and reduce staff turnover (Abotaleb, et al., 2014).

Accordingly, the concept of multi-skilling compels workers to be more competitive, and that allows workers to be scheduled longer on a project therefore allowing for more utilization and flexible resource scheduling in-cases such as unforeseen maintenance activities, because multi-skilled workforce possesses a wider variety of skills (Irene, 2009).

Even though, the distribution of work to workers is an important and common task for companies with high labour intensities, however, it is particularly complex if the workforce are multi-skilled individuals with different skill efficiency levels due to learning and depreciation of knowledge depending on the tasks assigned to (Heimerl & Kolisch, 2010). For this reason, companies must see the need to invest and develop their employee skills in similar system to plant maintenance, improvement of equipment and infrastructure (Motsoeneng, et al., 2013).

For instance, companies can provide their new career employees with multiple skills for different jobs by incurring extra costs for their human capital accumulation, so that the employees can obtain a good understanding of the firm's entire work process through their acquisition of multiple skills (Morita, 2005). Moreover, the best way to help entrench multi-skilling as organizational work culture opposed to strategy is through the use of kaizen, and the application of this concept works from grass-root to highest structures of an organization (Singh & Shah, 2014). Employees perceive training as a piece that allows them to improve their skills to offer customers better services and on the other hand for the company, training employees shows a strong commitment on employees and also demonstrates the value that an employer has on the employees (Kepha, Assumptah & Dismaso, 2014). Table 2.1 shows differences between multi-skilling and work specialization.

Multi-Skilling and Work Specialization Comparison;

Table 2.1: Comparing multi-skilling to work specialization

Multi-Skilling	Work Specialization
Makes employees stretch to the limits.	Jobs can become too simplified.
Needs constant support and thorough guidance throughout the process of acquiring multiple skills.	Employees become bored and tired, safety problems and accident rates increases.
Being a developmental process makes it slow.	Absenteeism affects operations.
Very sensitive issue, it is imperative to find a right person for a right job in a right space of time.	Quality of work may suffer.
Small businesses by necessity have multi-skilled people.	Industries employ specialized workers.

Source: Adapted from Singh, V. & Shah, S., 2014.

The research shows that the benefits of using multi-skilling are labour cost savings and reduction in workforce needed and also beneficial to workers because multi-skilling enables increase in average employment duration of construction workers and earning potential (Irene, 2009). Proper utilization of multi-skilled workforce should lead to savings due to lower turnover rates, high productivity rate and reduced accidents (Burleson, et al., 1998). Considering the need for companies to improve productivity and at the same time ensuring cost effectiveness has led some companies to adopt labour workforce multi-skilling as strategy for competitive advantage (Singh & Shah, 2014).

2.3.1 Research Studies about the Concept of Multi-Skilling

The study by DeVaro and Farnham (2010) to evaluate a product market volatility on a firms choice between multi-skilling and skill specialization was conducted based on a theoretical model that captured trade-offs between multi-skilling (greater flexibility to schedule workforce in production) and specialization (which shapes workers to be experts in responding to product market signals in their area of specialty). The study was conducted using 2004 Work Employee Relations Survey questionnaire and the data was nationally representative stratified random sample covering British workplaces with at least 5 to 9 employees. The findings were that greater volatility is substantially associated with greater specialization, but consistent with the model, the results hold only in multi-product companies. However the study was conducted inside and outside manufacturing suggesting the focus of the study broad and it did not consider multi-skilling in engineering project execution work.

The research by Irene (2009) to improve management strategies, decrease the mismatch between required and available skilled labour and to discuss the consequences of ignoring the interests of craftsmen. This quantitative study was conducted in the construction industry of Estonia, comparing multi-skilled to single skilled construction craftsman production outputs. The results analysis showed that no matter how volatile the construction project is, the composition of labour resources by trades is stable if employer uses multi-skilling. Whereas for single-skilled labour resource overloads and idle time periods would be unavoidable. However the study conducted in construction industry and it did not focus on engineering project execution work part of buildings construction work.

2.4 ESKOM DELIVERY PROJECTS: PROGRAMME MANAGEMENT PROCEDURE

Eskom programme management division assists the organisation to effectively, track, steer and manage projects from a strategic, enterprise orientated perspective. In line with the overall Eskom business strategic objectives there is currently a need to improve on cost management in the form of cost containment, accurate projections and control over expenditure (Eskom, 2016).

Objectively, programme management strives to enable the tracking of an aggregation of projects to oversee resource allocation, prioritize on-going investment decisions and track projects costs, schedule, risks and benefits as part of an overall programme management (Eskom, 2014).

2.4.1 Roles and Responsibilities

The Project engineering manager is responsible for the overall engineering effort including managing the integrated engineering team and coordinating technical effort with suppliers, contractors, and consultants as well as managing all internal Eskom processes and departments. The project planner provides resource scheduling, project controls tools, standards and services to support the Project engineering manager.

The Project team members are required to provide a weekly progress sheet and timesheet to the relevant Planner. This will provide the PEM and CoE manager with the necessary control tools to ensure the project is on track as well as the costs are booked and approved correctly within projections and according to the budget allocations. Lastly, project technicians ensures start to finish delivery of the final engineering solution. They co-ordinates and integrate design work provided by Design Engineering discipline to produce an integrated product (Eskom, 2016).

2.4.2 Measuring Project Delivery

The factors to consider when measuring project delivery success is a topic greatly debated by scholars, but it is generally agreed that for a project to be deemed successful, the project must be suitable for purpose and achieve all deliverables, however, time, cost and quality remain as central project management delivery targets (Brown, Adams & Amjad, 2007).

In contrary, traditional project management systems that entirely pursue success criteria of time, cost, quality and achieving technical requirements have been considered ineffective, with the shift focusing on multiple stakeholder expectations (Mir & Pinnington, 2014). Even though, the success of a project depends on completion of work before due date, within the project budget and achievement of technical deliverables, to some cases these limits are circumvented to lessen scheduling pressures through the use of a technique called project activity

crushing to help finish activities quicker and ultimately the project (Kim, Kang & Hwang, 2012). Good to note is that, in a business with flexible staff complement possessing multi-skills, planning of activities and project resource scheduling focuses on stakeholder needs than on staff capabilities (Rajendra, 2016).

2.5 PROJECT RESOURCE SCHEDULING AND COST

The use of labour workforce scheduling to correct overstaffing and or understaffing in the service industry across multiple projects is often challenged by lack of flexibility due to exclusive use of specialist labour force (Henao, Munoz & Ferrer, 2015). An organization with multi-skilled personnel enjoys flexible labour-force benefits which provide the employer ability to schedule and arrange workforce to best suit the needs of the business (Rajendra, 2016). This section examines the impact of assigning multi-skilled employees to different activities, study schedule efficiency and measure implications on cost savings.

Labour resource scheduling is a process of putting together a work timetable and assign staff to activities accordingly to help meet organizational service demands. And, this involves determining the number of workers with certain skills needed to complete a specific project task (Zha & Zhang, 2014). Consequently, this makes it extremely difficult to determine optimal solutions that minimises costs, meet workforce preferences, allocate activities equitably among labour resources and fulfil all the workplace constraints (Brown, et al., 2007).

As a result, companies provide project managers with the decision tools, such as spreadsheet and database tools to help schedule the right employees at the right time and at the minimal cost while ensuring high level of employee job satisfaction (Ernst, Jiang, Krishnamoorthy & Sier, 2004).

Concurring, with the rise in labour costs, project managers pay more attention to achieving optimal project resource scheduling to help reduce labour costs while ensuring product quality (Qin, Liu & Kuang, 2016). Recent literature reveals that utilization of multi-skilled labour resources in construction allowed for a flexible schedule and thereby improving productivity and reduction in indirect labour costs (Abotaleb, et al., 2014). Usually, the concept of multi-skilling is commonly found in the manufacturing and process industries, where some of the labour force is trained to be multi-skilled (Hegazy, Shabeeb, Elbeltagi & Cheema, 2000).

Meanwhile, the challenge with scheduling single skilled human resources is a well-known problem in project management, project scheduling with multi-skilled workforce is an extended problem due to the fact that this option requires a multi-skilled staff compliment as it assumes that any resource can competently perform a project task that requires a range of skills (Zha & Zhang, 2014).

Similarly, the advantage to multi-skilled resource strategy is that of which each worker possesses multiple skills which allows them to participate in any activity that fits one of their skills and this has been proposed to improve project workforce resource scheduling and utilization (Jaskowski, 2013).

However, assigning project work to human resources taking into account resource specific skills and efficiencies is a general planning task that has to be performed in any organisation (Heimerl & Kolisch, 2010). For example, project resource scheduling in construction projects is mainly affected by unpredictable factors such as cash flow and design changes (Arunadhevi, 2016). There are quite a number of different scheduling models established to reduce activity durations and hold-ups in projects, however most of these methods assume single skilled labour (Abotaleb, et al., 2014). For many years, the two approaches that have been proven to be useful in planning, scheduling and controlling construction projects have been the Critical Path Method (CPM) and the Project Evaluation and Review Technique (PERT) (Agyei, 2015).

However, research has shown that traditional scheduling techniques such as PERT and CPM are not suitable for handling linear projects (Liu & Wang, 2012). Given the rapid advancements in computer technology, more heuristic algorithms are now available to deal with complex linear scheduling challenges involving work efficiency and resource task allocation (Liu & Wang, 2012). These methods allow project managers more control of the schedule and to better estimate the early and late times at which activities can start and finish, calculate activity slack, outline critical activities, and assess the impact of changes in duration, logical relations and cost on the overall project duration (Render, et al., 2015).

Therefore, the success of multi-skilling strategy greatly relies on the project manager’s ability to schedule workers to appropriate tasks and compose teams effectively. Hence why, project managers still need to have important-

competencies in project scheduling and staffing of human resources, especially when facing the problem of labour resource skills constraints (Chan, 2014).

The study conducted by (Abotaleb, et al., 2014), shows that the use of multi-skilling handles one major concern; which is labour wages costs efficiency also referred to as specialist idle time cost. Figure 2.1 shows an example of a project where a carpenter was required to do carpentering activities from day 0 to day 5 and from day 9 to day 12, then he would be idle from day 5 to day 9 (4 days) but he would be paid his daily wage of 12 days (project duration) regardless of the fact that he worked for only 8 days.

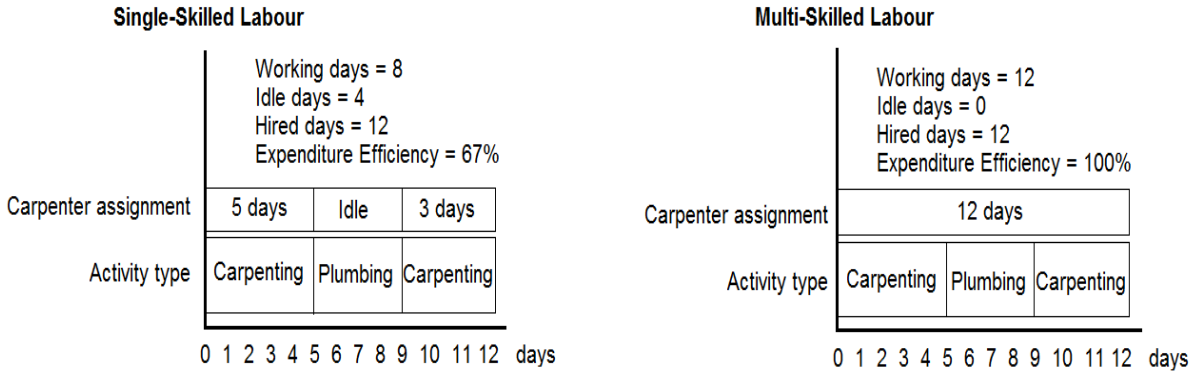


Figure 2.1: Labour wages expenditure efficiency

Source: Adapted from Abotaleb, I., Moussa, M. & Hussain, S., 2014.

Notably, with the use of multi-skilling labour resource, the carpenter would work in carpentering from day 0 to day 5, then from day 5 to day 9 he would take on plumbing, and then from day 9 to day 12 he goes back to work on carpentering; therefore having no idle days, as result multi-skilling maximizing the expenditure efficiency as illustrated in Figure 2.1.

An organization that has adopted multi-skilling can operate with a reduced number of employees to fulfil business operations, since multi-skilled employees move with the workload instead of waiting for the work to come to a stage where a specialist skill is needed and this leads to fewer idle work hours as a result reducing project-costs (Rajendra, 2016).

Accordingly, effective scheduling of multi-skilled labour resources reduces the project activity duration overruns and lags between activities, otherwise unavoidable when using single-skilled labour resources (Lill, 2009). The first three hypothesis statements of the study are as follows:

$H_1$1: The use of multi-skilling provides for flexible project resource scheduling

$H_1$2: Multi-skilling has positive effect on the project cost savings

$H_0$3: The use of multi-skilling has no significant impact on project duration

2.5.1 Research Studies on Multi Skilling, Project Scheduling and Cost

A study conducted by (Zha & Zhang, 2014), to develop a model to address the project scheduling problem with multi-skilled worker, in which autonomous and induced learning are both considered, to help assist the project manager to determine the start time, the finish time, and resource scheduling for each activity, Moreover, combined with the total cost formulation, the project manager can balance the project make-span with the total cost. The results show that each level of induced learning corresponds to a combination of project make-span and total cost. By means of determining the level of induced learning, the project manager can balance them in project scheduling. However the study was conducted in China as experiment and was not focused to any industry.

Lui and Yang (2011) created a model aiming at reducing total costs of the project through use of multi-skilled labour. The model takes into consideration a number of variables not discussed in previous models such as the overtime cost and the number of skills per employee. Be that as it may, there was no strong validation provided by comparing the output with conventional techniques or rather actual projects as examples.

Burleson, Haas, Tucker et al.,(1998) made known to some multi-skilling strategies such as dual-skill strategy, four-skill strategy, four-skill-helpers strategy, and unlimited-skill strategy as means to prove the benefits of the multi-skilling concept. The four strategies were compared by comparing the economic benefit of each of them in a $70,000,000 construction project. The findings were that the proposed multi-skilling strategies resulted to a reduction in project labour cost by 3% - 20%.

However, the mechanism for selecting the best strategy for a given project was not developed.

Henao, Muñoz and Ferrer (2015) conducted a study on the impact of multi-skilling on personnel scheduling in the service sector; a retail case. The study compared the impact of using multi-skilled resources to specialist resources on the efficiency of the schedule. The results showed that multi-skilled personnel may be a cheaper option compared to hiring part-time specialized staff, however depending on cost of training required to upskill staff and therefore a balance between multi-skilling and part-time specialist contract was found to be desirable in the retail sector.

2.6 JOB REDESIGN

In the 21st century competitive business world, considering new ways and means for creation of organizational efficiency is inevitable, given the rapid changes in the external business environment resulting to huge impacts to internal operations (Saravani & Abbasi, 2013). For example, the demand to satisfy customers, regulators, skilled workers, social activists and shareholders increases pressure on businesses to deliver excellent performance while maintaining diverse stakeholder needs at the same time (Tarus, 2014). Therefore, a new method of job design is necessary to motivate managers to adjust to changes presented by business environment, technological advancements, shareholder needs and workforce motivation. Job rotation is one of the most effective methods for empowering human resource (Saravani & Abbasi, 2013).

Job rotation means a planned out reshuffling of human resource labour between jobs for a period of time with the aim of cross skilling, ensuring job independency and increasing employee motivation (Saravani & Abbasi, 2013). Job rotation is particularly the product of Japanese companies' employment policies to ensure the attainment of knowledge and skills which help workers adapt to changes in technology and in the process improving value of the employees in labour market (Kaymaza, 2010). Furthermore, when businesses provide workforce with a large amount of firm-specific human capital, those workers become less subject to poaching by other companies, thus reinforcing returns on training investments made by the firm through job rotation (Morita, 2005).

Job redesign and rotation enhances productivity of human resource labour and increases level of performance for both the company and employees, because multi-skilling employees through on job training and classroom; creates a logical and effective interface between skills attainment and employee motivation (Saravani & Abbasi, 2013). Furthermore, with multi-skilling adoption, employees enjoy cross functional training to increase skills competency and at the same time organizations enjoy increasing talent pool, thus labour force resource availability (Srinivasan, 2014). Additionally, some organizations brag about bigger spending's each quarter on training and development of new skill-sets to improve resource competence and availability to perform more job processes. Noteworthy, key to the concept of multi-skilling is formal acknowledgement and encouragement of knowledge sharing amongst employees (Srinivasan, 2014).

Considerably, multi-skilling implementation programmes have radical capacity to create changes in nearly all dimensions of the business; workforce, workplace and labour union regulation, hence a good change management plan is recommended (Rajendra, 2016).

The gap in the literature is the limited devotion to the concept of job rotation as a tool that can be used to facilitate workforce multiskilling, influence project resource scheduling and reduce costs. As this type of training instrument would make it compulsory to move the training staff from one department to the next to master what goes on in other departments (Abomeh & Peace, 2015). The fourth hypothesis statement of the study is as follows:

$H4_1$(i): There is a positive relationship between multi-skilling and job redesign

$H4_1$(ii): Multi-skilling has a positive impact on adoption of multi skills.

2.6.1 Research Studies on Job Rotation and Performance

Past similar studies by (Saravani & Abbasi, 2013) attempted to investigate the effects of job rotation patterns on the performance of employees considering the skill diversity and job satisfaction and providing effective guidelines to enable managers to lead the organization toward a better future by desired policies and the results showed that Job rotation positively influences job performance

mediated by job satisfaction and skill variation. However the study was conducted in the banking industry and it did not consider project resource scheduling.

A study by Mossa, Boenzi, Digiesi, Mummolo and Romano (2016) proposed a model which aimed at finding optimal job rotation schedules in work environments characterized by low load manual tasks with a high frequency of repetition. The model is a mixed integer programming model allowing for the maximization of production rate jointly reducing and balancing human workloads and ergonomic risk within acceptable limits. Results show the models capacity to identify optimal job rotation schedules jointly achieving productivity and ergonomic risk goals. Performances of the solutions obtained improve as workforce flexibility increases. However the study was focused on high repetitive activities and did not consider electrical engineering non repetitive complex tasks.

2.7 CHAPTER SUMMARY

This chapter presented the theoretical framework for the research study to be constructed around. The literature reviewed on main objectives of the study educated the hypothetical statements and detailed insight on factors to consider when measuring the variables of the study.

The next chapter provides in detail the process of methodology, the techniques used and justification to best measure the study variables in-order to deliver conclusive results findings that can be generalized to the research site.

3 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This research methodology chapter outlines the structure and design of the study followed to best measure all the objectives, the research hypothesis statements learned by reviewed literature and solve research problem. Additionally, this chapter addresses rational on choice and justification of research technique, sampling technique, instrument design, procedure for data collection and statistical analysis. Furthermore, following is the reliability and validity, biasness, and ethical considerations of the study.

3.2 AIM OF THE STUDY

The aim of a research statement presents the purpose or intent of the entire study and this is the most important statement in the whole research study, hence it must be clear, unambiguous, and informative (Creswell, 2014).

The aim of this study is to evaluate the effect of using multi-skilled workforce in the execution of project activities by studying the changes in project execution resource scheduling flexibility, project labour costs and duration of projects in response to workforce multi-skilling and the use of job redesign as strategy to facilitate multi-skilling.

3.3 RESEARCH METHODOLOGY AND DESIGN

Research methodology can be referred to as the universal technique the investigator utilizes to conduct a research project and the methodological strategy the researcher finds best suitable to resolve the research problem (Leedy & Ormrod, 2013). Also, research methodology involves more than just knowing applicable research techniques suitable to a study but rather the justification underlying the rational for choice of research technique (Kothari, 2008). As a result, this procedure usually presents the researcher with new knowledge and an in depth understanding of the behaviour of variables under study and factors of influence relative to the research problem (Sekaran & Bougie, 2013).

Creswell (2014), research methodology entails a systemic procedure of collecting respondents' data, results analysis and presentation, discussion and conclusion of results in the structure designed for purpose of the research. In a quantitative investigation the objectives of the study are numerically quantified, whereas a qualitative research design seeks to understand non numeric objectives (Antwi & Hamza, 2015). The Table 3.1 shows fundamental differences between quantitative and qualitative research designs.

Table 3.1: Selecting a research design

Orientation	Quantitative Approach	Qualitative Approach
Paradigm/Worldview (assumption about world)	Positivism/Realism	Interpretivism/Idealism
Research Purpose	Numerical description	Subjective description
Ontology		
Epistemology	Dualist/Objectivist	Subjectivist
Methodology	Experimental/Manipulative	Hermeneutical/Dialectical
Research Methods (techniques and tools)	Empirical examination Measurement Hypothesis testing Randomization Blinding Structured protocols Questionnaires	Ethnographies Case studies Narrative research Interviews Focus group discussion Observations Field notes Recordings & Filmings
Scientific Method (role of theory)	Deductive approach, testing of theory	Inductive approach, generation of theory
Nature of Data Instruments	Variables Structured and Validated-data collection instruments	Words, images, categories In-depth interviews, participant observation, field notes, and openended questions
Data Analysis	Identify statistical relationships among variables	Use descriptive data, search for patterns, themes ad holistic features and appreciate variations
Results	Generalizable findings	Particularistic findings; provision of insider viewpoint
Final Report	Formal statistical report with: • Correlations • Comparisons of means • Reporting of statistical significance of findings	Informal narrative report

Source: Adapted from Sekaran, U. & Bougie, R., 2013.

There are other factors such as type of data required by the study, for instance primary data or secondary data, measurable or non-quantifiable objectives, these need to be considered when selecting a research method (Creswell, 2014).

The general difference between qualitative and quantitative research study designs is the procedure for collecting data, science for analysing and interpreting results and the method of concluding results (Sekaran & Bougie, 2013).

The justification for the quantitative research design for this study was based on Creswell's (2014) statement, that in a quantitative research design the researcher tests a theory by stating narrow hypothesis and administers collection of data to support or contest the hypothesis. Similarly, according to (Mackey & Gass, 2016), a quantitative research study normally begins with an experimental design where a defined hypothesis precedes the quantification of data with follow up numeric analysis. Therefore, the choice of this research design is justified, all hypothetical statements were developed based on review of literature and the research objectives are quantifiable in nature.

3.4 RESEARCH PARADIGM

Paradigms are a set of communally accepted ways of thinking by researchers in order to guide research process, design and methods to be conducted in a study (Kuhn, 2012). The outline for any research comprises of philosophies about the nature of reality and humanity (ontology), the theoretical framework that informs the research (epistemology), and how information may be gained and analysed (methodology) (Antwi & Hamza, 2015).

Antwi and Hamza (2015), states that the research paradigm considers the research design selected for the study, because quantitative research assumes positivist paradigm whereas qualitative research undertakes interpretivist paradigm. The reviewed literature on research paradigm together with earlier provided rational justification for quantitative design choice for this study and the use of Table 3.1 therefore justifies the positivist research paradigm choice for this research. This paradigm covers scientific research features such as purposiveness, rigor, testability, replicability, objectivity, generalizability, statistical accuracy and parsimony (Sekaran & Bougie, 2013).

3.5 STUDY SETTING

Eskom PTM delivers critical project execution services, commissioning and maintenance support of electrical engineering systems for Eskom Generation, Transmission, Group Capital and Distribution. This business unit is located in Johannesburg, Durban, Cape Town, Bloemfontein, Klerksdorp and Witbank.

However, Eskom PTM Central Group section consists of a mix of electrical engineering disciplines, which are Telecontrol, Protection Metering, DC Power Sources and Air Conditioning. Technician training and development is restricted to one of the disciplines and as a result technicians focus only on one part of project execution work. Being that, projects usually carry ide time labour costs, experience endless problems when it comes to project scheduling of teams and project duration overruns due current use of single skill specialization and thereby limiting technician utilisation and productivity.

The study was conducted at Eskom PTM Central Group a division of Eskom Group Technology. The target population of the study is eighty (80) staff members involved in project execution work. These staff members range from technical engineering personnel to project support services and project management.

3.6 POPULATION AND SAMPLE

3.6.1 Population

Sekaran and Bougie (2013) defines a study population as a group of individual elements or people or events of interest to the researcher to investigate and draw inferences accordingly. The population of this study is made up of eighty (80) Eskom PTM Central Group project execution staff members. This means the total number of employees who meet the criteria for recruitment to this study, targeted recruits range from technical engineering employees to project support services and project management.

3.6.2 Sample

According to Sekaran and Bougie (2013), a sample is widely referred to as a sub set of a population of elements. Sampling is a technique used to gather information about a population by scientifically measuring only a proportion representative of the total population of the study (Kothari, 2008). Stratton (2015) brings to attention a well-known phenomenon known as sampling error, which occurs when a sample size of a study is not a scientific representation of the entire population.

3.7 SAMPLING METHOD

Sampling methods provide an approach that enables researchers to moderate the amount of desired data to be collected by considering sample data instead of processing an entire population of elements (Saunders, et al., 2009). Selecting a sampling method depends on the nature of the study; the two most popular types of sampling techniques are probability and non-probability sampling (Leedy & Ormrod, 2013).

3.7.1 Probability Sampling

Probability sampling follows a logic that elements in a particular population have a known and non-zero probability of being picked as sample subjects. This sampling method is widely used where representativeness of the population is significant to qualify generalization. Probability sampling can be either restricted (complex probability sampling) or unrestricted (simple random sampling). Forms of restricted probabilities are cluster sampling which divides target population into clusters and randomly draws samples of the cluster, in stratified sampling; the target population is divided into mutually exclusive groups and in double sampling procedure adopts a double sampling procedure. Meanwhile unrestricted probability follows rational that every element in a particular population has a known and equal chance of being picked as sample subject (Sekaran & Bougie, 2013). Therefore, fitting to this study was simple random sampling since the elements in the target population were all project based staff members at Eskom PTM Central Group.

3.7.2 Non Probability Sampling

Non-probability sampling considers an idea that the elements in a target population do not have a known probability of being drawn as sample subjects. This method is mostly used when time and cost reasons are more important than inference generalization (Creswell, 2014). However, the aim of this study is to quantify and generalize findings to the target population.

3.7.3 Selection of Sample Size

Simple random sampling method was used as the sampling method, because each unit included in the target population has equal chance of inclusion in the sample. Moreover, this method is assumed to counter bias during sample element selection.

Establishing an optimal sample size for a study ensures adequate control to detect statistical significance. An exaggerated number of participants in a study is not only expensive but also unnecessarily increases the number of subjects to process. On the other hand, if a study experiences under-participation, it becomes statistically inconclusive and therefore incomplete (Suresh & Chandrashekara, 2012).

A 95% confidence interval and 5% level of significance was used to calculate the required sample size for the research study, confidence level means the amount of tolerable uncertainty and level of significance means the acceptable margin of error. Notably, is the use of higher confidence interval and or lower level of significance results to larger sample sizes ("Sample size calculator," 2016). Using sample size calculator, a sample size of 67 was computed adequately representative of total population of 80 elements.

3.8 THE RESEARCH INSTRUMENT

A quantitative research investigation makes use of surveys, experiments and questionnaires, to collect data that is revised and numerically presented to allow for data to be categorized using of statistical analysis. In other words, a quantitative researcher measures variables on a sample of elements to show the relationship between variables with the use of effect statistics such as correlations, relative frequencies and or differences between means; this is done with a focus on testing of theory (Antwi & Hamza, 2015). A survey design provides a quantitative description of tendencies, attitudes or opinions of a population by examining a sample of the population in question and from the sample findings researchers generalize or induce inferences about the population. Similarly, in an experiment the researcher can also use a sample and generalize to the population, however; an experimental design is intended to test the impact of a treatment on the results outcome thereby controlling all other possible influences to that outcome (Creswell, 2014). And, a questionnaire is pre-formulated written set of questions to which research study respondents record their answers, usually within rather closely defined alternatives (Sekaran & Bougie, 2013).

Questionnaires are commonly less expensive and time consuming than interviews and observations. Also, questionnaires are mostly designed to collect large numbers of quantitative data and can be administered personally, mailed, and or electronically distributed to the respondents; in consequence, they introduce a much larger chance of non-response and non-response error (Sekaran & Bougie, 2013). Noteworthy, within business and management researches, questionnaires are the most used instrument for collection of field data, where all respondents respond to the same set of questions and as a result questionnaires are an efficient way of collecting a large sample data (Saunders, et al., 2009).

The advantage of using electronic questionnaires is that it is cheaper, accommodates a large number of participants, respondents can complete the questions at their own convenience, though the non-response rate still remains a challenge, a number of techniques such as follow up notifications, keeping questionnaire brief and questionnaire design guidelines (Sekaran & Bougie, 2013).

The principles of questionnaire design focuses on the wording of the questionnaire, on how variables are categorized, scaled and coded, and lastly the presentation of the questionnaire in-terms of appearance (Sekaran & Bougie, 2013). Additionally, to encourage respondents to complete the questionnaire it must be kept as short as possible including questions themselves, it must be clearly worded and definition of concepts where necessary must be provided, it must begin with demographic questions to get respondents started and comfortable, follow appropriate use of measurement scales such dichotomous, Likert scales, etc., avoid open-ended questions if not intended for the study, avoid using leading questions as that influences respondents to respond towards a particular answer, take time to administer questionnaire pilot testing to uncover potential problems, and finally consider whether collection of data is for interval or nominal variable and a type of statistical technique intended for the study whether descriptive or inferential (Render, et al., 2015).

A designed electronic questionnaire was constructed for the use of collecting data from research participants in a structured manner that allows for optimal addressing of the research purpose, hypothesis statements and overall research objectives in order to answer the research question.

3.8.1 Questionnaire Pilot Testing

Saunders, Lewis & Thornhill, (2009) together with Sekaran and Bougie (2013) suggest that the purpose of pilot testing a questionnaire is to help offer the researcher a good opportunity to study and improve internal instrument constancy (reliability) and general quality of the instrument in terms of; language usage, wording, sequencing of questions, clarity, length and alignment to research objectives. And notable is that pilot testing is not ad-mistered on targeted subjects of the study. Furthermore, Leedy and Ormrod (2013) proposes that questionnaire pilot testing offers the researcher an idea on how intended respondents' may likely interact with the research instrument and likely respond.

3.9 PROCEDURE FOR DATA COLLECTION

This research study is of cross-sectional approach, a method undertaken when data is only collected once over a period of days or weeks or months in order to answer research objectives (Sekaran & Bougie, 2013). According to Kothari (2008), data can primary or secondary sources; primary data refers to data collected first hand by the researcher, whereas secondary data refers to data collected from sources that exists already. With this in mind, Sekaran and Bougie (2013) classifies interviews, focus groups, and administered questionnaires or observations as sources of primary data; meanwhile sources of secondary data range from economic indicators, books and periodicals, annual company reports, case studies, databases, census data, government publications, statistical abstract, etc.

A designed electronic questionnaire was distributed to all participants of the study, collected and captured through the use of statistical software technologies; Questionpro. Projected period of data collection was four weeks and during this phase a four stage process was followed. Firstly, an email with an overview of the study, rights of participation and anonymity was sent out to all the respondent recruits. Secondly, the link to the administered electronic questionnaire was sent. Thirdly, during the collection period of data a follow up email was sent to encourage participation. And lastly, a notification to thank respondents for their participation was sent.

3.10 DATA ANALYSIS AND INTERPRETATION

The process of data analysis and interpretation assumes after data collection phase, meaning when all responses gathered meet desired population sample representation of the study. And at this phase of the study, response data was coded, edited and taken through the procedure for outliers, data test for normality and missing observations (Sekaran & Bougie, 2013). The frequency distribution of responses and interpretation was conducted. Moreover, the analysis of data in quantitative research considers descriptive statistics and inferential statistics, thus a study concerned with the distribution of variables and a study intended for generalisation of results findings, respectively (Kothari, 2008).

Accordingly, Creswell (2014) explains that descriptive data analysis studies the mean scores, standard deviations and range. Also, essential to keep in mind, is that in quantitative research studies where the process of data analysis ends with descriptive analysis, the study respondents' may have been too small for further inferential statistical analysis.

The data collection software platform used was Questionpro, an electronic questionnaire was designed, distributed to all research respondents, response data was collected by the tool automatically and a response report was created. Lastly, all statistical analysis was conducted using STATA, a statistical software tool.

3.10.1 Descriptive Statistics

The purpose of using descriptive statistics was to simply provide summaries about the sample and observations made. The advantages of descriptive statistics are they collect and summarize large amounts of data, much easier to interpret, computes Mean scores and Standard deviations.

3.10.2 Normal Distribution Test

In general when performing research response statistics it is conventional to assume that the observations are normal. This assumption is foundation to the entire statistical framework and if misinterpreted the inference breaks down. Therefore, it is crucial to test this assumption before any statistical analysis of data (Das & Imon, 2016).

3.10.3 Spearman's Correlation

In a research that studies a relationship between two variables, the use of measures of correlation assumes that neither is functionally dependent upon the other. And, the quantitative measure of the strength of correlation is known as correlation coefficient and it expresses how closely a change in one of the variables is complemented by a change of the other variable (Zar, 2014). The Spearman rank order correlation is a nonparametric association measure of the strength and direction observed between two variables of a study.

Also, the correlation coefficient ranges from -1 to +1, the measurement of 0 indicates no correction, -1 shows a strongest negative correlation, and +1 shows a strongest positive correlation (Zaid, 2015).

3.10.4 Principal Component Analysis

Principal component analysis (PCA) a statistical technique used for data reduction (Long & Freese, 2014), STATA was used to pick out factors that are critical in each dimension in affecting another dimension .The purpose of PCA is to find combinations of the variables with the greatest variance (Afifi & Clark, 2012).

3.10.5 Hypothesis Testing

Hypothesis testing refers to the use of statistical procedures by researcher to draw inferences to the population using sample data (Creswell, 2014). Critical to note with regards to hypothesis testing; there are two hypotheses, null and alternative or rather research hypothesis. The testing process starts off with the assumption that the null hypothesis is true, the aim of this is to determine whether there is sufficient evidence to infer that the research hypothesis is true, and the researcher must be able to make a conclusive decision, be it that there is sufficient evidence in support of research hypothesis or there is insufficient evidence to support the research hypothesis (Keller, 2012).

The purpose of hypothesis testing is to determine accurately if the null hypothesis can be rejected in favour of the research hypothesis or vice versa, however this is conducted with a certain degree of confidence meaning there is a risk that the research can draw incorrect inference about a population (Sekaran & Bougie, 2013). The two possible errors are simply known as Type I and Type II errors, where Type I occurs when the researcher rejects a true null hypothesis and Type II occurs when the research does not reject a false null hypothesis (Keller, 2012). For this reason, the concept of statistical power becomes very important, this is a method used to calculate the probability of rejecting a null hypothesis correctly (Sekaran & Bougie, 2013).

3.11 RELIABILITY AND VALIDITY

The research instrument design ability to properly test objectives of the study as per intended explains the instrument measure of validity (Creswell, 2014). Sekaran and Bougie (2013) identify three well known types of validity testing, construct, criteria and content validity. Content validity measures research instrument ability to provide adequate representation of questions to resolve research objectives; criteria related validity is used when respondents are differentiated on a criterion the instrument is expected to predict and construction validity measures obtained results to theory used for the design of the test (Sekaran & Bougie, 2013).

The research study instrument validity allows for accurate and consistent collection of data (Saunders, et al., 2009). Furthermore, sources used in the study were all credible in terms of peer review, published text books, online/internet sources were kept below five percent in references and sources were mostly limited to age in existence that is eighty percent of the sources kept to less than five years since publish. The use of the electronic data collection and analysis ensures validity of data.

The reliability measure indicates the degree to which the research instrument ensures internal consistency across various items (Creswell, 2014). Research questionnaire internal consistency identifies correlation of responses from question to question within the research instrument (Sekaran & Bougie, 2013). According to Saunders, Lewis and Thornhill (2009), reliability relates to the strength of a research instrument to ensure consistent responses at different times and conditions.

Cronbach's alpha is most used technique to test reliability of a research instrument by testing internal consistency across various items in the research questionnaire. Cronbach's alpha (Cronbach 1951) assesses the reliability of a summative rating (Likert 1932) scale composed of specified items. Cronbach's alpha measures internal consistency, that is, how closely related a set of items are as a group (Tavakol & Dennick, 2011).

3.12 ELIMINATION OF BIAS

Response bias is the result of non-responses on survey assessments and it is on the bases that if non-respondents had responded their responses would have considerably changed the overall results findings (Creswell, 2014). In wave analysis, the investigator evaluates responses week by week to understand average response rate and act accordingly to improve the rate (Creswell, 2014). To minimize respondent biases and measurement errors, the investigator must ensure application research questionnaire design guideline principles such as but not limited to wording, sequence of questions, length of the questionnaire, design appearance etc. (Sekaran & Bougie, 2013). A phenomenon known as sampling error can result to bias or to large variances in the results findings, and to best minimize this sampling bias the investigator can randomize selection of elements to be sample subjects, as this will help align sample size to properly represent the population (Stratton, 2015).

3.13 ETHICAL CONSIDERATIONS

Ethics in business research is defined as expected standard social code of conduct that rules norms of behaviour while conducting research. Also, ethical conduct applies to systems of government, organizations and stakeholders that sponsor the research, the researcher conducting the research and the respondents (Sekaran & Bougie, 2013). Researchers must protect their research respondents, develop trust with them, safeguard integrity of research, guard against misconduct and rudeness that may reflect badly to their organizations or institutions (Creswell, 2014). Ethical conduct is reflected in each stage of the research process that is data collection, data analysis, reporting and dissemination of information on the internet (Sekaran & Bougie, 2013).

The gatekeeper letter was obtained from Eskom PTM Central Group manager for permission to conduct academic research study prior to electronic questionnaire distribution. All recruits for participation were over the age of eighteen, no monetary incentive for participation, rights for participation was explained and emphasis was made that each respondents' can quit the study at any time without a consequence or penalty. The questionnaire was designed not to discriminate against research participants, sponsors and those interested to the research. In

the informed consent form of the study the above ethical considerations were clearly explained and only after accepting the terms the electronic questionnaire allowed participants to engage with study. Lastly, participation to the study is kept and will remain anonymous, and the electronic questionnaire data is safely stored and confidential for five years in line with the University of Kwa-Zulu Natal research policy.

3.14 CHAPTER SUMMARY

This chapter provided the justification for the preferred research methodology and design technique, paradigm and study setting. The other key topics discussed in the chapter were the population and sampling techniques, research instrument, procedure for data collection, data analysis and interpretation, instrument reliability and validity, ethical consideration of the study, descriptive and inferential statistics.

In the next chapter, the presentation and interpretation of results findings informed by analysis of collected data was performed in correspondence with the main objectives of the study.

4 CHAPTER FOUR: ANALYSIS AND INTEPRETATION

4.1 INTRODUCTION

The aim of the study is to evaluate the effect of using multi-skilled workforce in the execution of project activities by studying the changes in project execution resource scheduling flexibility, project labour costs and duration of projects in response to workforce multi-skilling and the use of job redesign as strategy to facilitate multi-skilling. The goal of this chapter to analyse the data collected in order to test the hypothesis with the purpose of answering the research question. This chapter focuses on the analysis of data, presentation and interpretation of the response results and findings of the study. The respondents' response results are presented by means of figures and tables. The presentation of the results commences with the demographical information of the respondents followed by factors of project execution resource scheduling flexibility, project labour costs and duration of projects in response to workforce multi-skilling and the use of job redesign as strategy to facilitate multi-skilling. This is then tailed by the presentation of the results according to the objectives and hypotheses of the study. The analysis is in four parts, namely descriptive, correlations, factor analysis and paired t-tests.

The population size of the study was 80 employees; a group consisting of specialists and managers (S&M band), junior technicians (T11), senior technicians (T12) and senior supervisors (T13). The sample size calculation for this population was 67 participants with marginal error of 5% and 95% confidence interval. The total number of non-response was 17 that is 25%, and the maximum number of responses was 50 that is 75%. All captured data was analysed and presented as per study objectives, meaning responses were segmented into sections to best quantify finding results under each objective.

4.2 PERSONAL DEMOGRAPHIC INFORMATION

The first section of the questionnaire required respondents to complete general biographical information. The results to the questions asked in this section are presented in Table 4.1 and a brief interpretation follows immediately.

Table 4.1: Respondents demographic data

Variable	Label	Male		Female		Total	
		Freq.	Perc	Freq.	Perc	Freq.	Perc
Race	African	26	76.5	14	87.5	40	80.0
	Indian	8	23.5	2	12.5	10	20.0
	Total	**34**	**100.0**	**16**	**100.0**	**50**	**100.0**
Age group	21 to 30 years	10	29.4	7	43.8	17	34.0
	31 to 40 years	19	55.9	9	56.3	28	56.0
	41 to 50 years	5	14.7	0	-	5	10.0
	Total	**34**	**100.0**	**16**	**100.0**	**50**	**100.0**
Job grade	**T11**	9	27.3	7	43.8	16	32.7
	T12	15	45.5	5	31.3	20	40.8
	T13	5	15.2	1	6.3	6	12.2
	S&M Band	4	12.1	3	18.8	7	14.3
	Total	**33**	**100.0**	**16**	**100.0**	**49**	**100.0**
Experience	**< 5 Years**	11	33.3	5	31.3	16	32.7
	6 – 10 Years	11	33.3	8	50.0	19	38.8
	11 – 15 Years	7	21.2	3	18.8	10	20.4
	>15 years	4	12.1	0	-	4	8.2
	Total	**33**	**100.0**	**16**	**100.0**	**49**	**100.0**
Education levels	Diploma/equivalent	18	54.5	11	68.8	29	59.2
	Degree/ equivalent	15	45.5	5	31.3	20	40.8
	Total	**33**	**100.0**	**16**	**100.0**	**49**	**100.0**
Professional body	Yes	23	69.7	7	43.8	30	61.2
	No	10	30.3	9	56.3	19	38.8
	Total	**33**	**100.0**	**16**	**100.0**	**49**	**100.0**

Table 4.1 indicates that eight out of ten respondents (80%) were African, while two out of ten (20%) were Indian. Comparably, there were more males than females thus 68% to 32% respectively.

Twenty eight respondents (56%) were aged 31-40 years, a third (34%) were aged 21-30 years with a few (10%) who were aged 41-50 years.

Proportionally, females were more likely (43.8%) to be aged 21-30 years compared to males (29.4%). There were no significant differences in percentage of male (55.9%) and female (56%) respondents aged 31-40 years. Notably, there were no female respondents aged 41-50 years.

Four out of ten (40.8%) respondents were in the T12 (senior technician) job grade, a third (33%) were T11 (junior technician) while a few (19%) were in S&M (specialist and management) job band, and very few (12%) were in T13 (senior supervisor) job grade. Male respondents were more likely (45.5%) to be in T12 job grade than females (31.2%), while females were more likely to be in T11 job grade compared to males (43.85 vs. 27.3%). Almost four out of ten (39%) had between six to eight years work experience; a third with less than 5 years' experience, and a fifth (20%) with 11-15 years of experience. Very few respondents (8%) with over 15 years of work experience and were all males. Notably, females were more likely (50%) to have 6-10 years of work experience than males (33%) respectively.

Regarding education levels, six out of ten (59%) respondents had diploma or equivalent qualifications; while four out of ten (40%) had degrees. Females were more likely (69% vs. 55%) to have diplomas compared to males. Six in ten (61.2%) respondents belonged to a professional body; while 39% did not. Male respondents were much more likely (70%) to belong to a professional body compared to females (44%).

4.3 DESCRIPTIVE STATISTICS

A Likert-type question (or 'item') asked respondents to select one of five responses that are ranked in order of strength. The following section provides descriptive statistics in form of frequencies for the Likert scale responses for the different sub scales. Each section on frequency tables is followed by descriptive statistics which provide mean scores and standard deviations. The scores were computed to produce mean scores that represent the strength along the 1-5

scale where 1 was coded as Strongly Agree, 2 as Agree, 3 as Neutral, 4 as Disagree response and 5 as Strongly Disagree, as shown in Appendix 1. The standard deviations indicate how far the values are away from the mean value, while skewness quantifies symmetricity of data distribution.

4.3.1 Objective 1: Influence of Multi-Skilled Workforce on Project Scheduling Flexibility

This section comprises of four Likert scale statements to examine the influence of multi-skilled workforce on project scheduling flexibility. The frequency distribution of responses for each statement was summarized graphically as shown in Figures 4.1, 4.2, 4.3 and 4.4, and descriptive statistics summary follows afterwards.

4.3.1.1 Multi-Skilled workforce helps improve project labour resource availability

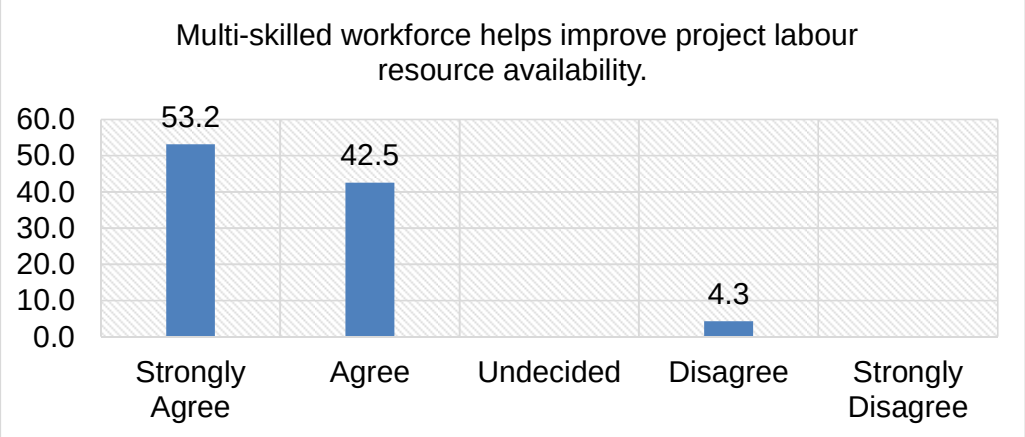


Figure 4.1: Response on multiskilling helps improve project labour resource availability

The results in Figure 4.1 indicate that an overwhelming majority (95.7%) of respondents believe that multi-skilled workforce helps improve project labour resource availability, compared to very few (4.3%) who did not agree.

4.3.1.2 Multi-skilled workforce improves project labour resource utilization

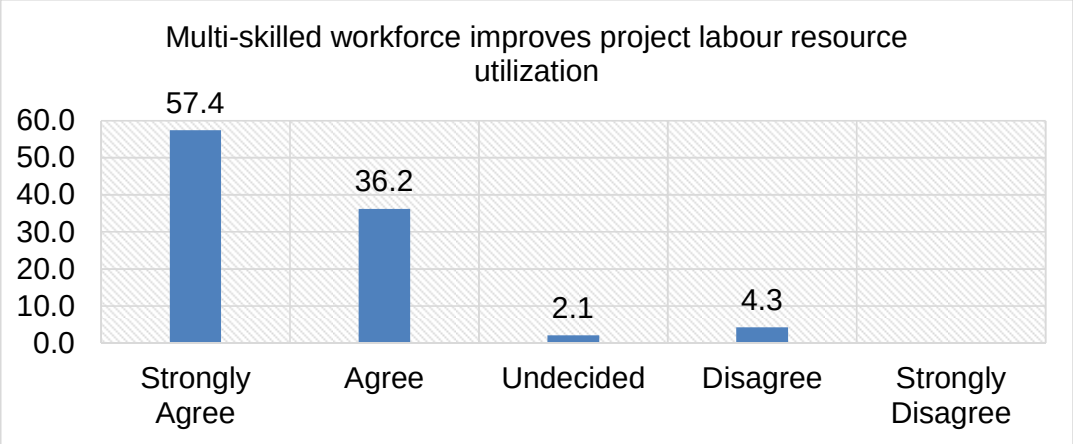


Figure 4.2: Response on multiskilling improves project labour force utilization

The results shows that nine out of ten (93.6%) of respondents believed that multi-skilled workforce improves project labour resource utilization, on the other-hand only 2.1% and 4.3% were undecided or opted to disagree, respectively.

4.3.1.3 The use of multi-skilled workforce could smoothen rescheduling of labour resources from one project to another in multiple project environments such as Eskom PTM.

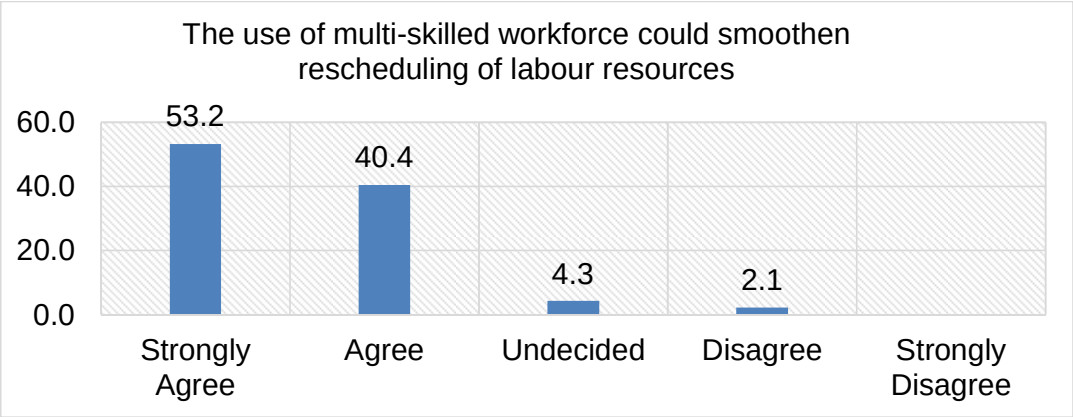


Figure 4.3: Response to multiskilling influence on rescheduling of labour

A large number of participants (93.6%) were certain that the use of multi-skilled workforce could smoothen rescheduling of labour resources from one project to-

another in multiple project environment such as Eskom PTM Central Group and only few were neutral or did not agree, 4.3% and 2.1% respectively.

4.3.1.4 Workforce multi-skilling helps cushion against unforeseen project schedule changes

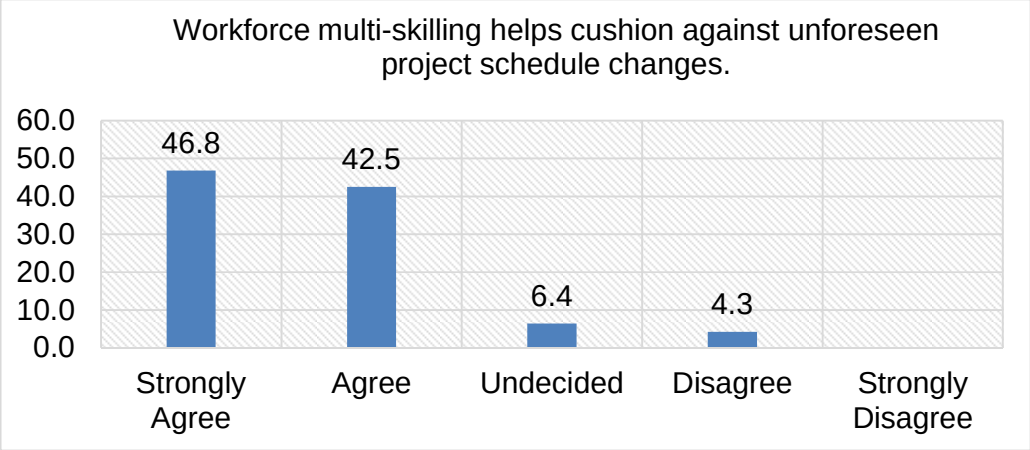


Figure 4.4: Response on multiskilling cushions against unplanned schedule changes

Approximately nine out of ten (89.3%) of participants in this section believed that workforce multi-skilling helps cushion against unforeseen project schedule changes, compared to a sum (10.7%) of those who were neutral and did not agree.

4.3.1.5 Descriptive Statistics Summary

Table 4.2: Project scheduling flexibility Statistics

3 system missing values	N	Mean	Std. Deviation	Min	Max
Workforce multi-skilling helps cushion against unforeseen project schedule changes.	47	1.68	0.783	1	4
Multi-skilled workforce helps improve project labour resource availability.	47	1.55	0.717	1	4
The use of multi-skilled workforce could smoothen rescheduling of labour resources from one project to another in multiple project environments such as Eskom PTM.	47	1.55	0.686	1	4
Multi-skilled workforce improves project labour resource utilization	47	1.53	0.747	1	4

Table 4.2 shows that all aspects of schedule flexibility had mean scores greater than 1 but less than 2. This indicates respondents' tendency to generally agree on all four aspects pertaining to project schedule flexibility. The standard deviation (the spread of the distribution of the variable) for all factors is less than 1, this indicates that there were no outliers in responses. Multi-skilled workforce helps improve project labour resource utilization (Mean score = 1.5) was the highest rated in terms of agreement, even though not significantly different from the other three factors.

4.3.2 Objective 2: Evaluating the relationship between multi-skilling and project costs

The purpose of this section was to evaluate the relationship between multi-skilling and project costs using four Likert scale statements. Participants' response under the four factors influencing multi-skilling and project costs was recorded and analysed. The frequency distribution of responses for each statement was summarized graphically as shown in Figures 4.5, 4.6, 4.7 and 4.8, and in closure to this section is descriptive statistics summary.

4.3.2.1 The use of multi-skilled workforce can help cut project labour costs for Eskom PTM Central Group by reducing the number of labour workforce required per project.

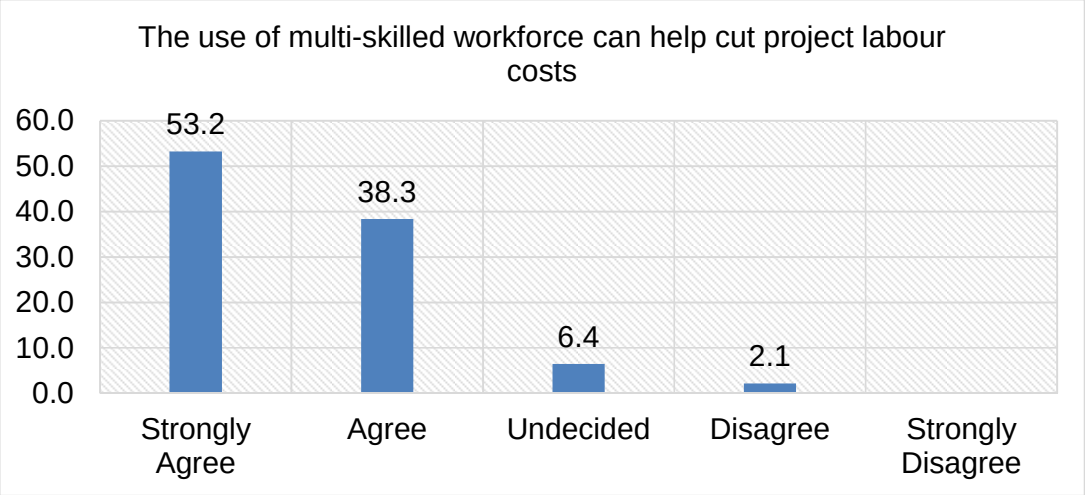


Figure 4.5: Response to multiskilling workforce on cutting labour cost

Figure 4.5 indicates that nine out of ten respondents (91.5%) felt that the use of multi-skilled workforce can help cut project labour costs for Eskom PTM Central Group by reducing the number of labour workforce required per project, a few (6.4%) were undecided while an insignificant proportion did not agree.

4.3.2.2 Multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs

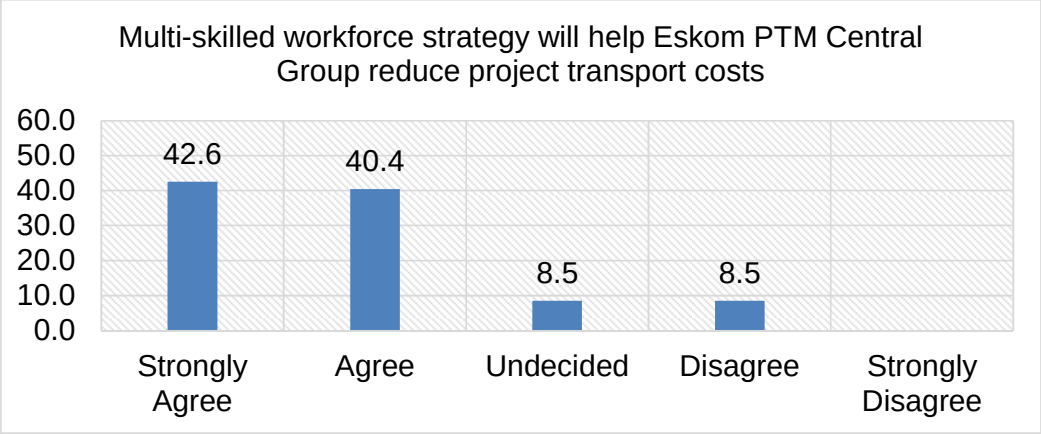


Figure 4.6: Response to multi-skilling on project transport cost reduction

Eight out of ten (83%) also felt that multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs, compared to less than 10% who either were undecided or did not agree.

4.3.2.3 Multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge.

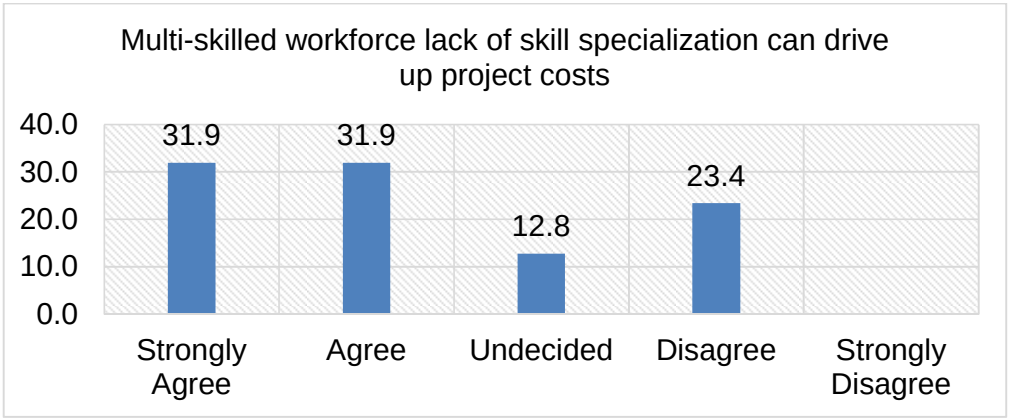


Figure 4.7: Responses to multiskilling on lack of specialization costs

A majority of respondents in this question (63.8%) felt that multi-skilled workforce lack of skill specialization can drive up project costs through defects resulted due to lack of expert knowledge and almost four out ten (36.2%) did

not in support this view. Also it could be interpreted that 23.4% of respondents thinks that multi-skilled workforce lack of skill specialization cannot drive up projects costs.

4.3.2.4 Provided that a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects.

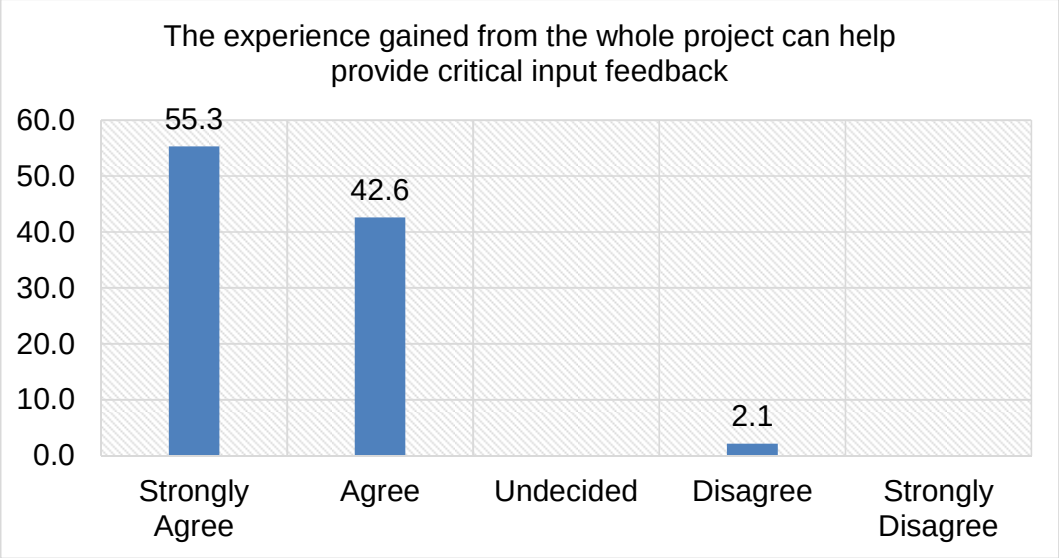


Figure 4.8: Response to experience gained throughout project lifecycle and feedback

Almost all respondents (97.9%) felt that provided a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects.

4.3.2.5 Descriptive Statistics Summary

Table 4.3: Multi-skilling and project costs statistics

3 missing system values	N	Mean	Std. Deviation	Min	Max
Multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge.	47	2.28	1.155	1	4
Multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs	47	1.83	0.916	1	4
The use of multi-skilled workforce can help cut project labour costs for Eskom PTM Central Group by reducing the number of labour workforce required per project.	47	1.57	0.715	1	4
Provided that a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects.	47	1.49	0.621	1	4

The highest rated factor (agreement) was that provided that a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects (Mean score=1.5). The lowest rated factor (mild agreement) was that Multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge (Mean score=2.3).

4.3.3 Objective 3: Evaluating the effect of multi-skilling on project duration

The aim of this section was to evaluate the effect of multi-skilling on project duration using three Likert scale statements fundamental to influence project duration. The frequency distribution of responses for each statement was summarized graphically as shown in Figures 4.9, 4.10 and 4.11, and following afterwards is descriptive statistics summary.

4.3.3.1 The use of multi-skilled workforce will not reduce job activity duration because the job is not performed by specialist personnel.

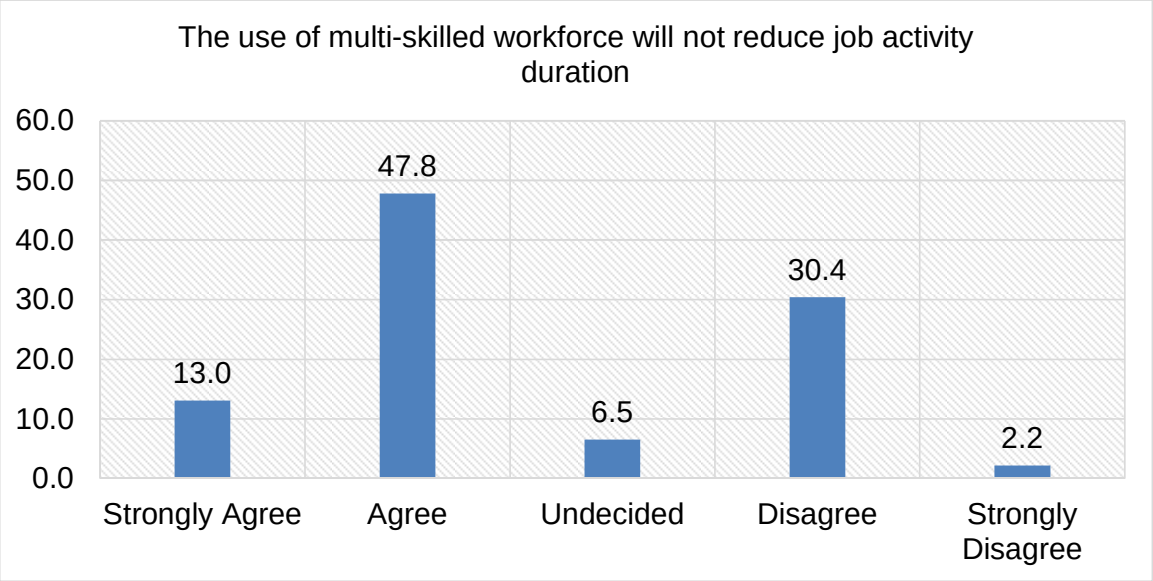


Figure 4.9: Responses to multi-skilled workforce on reduction of job activity duration

Six in ten (60.8%) of respondents felt that the use of multi-skilled workforce will not reduce job activity duration because the job is not performed by specialist personnel, whilst a third of respondents (32.6%) did not agree to this and less than one tenth (10%) were unsure.

4.3.3.2 Multi-skilled workforce utilization allows project managers control over activity sequencing meaning rearrangement of tasks to suit project time lines or targets.

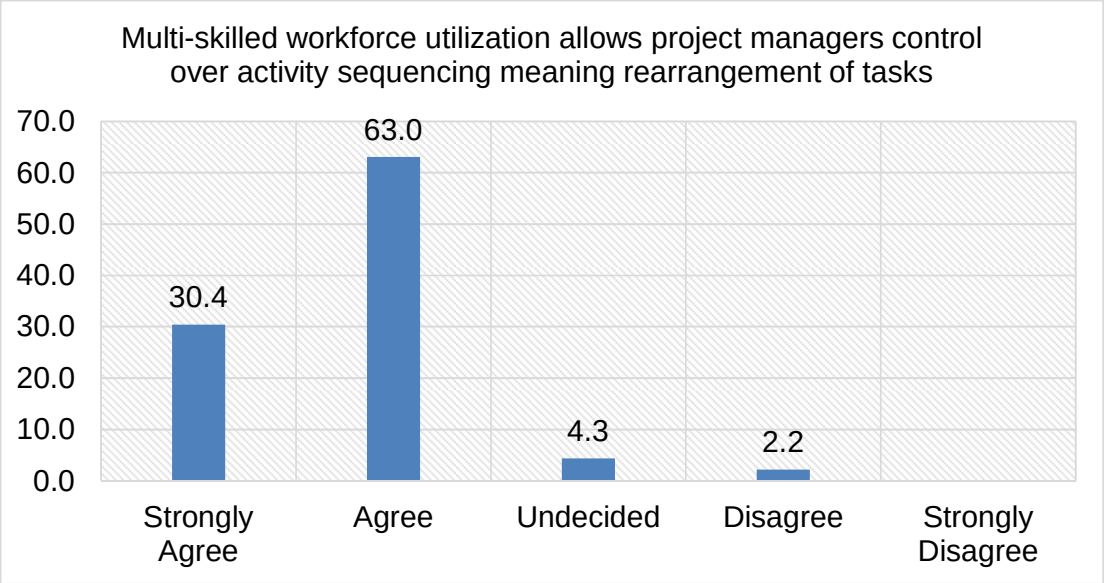


Figure 4.10: Responses to multiskilling ability to afford managers project control

Majority of respondents, nine in ten (93.4%) felt that multi-skilled workforce utilization allows project managers control over activity sequencing, in other words rearrangement of tasks to suit project time lines and targets. An insignificant 6.5% summation was a contribution of those that did not agree to and or undecided.

4.3.3.3 Multi-skilled workforce tend to take longer to finish an activity, but the time lost on activity duration compensates for idle time that a specialist would have spent waiting for the next specialist job (specialist idle time cost).

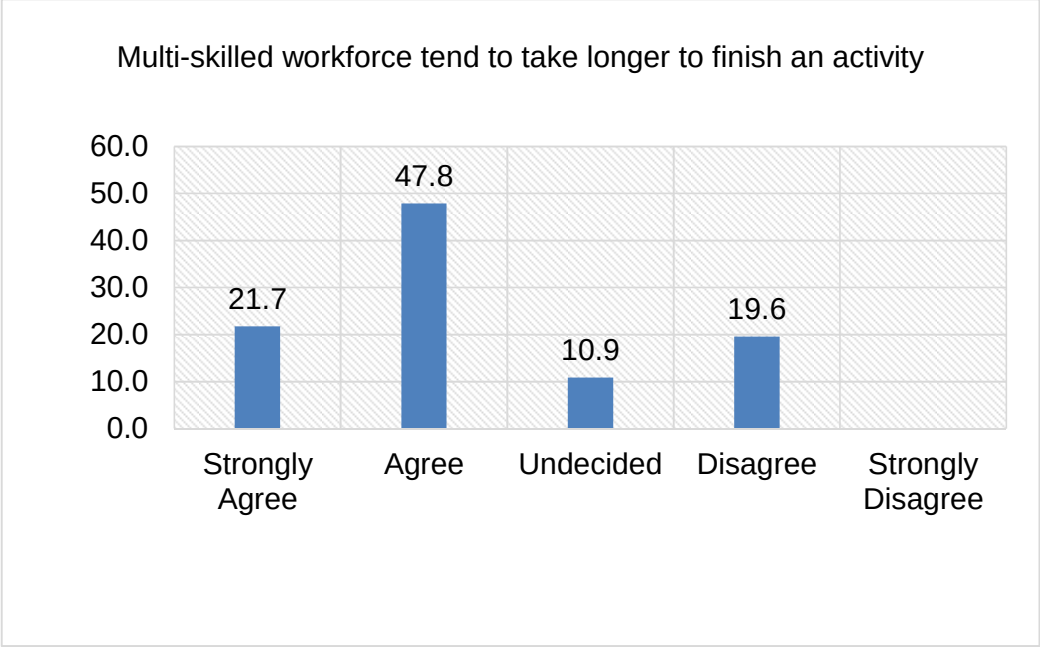


Figure 4.11: Response on multiskilling to solve specialist idle time cost

Seven out of ten (69.5%) felt that multi-skilled workforce tends to take longer to finish an activity, but the time lost on activity duration compensates for idle time that a specialist would have spent waiting for the next specialist job (specialist idle time cost). A fifth (19.6%) of them did not agree to this whilst one tenth (10%) of responses were undecided on this issue.

4.3.3.4 Descriptive Statistics Summary

Table 4.4: Multi-skilling and project duration statistics

4 missing system values	N	Mean	Std. Deviation	Min	Max
The use of multi-skilled workforce will not reduce job activity duration because the job is not performed by specialist personnel.	46	2.61	1.125	1	5
Multi-skilled workforce utilization allows project managers control over activity sequencing meaning rearrangement of tasks to suit project time lines or targets.	46	1.78	0.629	1	4
Multi-skilled workforce tend to take longer to finish an activity, but the time lost on activity duration compensates for idle time that a specialist would have spent waiting for the next specialist job (specialist idle time cost).	46	2.28	1.026	1	4

The use of multi-skilled workforce will not reduce job activity duration because the job is not performed by specialist personnel was the least rated factor in terms of agreement (Mean score equals 2.6) towards uncertainty. Multi-skilled workforce utilization allows project managers control over activity sequencing meaning the rearrangement of tasks to suit project time lines and targets was the highly rated factor (Mean score equals 1.8) agreement.

4.3.4 Objective $4_{(i)}$: Evaluating the effect of adopting multi-skilling strategy at Eskom PTM Central Group:

This section was segmented to current Eskom PTM Central Group project resource assessment, adoption of multiskilling at Eskom PTM Central Group and practical means such as job rotation and training to facilitate multiskilling. The purpose of the resultant subsections was to systemically evaluate the effect of adopting multi-skilling at Eskom PTM Central Group by exploring different influential factors.

4.3.4.1 Assessing Eskom PTM Central Group Project Resources:

To assess the current Eskom PTM Central Group project resources, participants were required to respond to their best ability and answers to the seven Likert scale statements were recorded and analyzed. The frequency distribution of responses for each statement was summarized graphically as shown in Figures 4.12 to 4.18, and following afterwards is descriptive statistics summary.

a) Eskom PTM Central Group project resources are adequately qualified (educated) in their respective field of specialization

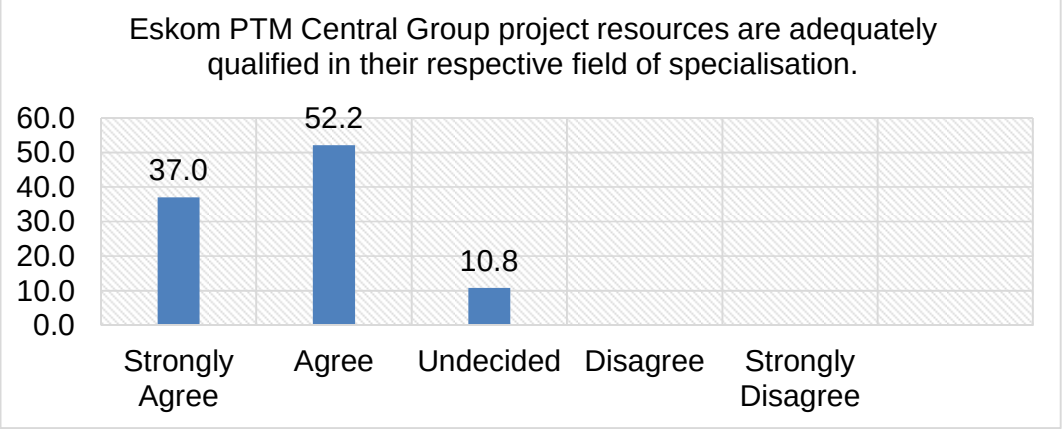


Figure 4.12: Responses to project resource qualification in job specialisation

Figure 4.12 indicates that almost nine out of ten (89.2%) of respondents felt that Eskom PTM Central Group project resources are adequately qualified in their respective field of specialization and 10.8% were undecided.

b) Project Support Services show extensive experience in managing projects

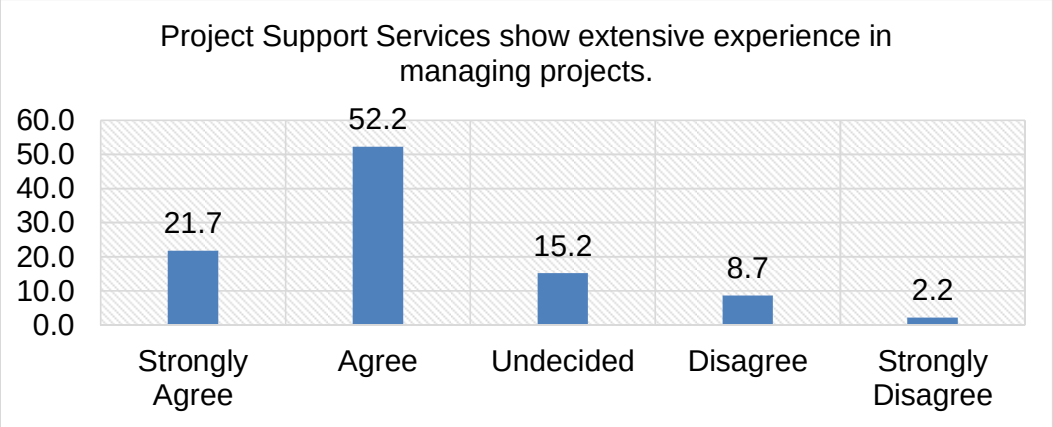


Figure 4.13: Responses to project support service experience

Seven out of ten (73.9%) of respondents believed that Project Support Services show extensive experience in managing projects, compared to a few (15%) who were undecided and very few (11%) who did not believe so.

c) Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities.

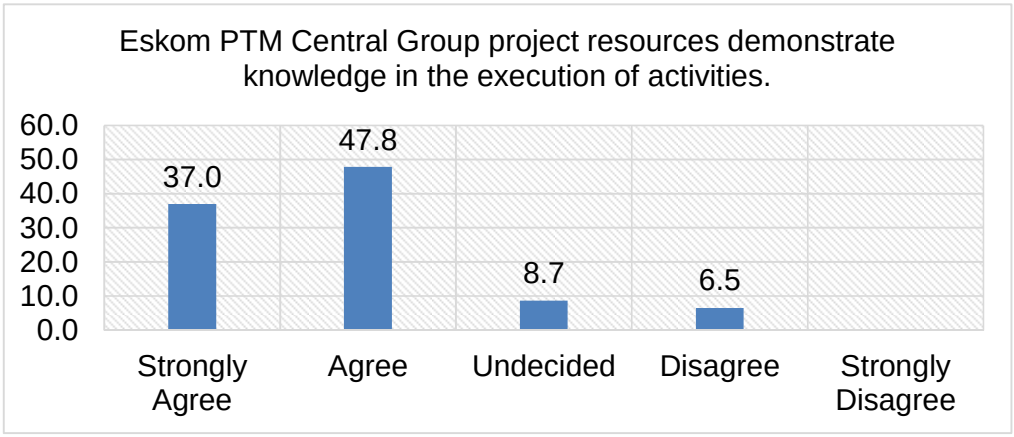


Figure 4.14: Responses to project resource knowledge in activity execution

Eight out of ten (84.8%) of respondents felt that Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities, with very few who either were unsure or did not feel so.

d) Eskom PTM Central Group project resources are competent in terms of skills, technical knowledge, experience and proficiency in the execution of projects.

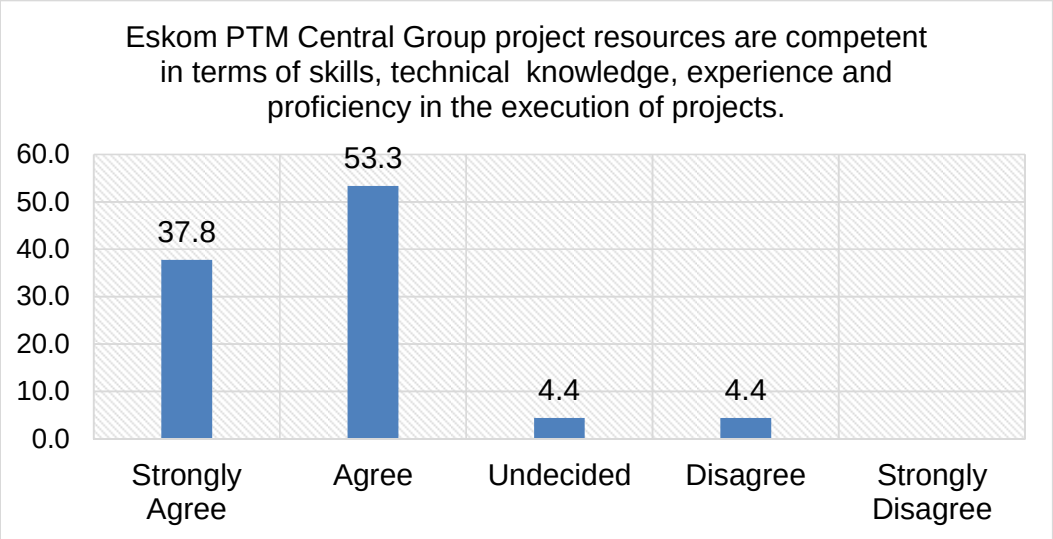


Figure 4.15: Responses to project resource competency

Vast majority of respondents, nine out ten (91%) positively perceived that Eskom PTM Central Group project resources are competent in terms of skills, technical knowledge, experience and proficiency in the execution of projects and 4.4% were either undecided or disagreeing.

e) However, project resources cannot perform activities across disciplines because departments are divided into specialist skills e.g. Protection, Tele-control, and Metering

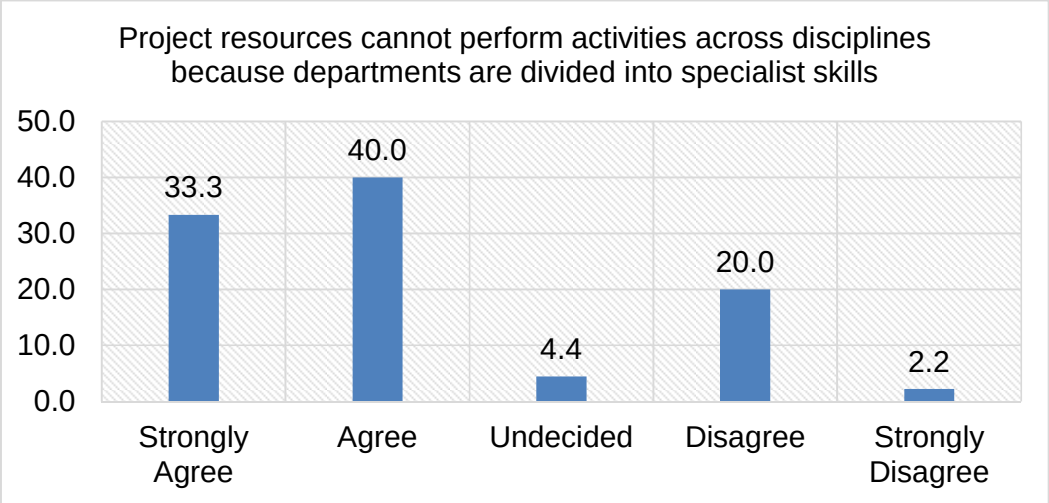


Figure 4.16: Responses to project resource ability to cross function between departments

Seven out of ten (73.3%) of respondents believed that project resources cannot perform activities across disciplines because departments are divided into specialist skills e.g. protection, tele-control, and metering, compared to a fifth (22%) who did not feel so and very few (4%) who were unsure.

f) Project management resources can negotiate project scope, time, cost and quality effectively with clients to meet in house business objectives

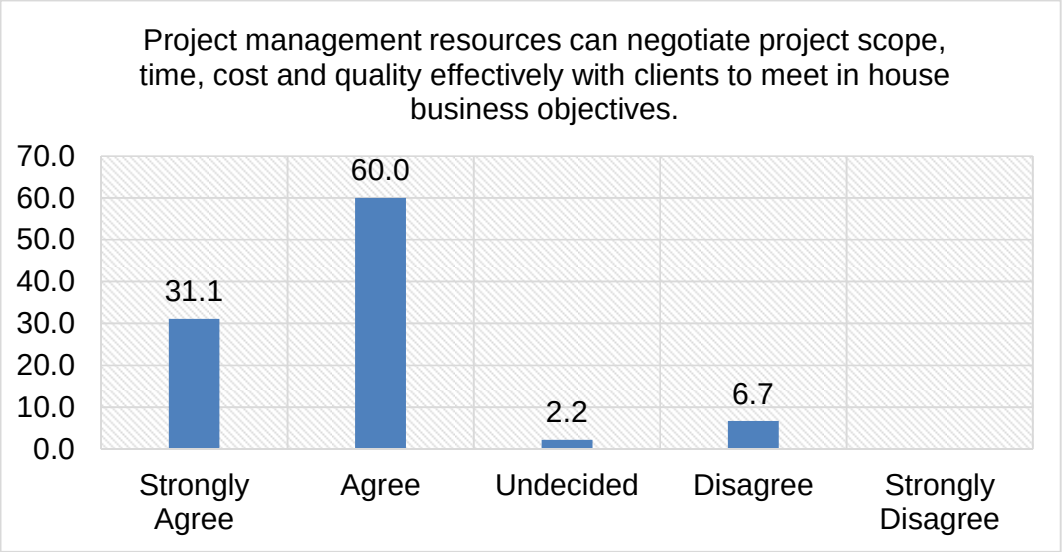


Figure 4.17: Responses to project management plan negotiation skills

A high percentage of participants', nine out of ten (91%) believed that project management resources can negotiate project scope, time, cost and quality effectively with clients to meet in house business objectives, and less than 10% did not.

g) Project management resources are effective at managing risks from both financial and technical standpoint

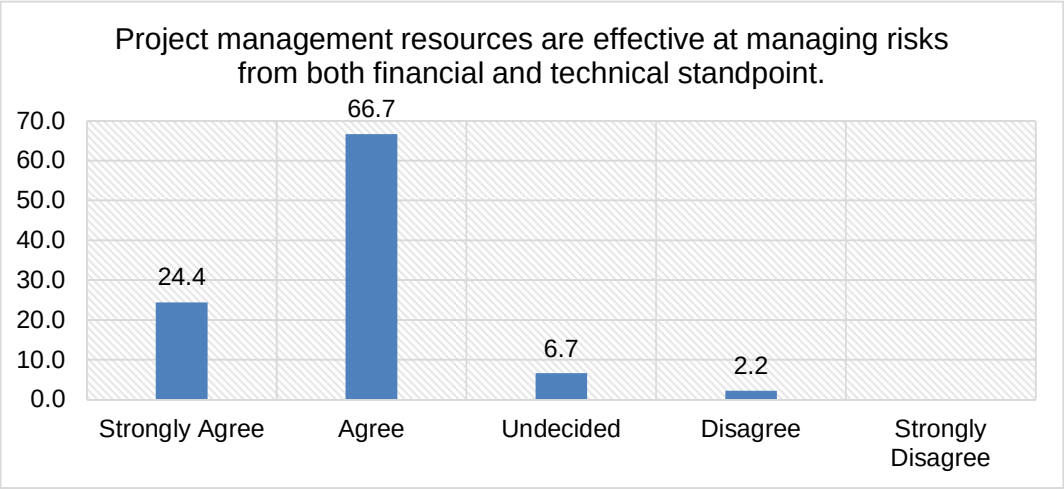


Figure 4.18: Responses to management of project risks, financials and technicality

A large proportion (91.1%) of respondents indicated in agreement that project management resources are effective at managing risks from both financial and technical standpoints and a very few were undecided and the in disagreement, 6.7% and 2.2% respectively.

h) Descriptive Statistics Summary

Table 4.5: The effect of adopting multi-skilling strategy statistics

	N	Mean	Std. Deviation	Min	Max
Eskom PTM Central Group project resources are adequately qualified (educated) in their respective field of specialization.	46	1.74	0.648	1	3
Eskom PTM Central Group project resources are competent in terms of skills, technical knowledge, experience and proficiency in the execution of projects.	45	1.76	0.743	1	4
Project management resources can negotiate project scope, time, cost and quality effectively with clients to meet in house business objectives.	45	1.84	0.767	1	4
Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities.	46	1.85	0.842	1	4
Project management resources are effective at managing risks from both financial and technical standpoint.	45	1.87	0.625	1	4
Project Support Services show extensive experience in managing projects.	46	2.17	0.950	1	5
However, project resources cannot perform activities across disciplines because departments are divided into specialist skills e.g. Protection, Tele-control, and Metering.	45	2.18	1.173	1	5

Eskom PTM Central Group project resources are adequately qualified (educated) in their respective field of specialisation together with Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities were the highest rated factors (Mean scores of 1.7) of agreement. The two lowest rated (relative) were that (i) Project Support Services show extensive experience in managing projects, and that (ii) However, project resources cannot perform activities across disciplines because departments are divided into specialist skills e.g. Protection, Tele-control, and Metering (Mean score of 2.17 and 2.18).

4.3.4.2 Assessing Adoption of Multi-Skilling at Eskom PTM Central Group

In order to assess the adoption of multi-skilling at Eskom PTM Central Group, sample subjects were required to respond to their best knowledge in answering to the six Likert scale statements. The frequency distribution of responses for each statement was summarized graphically as shown in Figures 4.19 to 4.24, and following afterwards is descriptive statistics summary.

a) Multi-skilling will encourage project resource learning from each other's past experiences

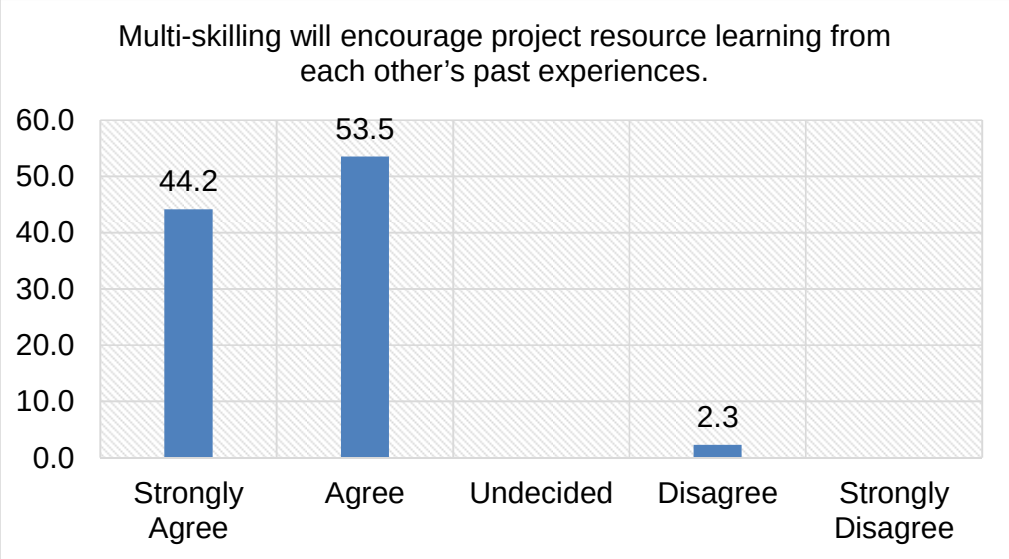


Figure 4.19: Response to multi-skilling ability to encourage learning

Almost all respondents (97.7%) believed that multi-skilling will encourage project resource learning from each other's past experiences and only very few disagree.

b) Multi-skilling will help Eskom PTM Central Group benchmark them-selves against best practice of the organization to uplift skillset and competency levels across all fields of work.

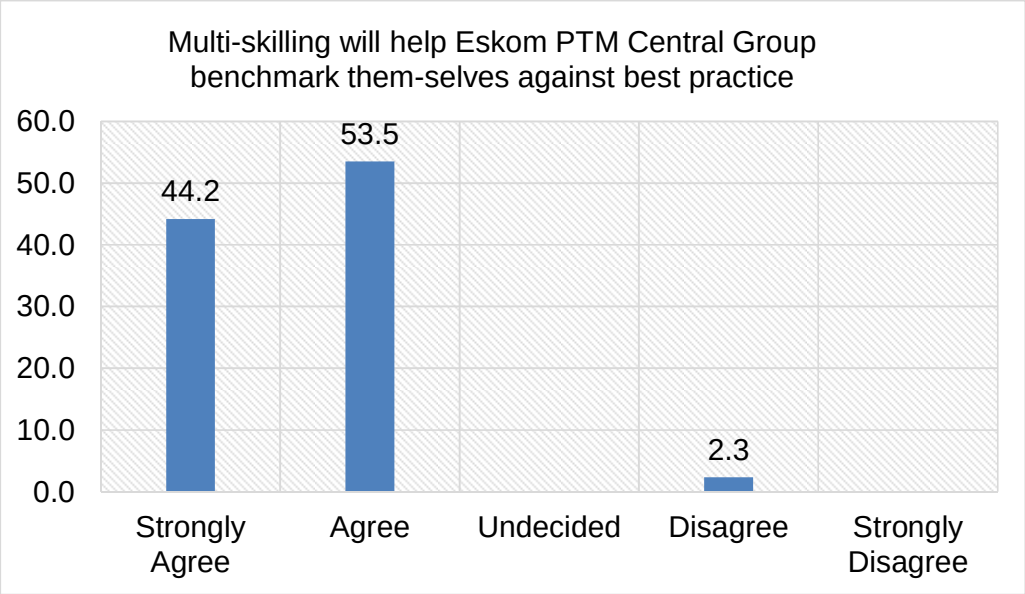


Figure 4.20: Response to multi-skilling and best practice

A vast majority of respondents (97.7%) felt that multi-skilling will help Eskom PTM Central Group benchmark them-selves against best practice of the organization to uplift skillset and competency levels across all fields of work and only a very few were in disagreement.

c) The use of multi-skilling at Eskom PTM will allow project resources to be easily scheduled between multiple projects

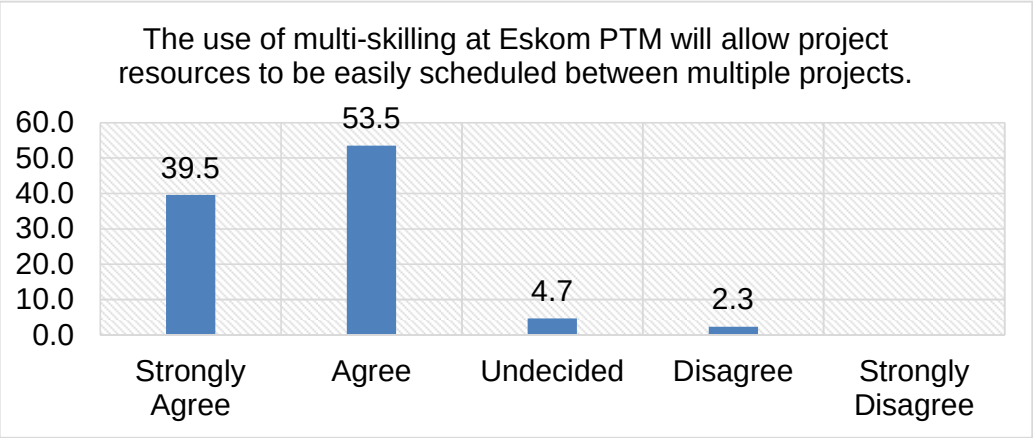


Figure 4.21: Responses to multi-skilling and project scheduling

Nine out of ten (93.0%) believed that the use of multi-skilling at Eskom PTM will allow project resources to be easily scheduled between multiple projects and less than one tenth did not agree.

d) Multi-skilled workforce will help increase project resource utilisation across all projects at Eskom PTM Central Group

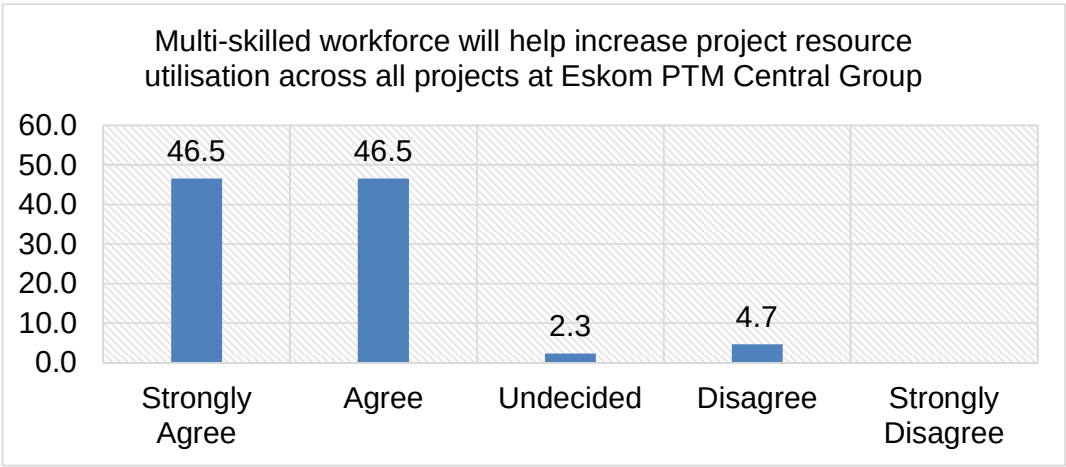


Figure 4.22: Responses to multi-skilling and project resource utilization

A 93% proportion (majority) of participants' held that multi-skilled workforce will help increase project resource utilisation across all projects at Eskom PTM

Central Group, with a minority of less than 10% who did not believe so. Notably, there was a tie between strongly agree and agree.

e) Using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section can generate cost recoveries against projects.

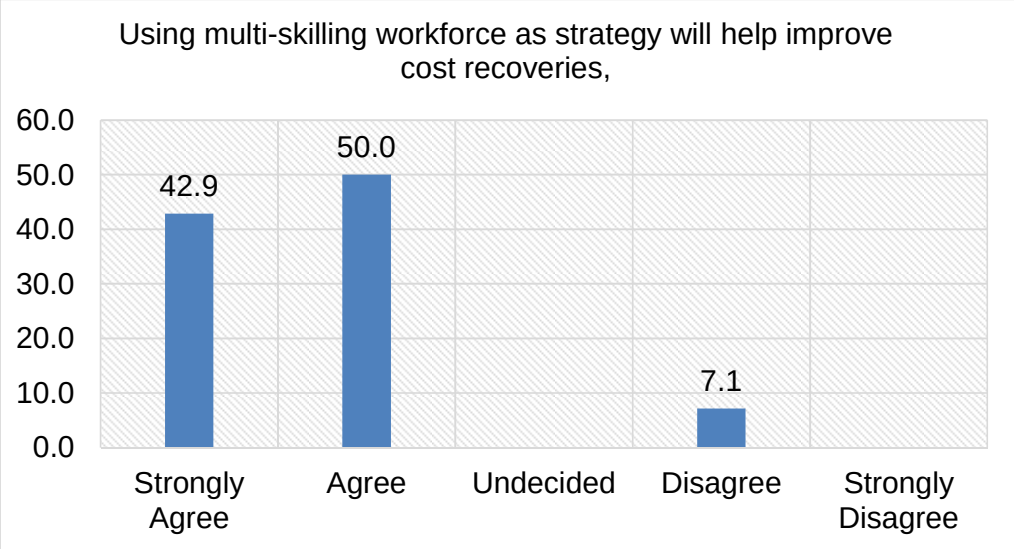


Figure 4.23: Responses to multi-skilling as strategy and cost recoveries

Approximately 93% of participants were of the view that using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section or department can generate cost recoveries against projects.

f) A well-executed change management process can help land multi-skilling strategy effectively at Eskom PTM Central Group

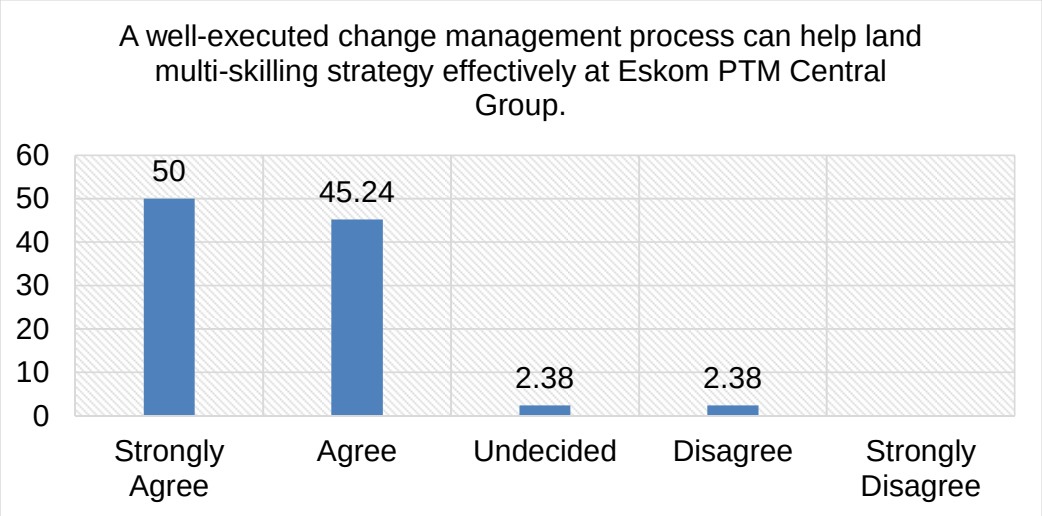


Figure 4.24: Response to change management process to support multi-skilling

An overwhelming majority (95.24%) of respondents believed that a well-executed change management process can help land multi-skilling strategy effectively at Eskom PTM Central Group and only a minority of 2.38% who were either in disagreement or in the neutral. Additionally, there were more participants who strongly agreed than those who agreed.

g) Descriptive Statistics Summary

Table 4.6: Assessing factors for adoption of multi-skilling

	N	Mean	Std. Deviation	Min	Max
A well-executed change management process can help land multi-skilling strategy effectively at Eskom PTM Central Group.	42	1.57	0.668	1	4
Multi-skilling will encourage project resource learning from each other's past experiences.	43	1.60	0.623	1	4
Multi-skilling will help Eskom PTM Central Group benchmark them-selves against best practice of the organization to uplift skillset and competency levels across all fields of work	42	1.61	0.623	1	4
Multi-skilled workforce will help increase project resource utilization across all projects at Eskom PTM Central Group	43	1.65	0.752	1	4
The use of multi-skilling at Eskom PTM will allow project resources to be easily scheduled between multiple projects.	43	1.70	0.674	1	4
Using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section can generate cost recoveries against projects	42	1.71	0.805	1	4

The highest rated factor (agreement) was A well-executed change management process can help land multi-skilling strategy effectively at Eskom PTM Central Group (Mean score of 1.5) suggesting a tendency that participants agreed more towards this factor.

The lowest rated factors (Mean scores of 1.7) were; (i) The use of multi-skilling at Eskom PTM will allow project resources to be easily scheduled between multiple projects. (ii) Using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section can generate cost recoveries against projects.

4.3.5 Evaluating the use of job redesign to facilitate workforce multi-skilling

This section talks to possible means practical to Eskom PTM Central Group to facilitate multi-skilling and make it a success story. Participants were asked factors that could be practical to the research site and responses were recorded and analysed. The frequency distribution of responses for each statement was summarized graphically as shown in Figures 4.25 to 4.27, and following afterwards is descriptive statistics summary.

4.3.5.1 On-job training can be used to facilitate multi-skilling at Eskom PTM Central Group

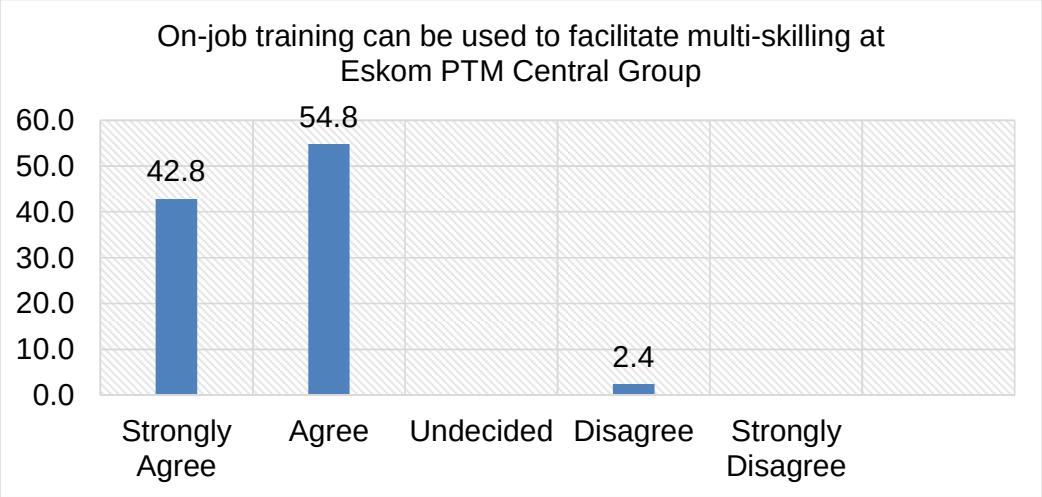


Figure 4.25: Responses to on-job training to facilitate multi-skilling

Job rotation is one of the most effective methods for empowering human resource (Saravani & Abbasi, 2013). Almost everybody (97.6%) in the sample study believed that on-job training can be used to facilitate multi-skilling at Eskom PTM Central Group and a very few in disagreement.

4.3.5.2 After on job training, job rotation can be used as one of other means to help facilitate multi-skilling

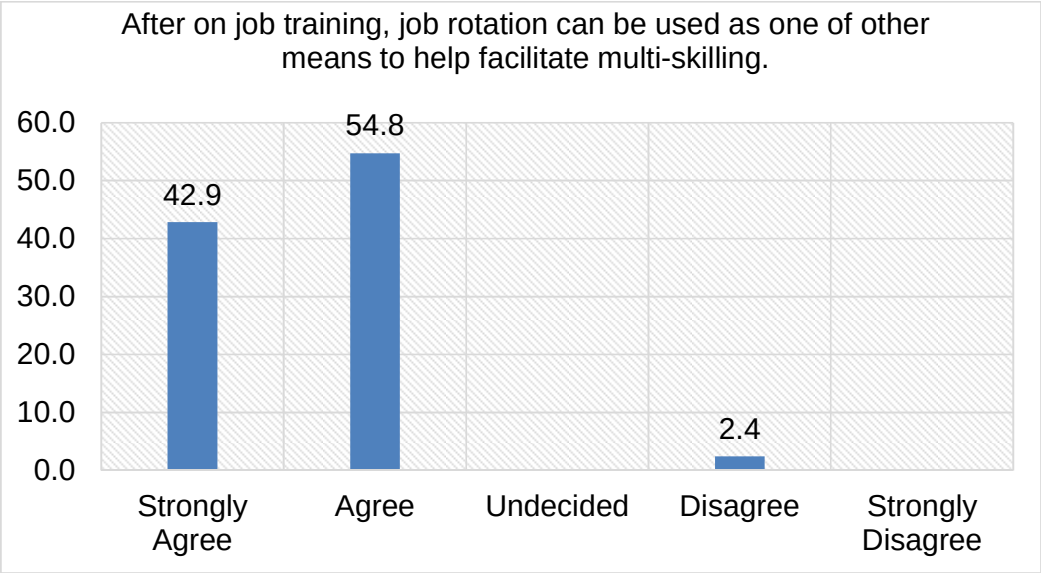


Figure 4.26: Responses to job rotation to facilitate multi-skilling

A massive weight in numbers of respondents (97.7%) were in support of this view and only 2.4% disagreed that after on job training, job rotation can be used as one of other means to help facilitate multi-skilling.

4.3.5.3 To support multi-skilling over and above on-job training and job rotation, managers can to set aside an adequate training budget for project resources to attend technical training on specific equipment.

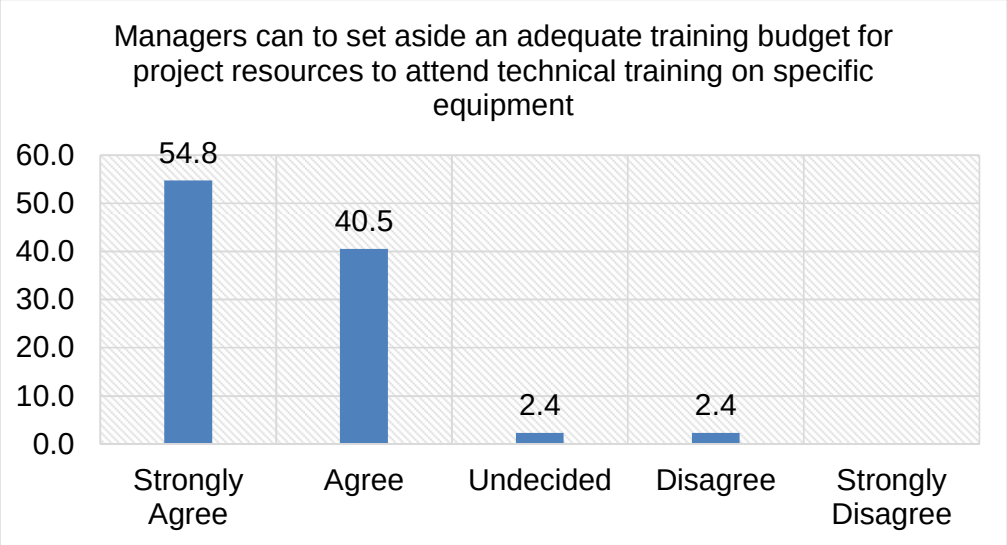


Figure 4.27: Responses to adequate training budget to facilitate multi-skilling

The majority of respondents (95.3%) believed that to support multi-skilling over and above on-job training and job rotation, managers can to set aside an adequate training budget for project resources to attend technical training on specific equipment. Notably, in this case there were more respondents who strongly agreed.

4.3.5.4 Descriptive Statistics Summary

Table 4.7: Practical means to facilitate multi-skilling

	N	Mean	Std. Deviation	Min	Max
To support multi-skilling over and above on-job training and job rotation, managers can to set aside an adequate training budget for project resources to attend technical training on specific equipment	42	1.52	0.671	1	4
On-job training can be used to facilitate multi-skilling at Eskom PTM Central Group	43	1.62	0.623	1	4
After on job training, job rotation can be used as one of other means to help facilitate multi-skilling.	42	1.62	0.623	1	4

All the practical means to facilitate multi-skilling at Eskom PTM Central Group mean scores indicate general agreement amongst respondents. To support multi-skilling over and above on-job training and job rotation, managers can to set aside an adequate training budget for project resources to attend technical training on specific equipment was the highest rated factor (Mean score of 1.5), while After on job training, job rotation can be used as one of other means to help facilitate multi-skilling was the least rated (Mean score=1.6).

4.4 RELIABILITY OF DATA

When using Likert-type scales it is very important to measure Cronbach's alpha coefficient for internal consistency reliability of scales (Creswell, 2014). Cronbach's alpha (Cronbach 1951) assesses the reliability of a summative rating (Likert 1932) scale composed of specified items. Cronbach's alpha measures internal consistency, that is, how closely related a set of items are as a group (Tavakol & Dennick, 2011). Table 4.8 below indicates results for all the Likert scale questions.

Table 4.8: Internal consistency reliability test

			item-test	**item-rest**	**Inter-item**	
Objectives	**Variable code**	Obs.	corr.	corr.	cov.	**alpha**
Influence of multi-skilled workforce on project scheduling flexibility	**SCHEDULE**	47	0.756	0.609	0.133	**0.815**
Relationship between multi-skilling and project cost savings	**COSTS**	47	0.811	0.703	0.129	**0.800**
Effect of multi-skilling on project duration	**DURATION**	46	0.582	0.362	0.155	**0.868**
Effect of adopting multi-skilling strategy at Eskom	**MULTISKILL**	45	0.649	0.494	0.152	**0.837**
Adoption of multi-skilling at Eskom	**ADOPTION**	42	0.865	0.791	0.120	**0.780**
Job redesign	**JOB**	42	0.844	0.763	0.124	**0.787**
unstandardized items	**Test scale**				0.135	**0.842**

The reviewed literature shows that results with an alpha coefficient of greater than 0.6 are very reliable and provide enhanced interpretation (Sekaran & Bougie, 2013).

The alpha coefficient for all the items was 0.84, this indicates that the questions in the designed electronic questionnaire instrument asked what they were intended to ask and provided reliable results for inferential statistics in the multivariate analysis.

4.5 NORMAL DISTRIBUTION TEST

Non normal data can occur because of the scaling of variables, for example the use of ordinal opposed to interval scaling or the limited sampling of subjects (Sekaran & Bougie, 2013). Table 4.9 shows the normal distribution test table.

Table 4.9: Skewness/Kurtosis tests for normality

Variable code	Obs	Pr(Skewness)	Pr(Kurtosis)	adj	chi2(2)	Prob>chi2
SCHEDULE	47	0.005	0.069		9.53	0.0085
COSTS	47	0.484	0.980		0.5	0.7778
DURATION	46	0.195	0.555		2.14	0.3427
MULTISKILL	45	0.826	0.502		0.51	0.7739
ADOPTION	42	0.009	0.055		8.87	0.0119
JOB	42	0.026	0.078		7.18	0.0276

From the univariate tests of normality, schedule, adoption, and job redesign does not appear to be normally distributed: p-values less than 0.05 (null hypothesis not rejected). Most data (responses) for these three variables lie below the mean score of two (2). The null hypothesis that multiskilling, costs, duration are not normally distributed is rejected, at least at the 5% level.

The graphs below depict the distribution of data for each sub dimension. An asymmetrical distribution with a long tail to the right (higher values) has a positive skew. An asymmetrical distribution with a long tail to the left (lower values) has a negative skew. Notably, all the dimensions are not normally distributed (bell shape); hence a conclusion is made to use non parametric tests in the inferential statistics that follow.

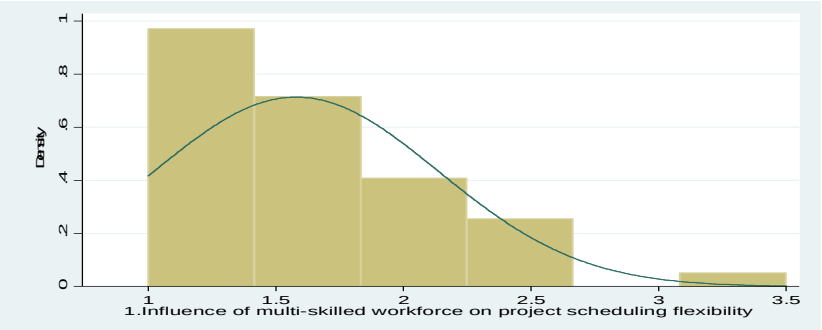


Figure 4.28: Project scheduling flexibility distribution test for normality

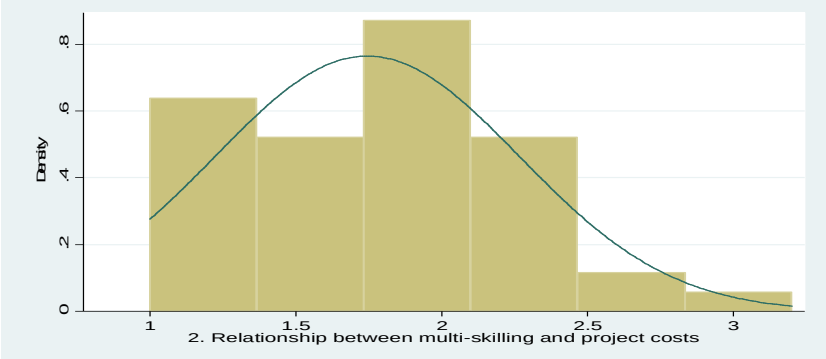


Figure 4.29: Multi-skilling and project costs distribution test for normality

Figure 4.30: Multi-skilling and project costs distribution test for normality

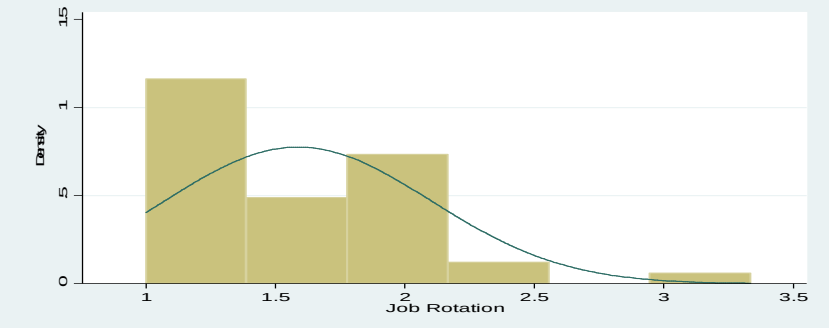


Figure 4.31: Multi-skilling and project costs distribution test for normality

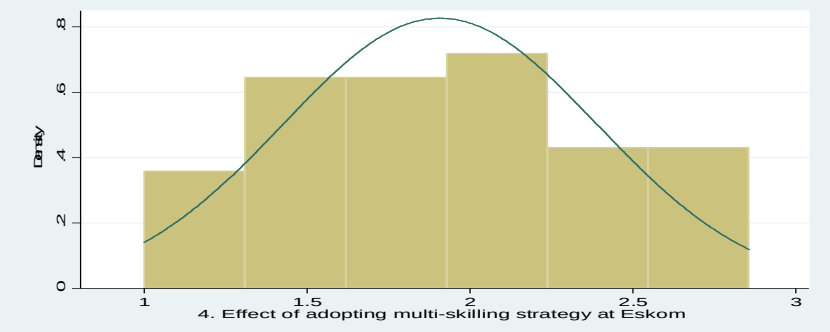


Figure 4.32: Multi-skilling and project costs distribution test for normality

Figures 4.28 to 4.32 indicate that most of the data lies' above the middle point, and between 1 and 2 a tendency to agree on all dimensions under the study. The graphs depict data that most of the data was not normally distributed, which is true for ordinal data such as Likert scale.

4.6 SPEARMAN'S CORRELATION

The Spearman rank order correlation is a nonparametric association measure of the strength and direction observed between two variables of a study. Also, the correlation coefficient ranges from -1 to +1, the measurement of 0 indicates no correction, -1 shows a strongest negative correlation, whilst +1 shows a strongest positive correlation (Zaid, 2015). The following table provides results for the association between the dependent and the independent variables. At statistical significance level of 5%.

4.6.1 Spearman's rank correlation

Table 4.10: Spearman's rank correlation results

	MULTIS~L	SCHEDULE	COSTS	DURATION	ADOPTION	JOB
MULTISKILL	1					
SCHEDULE	0.2872	1				
Two-tailed sig	0.0558					
COSTS	0.3586	0.5776	1			
Two-tailed sig	0.0156	0				
DURATION	0.3483	0.2569	0.3255	1		
Two-tailed sig	0.019	0.0848	0.0273			
ADOPTION	0.5464	0.6755	0.6418	0.3132	1	
Two-tailed sig	0.0002	0	0	0.0434		
JOB	0.4445	0.6022	0.7553	0.2846	0.7909	1
Two-tailed sig	0.0032	0	0	0.0677	0	

Table 4.10 above indicates that there are statistically significant associations between the different factors of multi-skilled workforce on the flexibility of project resource scheduling and project costs. Multi-skilling has weak positive association with flexibility of project resource scheduling ($r_{s=}0.3$; $p<0.05$), moderate association with project costs (($r_{s=}0.36$; $p<0.05$), duration ($r_{s=}0.35$; $p<0.05$), strong associations with adoption ($r_{s=}0.5$; $p<0.05$) and job redesign ($r_{s=}0.44$; $p<0.05$).

The results imply that an increase in multi-skilling is likely to improve project scheduling, costs, duration, and job redesign to facilitate multi-skilling.

Stronger positive associations, with statistically significant results are seen among project cost and schedule flexibility ($r_{S=}0.6$; $p<0.05$), schedule flexibility and adoption ($r_{S=}0.7$; $p<0.05$) as well as schedule flexibility and job redesign ($r_{S=}0.7$; $p<0.05$). Further strong positive associations occur between adoption and project costs ($r_{S=}0.6$; $p<0.05$), job redesign and project costs ($r_{S=}0.75$; $p<0.05$) and, job redesign and adoption ($r_S=0.8$; $p<0.05$). An increase in schedule flexibility, adoption strategies and job redesign is likely to contribute positively to project costs.

4.6.2 Spearman's rank correlations-demographics

Table 4.11: Spearman's rank correlations results on demographics

	MULTIS~L	SCHED~L	COSTS	DURA~N	ADOP~N	JOB
Gender	0.1229	0.1794	0.0157	0.0607	-0.0414	-0.0306
Two-tailed sig	0.4211	0.2277	0.9165	0.6888	0.7947	0.8476
Race	0.1031	0.0425	-0.0248	0.0964	0.2296	0.0506
Two-tailed sig	0.5003	0.7768	0.8683	0.5238	0.1435	0.7501
Age group	-0.2099	0.1745	0.2036	0.2205	0.107	0.1102
Two-tailed sig	0.1664	0.2408	0.17	0.1409	0.5001	0.4871
Job grade	-0.293	-0.1814	-0.0603	-0.0588	0.0241	-0.0406
Two-tailed sig	0.0508	0.2224	0.6871	0.6979	0.8797	0.7986
Experience	-0.2369	0.1242	0.193	0.205	0.1022	0.1312
Two-tailed sig	0.1172	0.4054	0.1936	0.1718	0.5195	0.4075
Education	0.0572	0.1481	0.1922	0.203	0.2363	0.293
Two-tailed sig	0.7092	0.3205	0.1956	0.176	0.1319	0.0596
Professional	0.0353	0.0842	0.0844	-0.3032	-0.0118	-0.0621
Two-tailed sig	0.8179	0.5738	0.5728	0.0405	0.9411	0.6959

Among demographic factors, it was only job grade and professional registration that showed significant negative weak associations (-0.293; -0.303<p-value<0.05). A unit decrease in grade is likely to lead to a low multiskilling levels. Furthermore, a unit professional registration is likely to lead to decrease project duration. The rest of the demographic factors were not significantly associated with the factors of multiskilling.

4.7 PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA) is a statistical method used for data reduction (Long & Freese, 2014). STATA was used to pick out factors affecting each of the study objectives. The purpose of PCA was to catch combinations of the variables with the highest variance (Afifi & Clark, 2012). In the following tables Table 4.12 to Table 4.16, only factors with an eigenvalue greater than one are considered critical (Acock, 2014).

4.7.1 Objective 1: The influence of multi-skilled workforce on project scheduling flexibility

Table 4.12: Principal component analysis: multi-skilled workforce on project scheduling

Component	Eigenvalue	Diff	Proportion	Cumu-lative	Principal components (eigenvectors)
Workforce multi-skilling helps cushion against unforeseen project schedule changes.	**2.41**	1.58	0.604	0.604	0.9456
Multi-skilled workforce helps improve project labour resource availability.	0.84	0.33	0.209	0.813	0.574
Multi-skilled workforce improves project labour resource utilization.	0.50	0.25	0.125	0.938	0.5106
The use of multi-skilled workforce could smoothen rescheduling of labour resources.	0.25	.	0.062	1.000	0.5523

Table 4.12 indicates that there was one most influential factor (eigenvalue>1) out of the four. This factor accounts for a 60.4% of total variance in the sub scale.

These results suggest that workforce multi-skilling cushion against unforeseen project schedule changes (factor loadings equals 0.95) could have as much as 2.4 times more weight than the other three in influencing project scheduling flexibility. The rest of the other factors, thus multi-skilled workforce helps improve project labour resource availability, multi-skilled workforce improves project labour resource utilization, and the use of multi-skilled workforce could smoothen rescheduling of labour resources, have no influence on project scheduling factors (eigenvalues less than 1).

4.7.2 Objective 2: Evaluating the relationship between multi-skilling and project costs

Table 4.13: Principal component analysis: multi-skilling and project costs

Component	Eigen-value	Diff	Proportion	Cumu-lative	Principal components (eigenvectors)
Multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge.	**2.25**	1.18563	0.4496	0.4496	0.8597
Multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs	**1.06**	0.310499	0.2125	0.6621	-0.7663
Multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge.	0.75	0.071644	0.1504	0.8125	0.5744
Provided that a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects.	0.68	0.423071	0.1361	0.9486	0.5143
The use of multi-skilled workforce can help cut project labour costs for Eskom PTM Central Group by reducing the number of labour workforce required per project.	0.26	.	0.0514	1	0.4832

Table 4.13 indicates that there were two most influential factors (eigenvalue>1) out of five. The first one accounts for a 44.9% while the second accounts for 21.3% of the total variance project costs. The two cumulatively contribute 66.2% of the total variance in project costs. These results suggest that the factor multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge (factor loadings=0.86) could have as much as 2.3 times as much weight as the other three in influencing project costs. The second most influential factor in this dimension is that multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs (factor loadings = 0.77), with a weight of 1.1 influence on project costs. These factors from 3 to 5 have no influence on project cost (eigenvalues are less than 1).

4.7.3 Objective 3: Evaluating the effect of multi-skilling on project duration

Table 4.14: Principal component analysis: multi-skilling on project duration

Component	Eigenvalue	Diff	Proportion	Cumu-lative	Principal components (eigenvectors)
The use of multi-skilled workforce will not reduce job activity duration because the job is not performed by specialist personnel.	**1.51**	0.366	0.502	0.502	**0.847**
Multi-skilled workforce utilization allows project managers control over activity sequencing meaning rearrangement of tasks to suit project time lines or targets.	**1.14**	0.788	0.380	0.882	**0.742**
Multi-skilled workforce tend to take longer to finish an activity, but the time lost on activity duration compensates for idle time that a specialist would have spent waiting for the next specialist job (specialist idle time cost).	0.35	.	0.118	1.000	

Table 4.14 indicates that there were two most influential factors (eigenvalue>1) out of three. The first one accounts for a 50.2% while the second accounts for 38% of total variance in the sub scale. The two cumulatively contribute to 88.2% of the total variance in project duration. These results suggest that the use of-

multi-skilled workforce will not reduce job activity duration because the job is not- performed by specialist personnel (factor loadings=0.84) could have as much as 1.5 times as much weight as the other two factors in influencing project duration.

The second most influential factor in this dimension is that multi-skilled workforce utilization allows project managers control over activity sequencing meaning rearrangement of tasks to suit project time lines and targets (factor loadings=0.74), it could have as much as 1.1 effect on project duration. The last factor has no influence on project duration (eigenvalues less than 1).

4.7.4 Objective 4(a): Evaluating the effect of adopting multi-skilling strategy at Eskom PTM Durban; Assessing project labour resources.

Table 4.15: Principal component analysis: adopting multi-skilling (an assessment on project labour resources)

Component	Eigen-value	Diff	Proportion	Cumu-lative	Principal components (eigenvectors)
Project Support Services show extensive experience in managing projects.	**2.88**	1.674	0.412	0.412	**0.7982**
However, project resources cannot perform activities across disciplines because departments are divided into specialist skills e.g. Protection, Tele-control, and Metering.	**1.21**	0.154	0.173	0.585	**0.7736**
Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities.	**1.06**	0.341	0.151	0.736	**0.6544**
Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities.	0.71	0.223	0.102	0.838	

Eskom PTM Central Group project resources are competent in terms of skills, technical knowledge, experience and proficiency in the execution of projects.	0.49	0.021	0.070	0.908	
Project management resources can negotiate project scope, time, cost and quality effectively with clients to meet in house business objectives.	0.47	0.294	0.067	0.975	
Project management resources are effective at managing risks from both financial and technical standpoint.	0.18	.	0.025	1.000	

Table 4.15 indicates that there were three most influential factors (eigenvalue>1) in multi-skilling adoption strategy, out of seven. The first one accounts for a 41.2%, the second accounts for 17.3% while the third factor accounts for 15% of the total variance in assessing Eskom PTM Central Group project resources for multi-skilling strategy adoption. The three cumulatively contribute to 73.6% of the total variance in project resource assessment for multi-skilling adoption as strategy. These results suggest that the first factor, project support services show extensive experience in managing projects (factor loadings = 0.79) could have as much as 2.9 times more weight than the other two factors in influencing project resource assessment for adoption of multi-skilling as strategy. The second most influential factor in this dimension is that project resources cannot perform activities across disciplines because departments are divided into specialist skills (factor loadings = 0.77), this could have as much as 1.2 effect on project resources assessment for multi-skilling strategy adoption. The third most influential factor in this dimension is that Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities (factor loadings = 0.65), this could have 1 times effect on-

this dimension. The other four factors have no influence in this regard (eigenvalues less than 1).

4.7.5 Objective 4(b): Evaluating the effect of adopting multi-skilling strategy at Eskom PTM Durban; assessing adoption of multi-skilling and job redesign.

Table 4.16: Principal component analysis: assessing adoption of multi-skilling

Component	Eigen-value	Diff	Proportion	Cum	Eigen-vectors
Using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section can generate cost recoveries against projects	**5.08**	3.583	0.564	0.564	0.754
On-job training can be used to facilitate multi-skilling at Eskom PTM Central Group	**1.49**	0.741	0.166	0.730	0.691
Multi-skilling will encourage project resource learning from each other's past experiences.	0.75	0.239	0.083	0.813	
Multi-skilling will help Eskom PTM Central Group benchmark them-selves against best practice of the organization to uplift skillset and competency levels across all fields of work	0.51	0.147	0.057	0.870	
The use of multi-skilling at Eskom PTM will allow project resources to be easily scheduled between multiple projects.	0.36	0.078	0.041	0.911	
Multi-skilled workforce will help increase project resource utilization across all projects at Eskom PTM	0.29	0.056	0.032	0.942	

After on job training, job rotation can be used as one of other means to help facilitate multi-skilling.	0.23	0.040	0.026	0.968	
To support multi-skilling over and above on-job training and job rotation, managers can to set aside an adequate training budget for project resources to attend technical training on specific equipment	0.19	0.093	0.021	0.989	
A well-executed change management process can help land multi-skilling strategy effectively at Eskom PTM Central Group.	0.10	.	0.011	1.000	

Table 4.16 indicates that there were two most influential factors (eigenvalue>1) in multi-skilling adoption strategy assessment, out of nine. The first one accounts for a 56.4%, while the second accounts for only 16.3% of the total variance in multi-skilling strategy adoption assessment. The two cumulatively contribute 73% of the total variance in this dimension. These results suggest that using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section can generate cost recoveries against projects (factor loadings=0.75) could have as much as 5 times more weight than the other eight factors in influencing this objective. The other most influential factor in this dimension is that On-job training can be used to facilitate multi-skilling at Eskom PTM Central Group (factor loadings=0.69), it could have 1.5 effects on multi-skills strategies adoption. The other seven factors have no influence on multi-skills strategies adoption (eigenvalues less than 1).

4.8 HYPOTHESIS TESTING

4.8.1 Paired t-tests

This sub section examines the relationship between the factors of multi-skilled workforce on project scheduling flexibility and project costs through paired t-tests for paired observations. This is done through four hypothesis tests. Specifically, the independent samples t-test compares the difference in the means from two groups to a given value, Stata calculates the t-statistic and its p-value under the assumption that the sample comes from an approximately normal distribution.

Hypothesis statements are predictions made by the researcher about expected results findings (Creswell, 2014). Therefore, following are research hypothesis statements:

4.8.1.1 Hypothesis 1: A relationship exists between multi-skilled workforce and project resource scheduling flexibility

The following table tests the null hypothesis that there is no relationship existing between multi-skilled workforce and project resource scheduling flexibility**.**

Table 4.17: Paired t-test: Multi-skilled workforce and project resource scheduling flexibility

Variable code	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
MULTISKILL	45	**1.91**	0.072	0.483	1.763	2.053
SCHEDULE	45	**1.61**	0.083	0.558	1.438	1.773
diff	45	**0.30**	0.093	0.624	0.115	0.490

Mean(diff) = mean (MULTISKILL - SCHEDULE), t = 3.3 Pr(|T| > |t|) = 0.002

The results indicate that there is a positive (0.30) difference between the means of multi-skilled workforce and project resource scheduling flexibility, the p-value associated with the t-test is statistically significant at 5% level ($p < 0.05$).

Hence, the null hypothesis (H_0: mean (diff) = 0) is rejected. A conclusion can therefore be made that there is a direct relationship between the two variables.

The t-statistics (t=3.3) suggests the use of multi-skilled workforce provides for flexible project resource scheduling as much as 3.3 times.

4.8.1.2 Hypothesis 2: Multi-skilling has a positive effect on the project cost savings

The following table tests the null hypothesis that there is no relationship existing between multi-skilled workforce and project cost savings.

Table 4.18: Paired t-test: Multi-skilled workforce and project cost savings

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
MULTISKILLED	45	**1.908**	0.072	0.483	1.763	2.053
COSTS	45	**1.773**	0.077	0.515	1.619	1.928
diff	45	**0.135**	0.084	0.565	- 0.035	0.304

Mean(diff) = mean(MULTISKILL - COSTS) t = 1.59 Pr(|T| > |t|) = 0.1174

The results indicate that there is negligible a positive (0.13) difference between the means of multi-skilled workforce and project costs, the p-value associated with the t-test is not statistically significant at 5% level (p >0.05). Hence, the null hypothesis (H_0: mean (diff) = 0) is *not rejected*. A conclusion can therefore be made that there is probably no positive relationship between multi-skilled workforce and project costs savings

4.8.1.3 Hypothesis 3: The use of multi-skilling has no significant impact on project duration

The following table tests the null hypothesis that there is no relationship existing between multi-skilled workforce and project duration.

Table 4.19: Paired t-test: Multi-skilled workforce and project duration

Variable code	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
MULTIS~L	45	**1.91**	0.072	0.483	1.763	2.053
DURATION	45	**2.22**	0.091	0.607	2.040	2.405
diff	45	**- 0.31**	0.094	0.630	- 0.504	- 0.125

Mean(diff) = mean(MULTISKILL - DURATION) t = -3.34 Pr(|T| > |t|) = 0.0017

The results indicate that there is a negative (0.31) difference between the means of multi-skilled workforce and project duration, the p-value associated with the t-test is statistically significant at 5% level ($p < 0.05$). Hence, the null hypothesis (H_0: mean (diff) = 0) is *rejected*. A conclusion can therefore be made that that there is no positive relationship between multi-skilled workforce and duration. In other words, the use of multi-skilling has 3.3 times negative significant impact on project duration.

4.8.1.4 Hypothesis $4_{(i)}$: There is a positive relationship between multi-skilled workforce and adoption of multi-skilling

The following table tests the null hypothesis that no relationship exists between multi-skilled workforce and adoption of multi-skilling.

Table 4.20: Paired t-test: Multi-skilled workforce and adoption of multi-skills

Variable code	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
MULTIS~L	42	**1.898**	0.074	0.482	1.748	2.048
ADOPTION	42	**1.635**	0.082	0.530	1.470	1.800
diff	42	**0.263**	0.075	0.484	0.112	0.414

Mean(diff) = mean(MULTISKILL-ADOPTION) t = 3.52 Pr(|T| > |t|) = 0.0011

The results above indicate that there is a positive (0.26) difference between the means of multi-skilled workforce and adoption of the multi skills, the p-value associated with the t-test is highly statistically significant at 5% level ($p < 0.05$). Hence, the null hypothesis (H_0: mean (diff) = 0) is *rejected*. A conclusion can therefore be made that that there is a positive relationship between multi-skilled workforce and adoption of multi-skills. In other words, the use of multi-skilling could have 3.5 times positive significant impact on multi skills adoption rate.

4.8.1.5 Hypothesis $4_{(ii)}$: There is a positive relationship between multi-skilling job redesign

The following table tests the null hypothesis that there is no relationship existing between multi-skilled workforce and job redesign.

Table 4.21: Paired t-test: Multi-skilled workforce and job redesign

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
MULTIS~L	42	**1.90**	0.074	0.482	1.748	2.048
JOB	42	**1.59**	0.079	0.514	1.427	1.748
diff	42	**0.31**	0.081	0.526	0.147	0.475

Mean(diff) = mean(MULTISKILL - JOB) t = 3.8 Pr(|T| > |t|) = 0.0004

The results above indicate that there is a positive (0.31) difference between the means of multi-skilled workforce and job redesign, the p-value associated with the t-test is highly statistically significant at 5% level ($p < 0.05$). Hence, the null hypothesis (H_0: mean (diff) = 0) is *rejected*. A conclusion can therefore be made that there is a positive relationship between multi-skilled workforce and job redesign. In other words, the use of multi-skilling could have 3.8 times positive significant impact on job redesign.

4.8.2 Hypothesis summary

There is evidence that the use of multi-skilled workforce provides for flexible project resource scheduling as much as 3.3 times. There is probably no positive relationship between multi-skilled workforce and project costs. Further results indicate that using multi-skilling has 3.3 times negative significant impact on project duration. The use of multi-skilling could have 3.8 times positive significant impact on job redesign. Lastly, the use of multi-skilling could have 3.5 times positive significant impact on multi skills adoption rate.

4.9 CHAPTER SUMMARY

This chapter was focused on the analysis and interpretation of respondents' data collected using an electronic questionnaire instrument on Question-pro and all statistical analyses were conducted using STATA. The demographic characteristics analysis of respondents' was followed by frequency distribution and descriptive statistics presentation and interpretation of the study objectives. Test for questionnaire internal reliability and normal distribution tests were conducted to validate research study data. Accordingly; correlation analysis, principal component analysis and hypothesis testing was conducted.

The next chapter forms the analysis and discussion of results, furthermore connects results findings to the literature reviewed earlier in chapter two.

5 CHAPTER FIVE: DISCUSSION

5.1 INTRODUCTION

This chapter provides discussion based on research results findings presented in chapter 4. The results will be interpreted and explained in conjunction with conducted literature review earlier in chapter 2 to understand how the results linkup with the objectives of the study. Furthermore, this chapter is divided into subsections; frequencies, percentages and descriptive statistics data, correlation of variables, hypothesis testing, structural equation model and multiple regression analysis discussion. Next is a recap of research aim and objectives;

The aim of the study is to evaluate the effect of using multi-skilled workforce in the execution of project activities by studying the changes in project execution resource scheduling flexibility, project labour costs and duration of projects in response to workforce multi-skilling and the use of job rotation as strategy to facilitate multi-skilling.

- To measure the influence of multi-skilling on flexibility of project scheduling
- To evaluate the relationship between multi-skilling and project labour costs
- To study the effect of multi-skilling on the duration of the project
- To evaluate multi-skilling and adoption rate of multi skills
- To evaluate the use of job redesign to facilitate workforce multi-skilling

5.2 DESCRIPTIVE STATISTICS INTERPRETATION AND DISCUSSION

5.2.1 Biographical Information of Participants

The biographical information obtained showed that most participants were more likely to be Africans between the ages of 31-40 years, holding a senior technician position (T12) with 6-10 years of experience, possessing a national diploma and belonging to a professional body. These suggests that most respondents' were matured, experienced, educated and registered to a professional body, meaning responses obtained are a good indicative reflection of the research site and will best contribute truly in examining the research objectives.

5.2.2 Objective 1: Influence of Multi-Skilled Workforce on Project Scheduling Flexibility

This objective studied the influence of multi-skilled workforce on project scheduling flexibility using four Likert scale statements.

An overwhelming majority (95.7%) of respondents believe that multi-skilled workforce helps improve project labour resource availability. The descriptive statistics showed a Mean score of 1.55 suggesting the highest tendency of agreement and a standard deviation of 0.717 indicating there were no outliers in responses. The results concur with the literature review, a study by Irene (2009) suggests that to improve management strategies, decrease the mismatch between required and available skilled labour. And, the results analysis of the study showed that no matter how volatile the construction project is, the composition of labour resources by trades is stable if employer uses multi-skilling.

Nine out of ten (93.6%) of respondents believed that multi-skilled workforce improves project labour resource utilization. The descriptive statistics showed a Mean of 1.53 and standard deviation of 0.747 suggesting second highest agreement rate and zero response outliers. These results align with conducted literature review, the advantage to multi-skilled resource strategy is that each worker possesses multiple skills that allow them to participate in any activity that fits one of their skills and this has been proposed to improve project workforce resource scheduling and utilization (Jaskowski, 2013).

The majority of participants (93.6%) were certain that the use of multi-skilled workforce could smoothen rescheduling of labour resources from one project to another in multiple project environments such as Eskom PTM Central Group. The descriptive statistics showed a Mean score of 1.55 and standard deviation of 0.686 suggesting a tendency of agreement and no response outliers. The results are supported by literature reviewed, which state The concept of multi-skilling allows firms the flexibility to reallocate labour resources in response to volatile industry demands (DeVaro & Farnham, 2010).

Approximately nine out of ten (89.3%) of participants in this section believed that workforce multi-skilling helps cushion against unforeseen project schedule changes. Descriptive statistics shows a Mean score of 1.68 suggesting a tendency to agree and standard deviation 0.783 indicating that there were no outliers in the responses. The results translates well to the literature reviewed, that is the concept of multi-skilling allows firms the flexibility to reallocate labour resources in response to volatile industry demands (DeVaro & Farnham, 2010).

5.2.3 Objective 1: Summary

Project resource scheduling flexibility was one of the most important factors considered when measuring project delivery success, hence why it is always advisable for businesses to embark on alternative human resource team configurations to provide project scheduling flexibility. The fact that majority of respondents agreed to all factors in this objective of the study could mean that multi-skilled workforce has an influence on project scheduling flexibility. And, multi-skilled workforce helps improve project labour resource utilization was the highest rated factor in terms of agreement but not significantly different from the other three factors. Since all the literature reviewed supported the results in this objective, it could also mean that Eskom PTM Central Group department could most probably agree with reviewed literature that an organization with multi-skilled personnel enjoys flexible labour-force benefits which provide the employer ability to schedule and arrange workforce to best suit the needs of the business (Rajendra, 2016).

5.2.4 Objective 2: Evaluating the relationship between multi-skilling and project costs

Nine out of ten respondents (91.5%) felt that the use of multi-skilled workforce can help cut project labour costs for Eskom PTM Central Group by reducing the number of labour workforce required per project. The descriptive statistics showed a Mean score of 1.57 and standard deviation 0.715, suggesting the high trend towards agreement and no outliers in responses. The results are supported by conducted literature review stating that an organization that has adopted multi-skilling can operate with a reduced number of employees to fulfil business operations, since multi-skilled employees move with the workload instead of waiting for the work to come to a stage where a specialist skill is needed and this leads to fewer idle work hours as a result reducing project costs (Rajendra, 2016).

Eight out of ten (83%) also felt that multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs, compared to less than 10% who either were undecided or did not agree. The descriptive statistics showed a Mean score of 1.83 which proposes that there was a general tendency to agree and the standard deviation 0.916 shows there were not outliers in responses. These results are in line with literature from recent research which view utilization of multi-skilled workforce as strategy to increase productivity, decrease indirect labour costs, and reduce staff turnover (Abotaleb, et al., 2014).

Not many respondents in this question (63.8%) felt that multi-skilled workforce lack of skill specialization can drive up project costs through defects resulted due to lack of expert knowledge. Descriptive statistics showed a Mean score 2.28 and standard deviation 1.155 suggesting a second highest inclination to agreement and that there were no response outliers. The results concur with the literature reviewed, the challenge with scheduling single skilled human resources is a well-known problem in project management but project scheduling with multi-skilled workforce is an extended problem due to the fact that this option requires a multi-skilled staff compliment as it assumes that any resource can competently perform a project task that requires a range of skills (Zha & Zhang, 2014).

Almost all respondents (97.9%) felt that provided a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects. The descriptive statistics Mean score 1.49 and standard deviation 0.621, showing the highest propensity to agreement and no response outliers. These results concur with conducted literature review, employees perceive training as a piece that allows them to improve their skills to offer customers better services and on the other hand for the company, training employees shows a strong commitment on employees and also demonstrates the value that an employer has on the employees (Kepha, et al., 2014). At Eskom PTM there are sessions conducted on lessons learnt during the lifecycle of the project, which must be consolidated and submitted to Knowledge Management to be captured in the organisational data repository for future reference and benefit to similar programmes.

5.2.5 Objective 2: Summary

There was strong alignment between the results and literature reviewed. These results showed that majority of respondents were in agreement with all the factors in this objective and this could mean that there is a relationship between multi-skilling and project costs. And, the highest ranked factor in terms of agreement rate stated, provided that a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects. The results overview of this objective is supported by the literature reviewed which states that proper utilization of multi-skilled workforce should lead to cost savings due to lower turnover rates, high productivity rate and reduced accidents (Burleson, et al., 1998), also a study conducted by (Abotaleb, et al., 2014), showed that the use of multi-skilling handles one major concern; which is labour wages costs efficiency.

5.2.6 Objective 3: Evaluating the effect of multi-skilling on project duration

Six in ten (60.8%) of respondents, felt that the use of multi-skilled workforce will not reduce job activity duration because the job is not performed by specialist personnel. The descriptive statistics showed a Mean score of 2.61 and a standard deviation of 1.125 suggesting mild tendency to generally agree and there were no outliers in responses. The results refute reviewed literature which state, effective scheduling of multi-skilled labour resources reduces the project activity duration overruns and lags between activities, otherwise unavoidable when using single-skilled labour resources (Lill, 2009). Logically, specialist personnel will probably always be an expert in a particular job skill than multi-skilled personnel.

Majority of respondents, nine in ten (93.4%) felt that multi-skilled workforce utilization allows project managers control over activity sequencing, in other words rearrangement of tasks to suit project time lines and targets. The descriptive statistics showed a Mean score of 1.78 and standard deviation of 0.629, this shows a highest susceptibility to agreement and no outliers in responses. These results concur with reviewed literature which states that, in a business with flexible staff complement possessing multi-skills, planning of activities and project resource scheduling focuses on stakeholder needs than on staff capabilities (Rajendra, 2016). This then mean multi-skilling can be a very useful tool to consider when planning project staffing and scheduling.

Seven out of ten (69.5%) felt that multi-skilled workforce tends to take longer to finish an activity, but the time lost on activity duration compensates for idle time that a specialist would have spent waiting for the next specialist job (specialist idle time cost). The descriptive statistics showed a Mean score of 2.28 and a standard deviation 1.026, showing mild tendency of agreement and no response outliers. These results concur with literature reviewed which states that the use of multi-skilling handles a major concern known as labour wages costs efficiency and also referred to as specialist idle time cost (Abotaleb, et al., 2014). In response to results, the project management can compile and analyse programme assurance reports regularly in order to determine programme deviations, and implement corrective action plans.

This means that the planned versus actual results are compared in-terms of physical deliverables and expenditure to determine whether the programme is on track, including earned value analysis (Eskom, 2016).

5.2.7 Objective 3: Summary

There was a good alignment of results to reviewed literature. The results showed that majority of respondents were in agreement with all the factors in this objective and this could mean that multi-skilling has an effect on project duration. The highest ranked factor in this dimension in terms of agreement rate was that multi-skilled workforce utilization allows project managers control over activity sequencing meaning rearrangement of tasks to suit project time lines or targets. This suggests a solution to the cost recovery problem facing Eskom PTM Central Group, where optimal utilization of resources on project work is vital for departments to meet monthly direct labour overheads. The longer a resource is scheduled on projects the better because projects buy direct labour time from corresponding departments.

5.2.8 Objective $4_{(a)}$: Evaluating multi-skilling and adoption of multi skills

This objective seeks to evaluate the effect of multi-skilling on the adoption of skills, to best understand how multi-skilling can be used as strategy at Eskom PTM Central Group and bring about alternative solutions to the existing problem of project resource constraints, scheduling issues, project duration overruns and costs. The first attempt is to assess current Eskom PTM Central Group project resource proficiency in project execution, to understand whether their lack of multi-skilling practice is a constituency of departmental job description structure or employee capacity to possess multiple skills. The next step is to assess the likeliness for the department to adopt multi-skilling and its promising solutions to current faced challenges by the business unit.

5.2.8.1 First Sub Objective: Assessing Eskom PTM Central Group Project Resources:

Almost nine out of ten (89.2%) of respondents, felt that Eskom PTM Central Group project resources are adequately qualified in their respective field of specialization. The descriptive statistics showed a Mean score of 1.74 and a standard deviation of 0.648, suggesting a general propensity to agreement and no response outliers were observed. The results are in-line with observed respondents' biographic information which suggests that the all participants held either a diploma or degree, with the majority holding a diploma. Furthermore, Eskom requirements for entry level junior technician (T11) are a national diploma and zero years of experience. Also in this category six out of ten (61 %) respondents belong to a professional body, suggesting high level of professionalism amongst Eskom PTM Central Group employees.

Seven out of ten (73.9%) of respondents believed that Project Support Services show extensive experience in managing projects. The descriptive statistics show a Mean score of 2.17 and a standard deviation of 0.950, suggesting a general tendency of agreement and no outliers in responses. The results concur with reviewed literature that the project engineering manager is responsible for the overall engineering effort including managing the integrated engineering team and coordinating technical effort with suppliers, contractors, and consultants as well as managing all internal Eskom processes and departments (Eskom, 2016).

Eight out of ten (84.8%) of respondents, felt that Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities. The descriptive statistics show a Mean score of 1.85 and a standard deviation of 0.842, suggesting a general trend of agreement and no outliers in responses. The results align with the literature review, project team members are required to provide a weekly progress sheet and timesheet to the relevant project co-ordinator or planner to ensure proficiency in execution (Eskom, 2016). Also, Eskom PTM Central Group conducts monthly progress meetings to measure planned versus actual progress, however most scholars critique this initiate due to its reactive nature and lack of control in real time execution activities.

Vast majority of respondents, nine out ten (91%) positively perceived that Eskom PTM Central Group project resources are competent in terms of skills, technical knowledge, experience and proficiency in the execution of projects. The descriptive statistics show a Mean score of 1.76 and a standard deviation of 0.743, suggesting high inclination to agreement and no outliers in responses. The results support the literature reviewed, project technicians ensures start to finish delivery of the final engineering solution. They co-ordinates and integrate design work provided by Design Engineering discipline to produce an integrated product (Eskom, 2016). Predominantly, Eskom PTM Central Group overheads are covered by revenue contributions from project execution work, thus installation and commissioning of Eskom Distribution and Transmission substations.

Seven out of ten (73.3%) of respondents believed that project resources cannot perform activities across disciplines because departments are divided into specialist skills e.g. protection, tele-control, and metering. The descriptive statistics indicate a Mean score of 2.18 and a standard deviation of 1.173, suggesting a mild tendency of agreement and no outliers in responses. The results are supported by how Eskom PTM Central Group business unit is structured. This department comprises a mix of electrical engineering disciplines; Telecontrol, Protection, Metering, DC Power Sources and Air Conditioning. However, technician training and development is restricted to one of the disciplines mentioned above and as a result technicians focus only on one part of project execution scope of work.

A vast majority of participants, nine out of ten (91%) believed that project management resources can negotiate project scope, time, cost and quality effectively with clients to meet in house business objectives. The descriptive statistics show a Mean score of 1.84 and a standard deviation of 0.767, suggesting a high propensity to agreement and no outliers in responses. The results concur with reviewed literature which states that the project co-ordinator provides resource scheduling, project controls tools, standards and services to support the Project engineering manager (Eskom, 2016).

A large proportion (91.1%) of respondents indicated in agreement that project management resources are effective at managing risks from both financial and technical standpoints. The descriptive statistics show a Mean score of 1.87 and a standard deviation of 0.625, this suggests a high inclination to agreement and no outliers in responses. The results concur with reviewed literature that states that Eskom programme management strives to enable the tracking of an aggregation of projects to oversee resource allocation, prioritize on-going investment decisions and track projects costs, schedule, risks and benefits as part of an overall programme management (Eskom, 2014).

5.2.8.2 First Sub Objective: Summary

The results showed to be strongly aligned with reviewed literature. The fact that the results indicated that majority of respondents were in agreement with all the factors in this objective could mean that the assessment of Eskom PTM Central Group project resources for proficiency in current skills before multi-skilling was positive. The highest ranked factors in this aspect in terms of rate of agreement were that Eskom PTM Central Group project resources are adequately qualified (educated) in their respective field of specialisation, also Eskom PTM Central Group project resources are competent in terms of skills, technical knowledge, experience and proficiency in the execution of projects.

5.2.8.3 Second Sub Objective: Assessing Adoption of Multi-Skilling at Eskom PTM Central Group

Almost all respondents (97.7%) believed that multi-skilling will encourage project resource learning from each other's past experiences and only very few disagree. The descriptive statistics show a Mean score of 1.60 and a standard deviation of 0.623, this suggests a high inclination to agreement and no outliers in responses. The results concur with reviewed literature that states the key to the concept of multi-skilling is formal acknowledgement and encouragement of knowledge sharing amongst employees (Srinivasan, 2014). Also beneficial to Eskom PTM Central Group in this regard is the transferring of tacit knowledge among project members, thus safeguarding knowledge in cases of knowledgeable staff movements.

Also noteworthy is that the highest ranked factor in objective 2 (Provided that a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects) proposed an idea that multi-skilling offers platform for knowledge sharing and in that help provide alternative cost cutting solutions.

A vast majority of respondents (97.7%) felt that multi-skilling will help Eskom PTM Central Group benchmark them-selves against best practice of the organization to uplift skillset and competency levels across all fields of work. The descriptive statistics show a Mean score of 1.61 and a standard deviation of 0.623, this suggests a high inclination to agreement and no outliers in responses. The results align with reviewed literature which states that key to the concept of multi-skilling is formal acknowledgement and encouragement of knowledge sharing amongst employees (Srinivasan, 2014).

Nine out of ten (93.0%) believed that the use of multi-skilling at Eskom PTM will allow project resources to be easily scheduled between multiple projects. The descriptive statistics indicate a Mean score of 1.70 and a standard deviation of 0.674, this suggests a high inclination to agreement and no outliers in responses. The results concur with reviewed literature that an organization with multi-skilled personnel enjoys flexible labour-force benefits which provide the employer ability to schedule and arrange workforce to best suit the needs of the business (Rajendra, 2016). This could solve the challenge for Eskom PTM Central Group of having to source labour resources from other provinces for last minute project crushing in-order to meet project timelines. Rightfully, this aspect strengthens results obtained in objective 1 that multi-skilled workforce could have an influence on project scheduling flexibility.

A nine out ten majority (93%) of participants held that multi-skilled workforce will help increase project resource utilisation across all projects at Eskom PTM Central Group. The descriptive statistics show a Mean score of 1.65 and a standard deviation of 0.752, this suggests a high inclination to agreement and no outliers in responses. The results support reviewed literature that the advantage to multi-

skilled resource strategy is that each worker possesses multiple skills that allow them to participate in any activity that fits one of their skills and this has been proposed to improve project workforce resource scheduling and utilization (Jaskowski, 2013). Accordingly, these results concur with results obtained by the highest ranked factor under objective 1 (multi-skilled workforce improves project labour resource utilization).

Approximately 93% of participants were of the view that using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section or department can generate cost recoveries against projects. The descriptive statistics indicate a Mean score of 1.71 and a standard deviation of 0.805, this suggests a high inclination to agreement and no outliers in responses. The results concur with reviewed literature that the concept of multi-skilling compels workers to be more competitive, and that allows workers to be scheduled longer on a project therefore allowing for more utilization and flexible resource scheduling in-cases such as unforeseen maintenance activities, because multi-skilled workforce possesses a wider variety of skills (Irene, 2009). Interestingly, the longer a project resource remains utilized in projects could translate to a win-win result for both project engineering and Eskom PTM Central Group, because the results in this aspect concurs with results obtain by the highest ranked factor in objective 2 which states provided that a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects.

An overwhelming majority (95.24%) of respondents believed that a well-executed change management process can help land multi-skilling strategy effectively at Eskom PTM Central Group. The descriptive statistics indicate a Mean score of 1.57 and a standard deviation of 0.668, this suggests a high propensity to agreement and no outliers in responses. The results support the literature reviewed which states that multi-skilling implementation programmes have radical capacity to create changes in nearly all dimensions of the business; workforce,

workplace and labour union regulation, hence a good change management plan is recommended (Rajendra, 2016).

5.2.8.4 Secondary Sub Objective: Summary

The results obtained in this objective indicate a strongly alignment with the reviewed literature. Moreover, the results were cross referenced to other objectives of this research and results from similar factors concurred, in that also proved consistency in responses. Therefore, fact that these results show majority of respondents agreeing with all factors in this objective could mean that the Adoption of Multi-Skilling at Eskom PTM Central Group is very possible. And, due to statistical insignificance the highest ranked factors in this aspect in terms of agreement were more than one; (i) A well-executed change management process can help land multi-skilling strategy effectively at Eskom PTM Central Group. (ii) Multi-skilling will encourage project resource learning from each other's past experiences. And, (ii) Multi-skilling will help Eskom PTM Central Group benchmark them-selves against best practice of the organization to uplift skillset and competency levels across all fields of work.

5.2.8.5 Objective 4(b): Evaluating the use of job redesign to facilitate workforce multi-skilling

This objective focuses on possible practical means to facilitate multi-skilling at Eskom PTM Central Group and make it a success. Job redesign in this context suggests an alternative option to remodel workplace processes such that employees can attain more skill sets and perform cross functional duties and in that increasing departmental talent pool. There were three identified practical ways for Eskom PTM Central Group to facilitate multi-skilling; on job training, job rotation and classroom training.

Almost everybody (97.6%) in the sample study believed that on job training can be used to facilitate multi-skilling at Eskom PTM Central Group. The descriptive statistics indicate a Mean score of 1.60 and a standard deviation of 0.623, this suggests a high tendency to agreement and no outliers in responses.

The results concur with literature reviewed which states that with multi-skilling adoption, employees enjoy cross functional training to increase skills competency and at the same time organizations enjoy increasing talent pool, thus labour force resource availability (Srinivasan, 2014).

A massive weight in numbers of respondents (97.7%) were in support of this view that after on job training, job rotation can be used as one of other means to help facilitate multi-skilling. The descriptive statistics indicate a Mean score of 1.62 and a standard deviation of 0.623, this suggests a high propensity to agreement and no outliers in responses. These results concur with reviewed literature stating that job rotation enhances productivity of human resources and improve organizational performance at both company and individual level by multi-skilling employees through training, and therefore creating a logical efficient interface between skill and employee motivation (Saravani & Abbasi, 2013).

The majority of respondents (95.3%) believed that to support multi-skilling over and above on-job training and job rotation, managers can to set aside an adequate training budget for project resources to attend technical training on specific equipment. The descriptive statistics indicate a Mean score of 1.52 and a standard deviation of 0.671, this suggests a high propensity to agreement and no outliers in responses. The results align with literature reviewed which states that with multi-skilling adoption, employees enjoy cross functional training to increase skills competency and at the same time organizations enjoy increasing talent pool, thus labour force resource availability (Srinivasan, 2014). Additionally, some organizations brag about bigger spending's each quarter on training and development of new skill-sets to improve resource competence and availability to perform more job processes (Srinivasan, 2014).

5.2.8.6 Objective 4(b): Summary

There was strong alignment between the results of this sub objective and literature reviewed. The results indicate that bulk of respondents were in agreement with all the factors in this dimension and this could mean that job redesign can be used to facilitate workforce multi-skilling at Eskom PTM Central Group. The highest ranked factor in this category in terms of propensity to agreeing was that to support multi-skilling over and above on-job training and job rotation, managers can to set aside an adequate training budget for project resources to attend technical training on specific equipment.

5.3 RESEARCH STUDY VARIABLE CORRELATIONS

This section will discuss statistical variable correlations of the study and draw up results to defined hypothesis statements. Normal distribution test was conducted and all data was not normally distributed, hence a conclusion was made to use non parametric tests in the inferential statistics performed.

5.3.1 Spearman's Correlation

The conducted Spearman's correlation test indicated that multi-skilling has a weak positive association with project resource scheduling flexibility, moderate association with project costs, duration, strong associations with adoption and job redesign. The results suggest that an increase in multi-skilling is likely to improve project scheduling, costs, duration, and job redesign to facilitate multi-skilling. Interestingly, according to Brown, et al..(2007) for a project to be deemed successful, the project must be suitable for purpose and achieve all deliverables, however, time, cost and quality remain as central project management delivery targets. Aligning the correlation results to this theory, it can be interpreted that an increase in multi-skilling could translate to success of a project, taking into account that the objectives of this study are project delivery measures of success. And therefore the correlation results support the hypothesis statements of this study; H1: The use of multi-skilled workforce provides for flexible project resource scheduling, H2: Multi-skilling has a positive effect on the project cost savings, H3: The use of multi-skilling has no significant impact on project duration.

Also, $H4_{(i)}$: Multi-skilling has a positive impact on multi skills adoption rate and $H4_{(ii)}$: There is a positive relationship between job redesign and multi-skilling.

5.3.2 Principal Component Analysis

5.3.2.1 Objective 1: The influence of multi-skilled workforce on project scheduling flexibility

The principal component analysis indicates that for multi-skilling to have an influence on project scheduling flexibility, improvement measures must be put in place for the factor (workforce multi-skilling helps cushion against unforeseen project schedule changes) as it accounts for more than half of total variance in objective 1 scale and 2.4 times more influential than other factors in this regard.

5.3.2.2 Objective 2: Evaluating the relationship between multi-skilling and project costs

The objective to evaluate a relationship between multi-skilling and project costs under principal component analysis shows two factors with a combined 66.2% weight on total variance and 3.3 times more influential than other factors. These factors; (i) multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge, and (ii) Multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs; suggest that Eskom PTM Central Group would need to improve on these factors to fully realize maximum positive results from this objective 2.

5.3.2.3 Objective 3: Evaluating the effect of multi-skilling on project duration

The principal component analysis on objective 3 that is evaluating the effect of multi-skilling on project duration and two factors indicated Eigenvalues of 1.51 and 1.14 were the most weighed to be influential under the scale. The results mean that the combined 88.2% contribution of the total variance by these two factors spells immediate trouble for this objective translate to optimal contribution potential. Therefore, it is crucial to find an alternative solution or improvement to the following factors; (i) the use of multi-skilled workforce will not reduce job activity duration because the job is not performed by specialist personnel,

and (ii) multi-skilled workforce utilization allows project managers control over activity sequencing meaning rearrangement of tasks to suit project time lines or targets.

5.3.2.4 Objective 4(a): Evaluating the effect of adopting multi-skilling strategy

The principal component analysis indicated three factors with 73.6% contribution to total variance in this regard and also combined could have as much as 5.15 times more weight than other factors influencing project resource assessment for multi-skilling adoption as strategy. These results suggest a need for improvement in these following areas as results show conflicts in respondent views, (i) Project support services show eextensive experience in managing projects. (ii) Project resources cannot perform activities across disciplines because departments are divided into specialist skills e.g. Protection, Tele-control, and Metering. And, (iii) Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities.

5.3.2.5 Objective 4(b): Evaluating the use of job redesign to facilitate workforce multi-skilling

The principal component analysis indicated two factors with Eigenvalues of 5.08 and 1.49, with 56.4% and 16.6% variance contribution, respectively. These results mean that Eskom PTM Central Group needs to revise and improve on the following factors, hence the conflicts in respondent views; (i) Using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section can generate cost recoveries against projects, and (ii) On-job training can be used to facilitate multi-skilling at Eskom PTM Central Group.

5.4 HYPOTHESIS TESTING

The hypothesis testing section further examines the associations drawn between multi-skilling and these objective factors; project resource scheduling flexibility, project costs, project duration, adoption and job redesign.

5.4.1 Hypothesis 1: The use of multi-skilled workforce provides for flexible project resource scheduling

This hypothesis tested for an existence of a relationship between the use multi-skilling and project resource scheduling flexibility. A conclusion was made that there is a direct relationship between the two variables, meaning the research hypothesis was accepted. Furthermore, t-statistics suggests that the use of multi-skilled workforce provides for flexible project resource scheduling as much as 3.3 times. These results are consistent with conducted correlations statistics and reviewed literature stating that the concept of multi-skilling allows firms the flexibility to reallocate labour resources in response to volatile industry demands (DeVaro & Farnham, 2010). And, an organization with multi-skilled personnel enjoys flexible labour-force benefits which provide the employer ability to schedule and arrange workforce to best suit the needs of the business (Rajendra, 2016).

5.4.2 Hypothesis 2: Multi-skilling has a positive effect on the project costs

This hypothesis tested for an existence of a relationship between use of multi-skilling and project cost savings. A conclusion was made that there is probably no positive relationship between use of multi-skilled workforce and project cost savings and the research hypothesis was rejected. These results are inconsistent with the obtained Spearman's correlation results that multi-skilling has a moderate positive association with project cost savings. And also in-contrast with reviewed literature, Burleson, et al., (1998) studies on multi-skilling strategies proposed that proper utilization of multi-skilled workforce could lead to savings due to lower turnover rates, high productivity rate and reduced accidents and the findings showed that multi-skilling strategies resulted to a reduction in project labour costs by 3%-20%. And also, a study by (Abotaleb, et al., 2014), showed that the use of multi-skilling handles a major concern; which was labour wages costs efficiency.

The hypothesis conclusion suggests that the use of multi-skilling at Eskom PTM Central Group could probable have no influence on project cost savings.

5.4.3 Hypothesis 3: The use of multi-skilling has no significant impact on project duration

This hypothesis tested for an existence of a relationship between use of multi-skilled workforce and project cost savings. A conclusion was made that there is no positive relationship between multi-skilled workforce and project duration and the research hypothesis was rejected. These results are inconsistent with the conducted Spearman's correlation results that multi-skilling has moderate positive association with project duration. And also reviewed literature refute the results, stating that effective scheduling of multi-skilled labour resources reduces the project activity duration overruns and lags between activities, otherwise unavoidable when using single-skilled labour resources (Lill, 2009). The results also suggest that the use of multi-skilling at Eskom PTM Central Group could have as much as 3.3 times negative impact on project duration.

5.4.4 Hypothesis $4_{(i)}$: There is a positive relationship between multi-skilled workforce and adoption of multi-skilling

This hypothesis tested for an existence of a relationship between use of multi-skilled workforce and adoption of multi-skilling. A conclusion was made that there is a positive relationship between multi-skilled workforce and adoption of multi-skilling, meaning the research hypothesis was accepted. These results are consistent with conducted Spearman's correlation results and also with the conducted literature review which states that with multi-skilling adoption, employees enjoy cross functional training to increase skills competency and at the same time organizations enjoy increasing talent pool, thus labour force resource availability (Srinivasan, 2014). The results suggest that the use of multi-skilled workforce at Eskom PTM Central Group could significantly have as much as 3.5 times positive influence on the adoption of multi-skilling.

5.4.5 Hypothesis $4_{(ii)}$: There is a positive relationship between multi-skilling and job redesign

This hypothesis tested for an existence of a relationship between use of multi-skilled workforce and job redesign. A conclusion was made that there is a positive relationship between multi-skilled workforce and job redesign, meaning the research hypothesis was accepted. These results concur with conducted Spearman's correlation results and also with the conducted literature review which states that with multi-skilling adoption, employees enjoy cross functional training to increase skills competency and at the same time organizations enjoy increasing talent pool, thus labour force resource availability (Srinivasan, 2014). This means that the use of multi-skilling at Eskom PTM Central Group could considerably have as much as 3.8 times positive significant impact on job redesign.

5.4.6 Hypothesis summary

There is evidence that the use of multi-skilled workforce provides for flexible project resource scheduling as much as 3.3 times. There is probably no positive relationship between multi-skilled workforce and project costs. Further results indicate that use of multi-skilling has 3.3 times negative significant impact on project duration. The use of multi-skilling could have 3.8 times positive significant impact on job redesign. Lastly, the use of multi-skilling could have 3.5 times positive significant impact on adoption of multi-skilling.

5.5 CHAPTER SUMMARY

This chapter discussed in detail results findings presented in chapter four. The results were discussed in alignment with the objectives of the study, reviewed literature and statistical models used in the analysis. The discussion on descriptive statistics provided insight and interests for variables defining the purpose of the research to be further analysed for associations and then conclude hypothetical statements of the research. Also, the discussion highlighted that some of the variables indicated weak associations, whilst some showed moderate associations and there no negative associations. The majority of results showed strong alignment with reviewed literature with only a few found to be inconsistent with the hypothesis test conclusions.

The next chapter concludes the research study; discuss limitations of the study, opportunities and direction for future research and recommendations.

6 CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter provides the conclusion of the research study and recommendations. The researcher navigates from main purpose of the research, developed research objectives, research hypothesis results findings and solution to the main research problem. The encountered problems, limitations of the study, opportunities for further research and recommendations on identified gaps of the study by empirical evidence will be highlighted and discussed.

6.2 CONCLUSION

The purpose of this section is to connect the objectives of the study with the discussed results findings, provide a conclusion for each of the objectives and generalize the findings to the research site.

6.2.1 Objective 1: Influence of Multi-Skilled Workforce on Project Scheduling Flexibility

The conducted descriptive statistics showed that multi-skilled workforce could have an influence on project scheduling flexibility, but the results could not be used alone to draw conclusions. Accordingly, Spearman's correlation of associations was conducted and the results showed that the use of multi-skilled workforce to have a weak positive association with project scheduling flexibility. However correlations alone cannot be used to generalize results findings of a sample. Therefore, a conducted paired t-test hypothesis test concluded that the use of multi-skilled workforce provides for flexible project resource scheduling as much as 3.3 times. In other words, at Eskom PTM Central Group the use of multi-skilled workforce can have up to 3.3 times more influence on project resource scheduling flexibility.

6.2.2 Objective 2: Evaluating the relationship between multi-skilling and project costs.

The descriptive statistics results in this regard showed that majority of respondents were in agreement with all the factors in this objective. Spearman's correlation results of association showed a moderate association between the two variables. Conclusively, paired t-test hypothesis results suggested a non-positive relationship between the two variables. This means the use of multi-skilling at Eskom PTM Central Group will probably have no positive influence on project cost savings.

6.2.3 Objective 3: Evaluating the effect of multi-skilling on project duration

A majority of respondents were in agreement that the use of multi-skilled workforce has an influence on project duration. The correlation results of association indicated a moderate positive association between the variables. A paired t-test hypothesis made conclusion that there is no positive relationship between the use of multi-skilled workforce and project duration. The results conclude that the use of multi-skilled workforce at Eskom PTM Central Group has no positive relationship with project duration.

6.2.4 Objective 4(a): Evaluating the effect of adopting multi-skilling strategy

The majority of respondents in this regard were also in agreement that multi-skilling has an influence on adoption of skills. The correlation results of association indicated a strong positive association between the two variables. Using hypothesis results, a conclusion was made that there is a positive relationship between multi-skilled workforce and adoption of multi-skills. This can be translated; the use of multi-skilling at Eskom PTM Central Group has a positive effect on the adoption of multi skills.

6.2.5 Objective 4(b): Evaluating the use of job redesign to facilitate workforce multi-skilling

A large number of respondents were also in agreement with the factors of job redesign to facilitate workforce multi-skilling at Eskom PTM Central Group. The results of associations showed a strong association between the variables.

Hypothesis testing provided a conclusion that there is a positive relationship between multi-skilled workforce and job redesign. This concludes that at Eskom PTM Central Group job redesigned can be used to facilitate multi-skilling.

6.3 IMPLICATIONS OF THIS RESEARCH

This research contributes to knowledge of engineering project management of operations and effective staffing of teams. The arrangement of research objectives was a carefully thought out exercise to allow for research results to be quantified and generalized to the research site to enhance business decision making. Academic and or business researchers can use this research to further study the concept of multi-skilling and its impact in engineering projects, since most literature on multi-skilling covers the retail sector, moderate on construction industry and very few in project engineering management. Lastly, the research provides scientific results findings and analysis procedure used to draw up conclusions about the effect of using multi-skilling on project resource scheduling, project cost savings, project duration, adoption of multi-skills and the influence of job redesign in facilitating multi-skilling. The research site participants and stakeholder will be afforded a presentation on results findings, trends picked by the study and recommendations.

6.4 LIMITATIONS OF THE STUDY

There were no major problems encountered during this research, except for the usual research associated challenges such as ethical clearance application which took longer than anticipated by the research study time lines. The other challenge was the response rate at the beginning of the study, there was a low response rate but after a follow up email respondents participation increased greatly. However, a total number of non-responses was 17, in other words 25% of the recruits did not participate to the study. The size of the sample was limited by the research site population, that is Eskom PTM Central Group project execution personnel, meaning the views were only limited to this group and no opinions from other Eskom divisions were factored. The study assumed that all respondents have basic project execution and technical backgrounds, since employees at research site are technical personnel by profession.

6.5 RECOMMENDATIONS TO SOLVE THE RESEARCH PROBLEM

- The researched concluded that multi-skilled workforce has a positive influence on project scheduling flexibility at Eskom PTM Central Group. However, it is recommended for this business unit to pay more attention to the factor “workforce multi-skilling helps cushion against unforeseen project schedule changes” as it showed to be in-contrast with other contributing factors to the flexibility of project scheduling.
- Eskom PTM Central Group should improve on the idea that, multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge, and that multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs to yield positive results from multi-skilling and project cost savings objective.
- It imperative for Eskom PTM Central Group to search for alternative ways to fast-track multi-skilling initiatives to maximize the benefits of this strategy, especially on time taken to complete a task and therefore improving project duration as well as cost savings.
- Multi-skilling should be undertaken with a goal to match each task performance to a specialist output level for continuous improvement and centralize multi-skilling to help afford project managers better control of projects.
- Assessment to project labour resources showed that there is need for project support services to show more experience and professionalism in managing projects, to improve proficiency in project management.
- It is recommended that technical project labour resources must be afforded a platform to practice cross skilling perhaps by doing away with specialist departments and rather form a multi-skilled talent pool.
- A skill ranking system should be developed to trace skill gaps and areas of improvement to sustain adoption of multi-skilling as strategy at Eskom PTM Central Group and increase talent pool without having to increase head counts.

6.6 DIRECTIONS FOR FUTURE STUDIES

- A research study focusing on the organization's youth (21-30 years) on views of multi-skilling in project execution, would provide beneficial insight given that in this study the majority of participants were between the ages 31-40 years of age.
- An investigation on incentive strategies that can be used to influence multi-skilling in project engineering and bring about more contributing factors to sway organizational operations towards multi-skilling.
- A study conducted to investigate upon the adoption of multi-skilling; the impact of job cuts over economic benefits of multi-skilling.

6.7 CHAPTER SUMMARY

This chapter concluded the research study, implications and contributions to knowledge of multi-skilling in the execution of engineering projects was discussed together with the research recommendations suitable and practical to Eskom PTM Central Group, amongst other entities, can benefit from the findings of this research. And also recommendations for future research projects were provided for interested researchers to further expand knowledge in this regard. In closing; all objectives developed for purpose of answering the research problem were all fulfilled within the science of research for which this study was designed for.

7 REFERENCES

Abomeh, O. & Peace, N., 2015. Effects of Training on Employees' Productivity in Nigeria Insurance Industry. *British Journal of Economics, Management & Trade,* 7(3), pp. 227-235.

Abotaleb, I., Moussa, M. & Hussain, S., 2014. *Optimization of Allocating Multi-Skilled Labor Resources Using Genetic Algorithms.* Halifax, CSCE 2014 General Conference.

Acock, A. C., 2014. *A Gentle Introduction to Stata.* 4 ed. College Station: TX: Stata Press..

Adamu, N., Nensok, M. & Aka, A., 2012. *Multi-skilling Barriers In the Construction Industry In North-Western Nigeria.* Abuja, West Africa Built Environment Research (WABER) Conference.

Adeyoyin, S. et al., 2015. *Effects of Job Specialization and Departmentalization on Job Satisfaction Among the Staff of a Nigerian University Library,* Lincoln: University of Nebraska.

Afifi, A. M. S. & Clark, V., 2012. *Practical Multivariate Analysis.* 5 ed. Boca Raton: CRC Pres.

Agyei, W., 2015. Project Planning And Scheduling Using PERT And CPM Techniques With Linear Programming: Case Study. *International Journal of Scientific & Technology Research,* 4(8), pp. 222-227.

Ahmadian Fard Fini, A., Rashidi, T., Akbarnezhad, A. & Travis Waller, S., 2016. Incorporating Multiskilling and Learning in the Optimization of Crew Composition. *Journal of Construction Engineering and Management,* 142(5), p. 04015106.

Akinola, J., Ogunsemi, D. & Dada, M., 2015. *Impact of Multiskilling on Competency of Nigerian Quantity Surveryors.* Abuja, The Nigerian Institute of Quantity Surveyors.

Aliyu, A. A., Bello, M. U., Kasim, R. & Martin, D., 2014. Positivist and Non-Positivist Paradigm in Social Science Research: Conflicting Paradigms or Perfect Partners?. *Journal of Management and Sustainability,* 4(3), pp. 79-95.

Antwi, S. K. & Hamza, K., 2015. Qualitative and Quantitative Research Paradigms in Research: A Philosophical Reflection. *European Journal of Business and Management ,* 7(3), pp. 217-225.

Arunadhevi, P., 2016. Optimization of Construction Project Scheduling by Using Linear Programming. *nternational Journal of Advanced Research Trends in Engineering and Technology,* 3(2), pp. 1268-1273.

Attia, E., Duquenne, P. & Le-Lann, G., 2013. Considering Skills Evolutions in Multi-Skilled Workforce Allocation With Flexible Working Hours. *International Journal of Production Research,* 52(15), p. 4548–4573.

Brown, A., Adams, J. & Amjad, A., 2007. The relationship Between Human Capital and Time Performance in Project Management: A Path Analysis. *International Journal of Project Management,* 25(2007), p. 77–89.

Burleson, R., Haas, C., Tucker, R. & Stanley, A., 1998. Multiskilled Labor Strategies in Construction. *ASCE Journal of Construction Engineering and Management,* 124(6), p. 480–489.

Chan, K., 2014. Multiple Project Team Membership and Performance: Empirical Evidence From Engineering Project Teams. *SAJEMS Special Issue,* 17(2014), pp. 76-90.

Creswell, J., 2014. *Research Design : Qualitative, Quantitative, and Mixed Methods Approaches.* 4 ed. London: SAGE Publications Ltd.

Das, K. R. & Imon, R. A. H. M., 2016. A Brief Review of Tests for Normality. *American Journal of Theoretical and Applied Statistics,* 5(1), pp. 5-12.

DeVaro, J. & Farnham, M., 2010. *Two Perspectives on Multiskilling and Product Market Volatility ,* East Bay: Economic and Social Research Council.

Dickson, O., 2003. *A pilot Investigation of the Potential Impact of the Practical Design and Implementation of Multi-Skilling to Optimise Employees and Achieve Improved Productivity Within the Automobile Manufacturing Industry.,* Durban: University of KwaZulu Natal.

Ernst A, T., Jiang, H., Krishnamoorthy, M. & Sier, D., 2004. Staff Scheduling and Rostering: A Review of Applications, Methods and Models. *European Journal of Operational Research,* 153(2004), p. 3–27.

Eskom, 2014. *Deliver Projects - Programme Management Procedure,* Johannesburg: s.n.

Eskom, 2016. *Engineering Cost Control on Capital Projects Works Instruction,* Johannesburg: s.n.

Gomar, J., Haas, C. & Morton, D., 2012. Assignment and Allocation Optimization of Partially Multiskilled Workforce. *Journal of Construction Engineering and Management,* 128(2), pp. 103-108.

Hegazy, T., Shabeeb, A., Elbeltagi, E. & Cheema, T., 2000. Algorithm For Scheduling With Multiskilled Constrained Resources.. *Journal of Construction Engineering and Management,* 126 (6), pp. 414-421.

Heimerl, C. & Kolisch, R., 2010. Work Assignment to and Qualification of Multi-Skilled Human Resources Under Knowledge Depreciation and Company Skill Level Targets. *International Journal of Production Research,* 48(13), p. 3759–3781.

Horbury, C. & Wright, M., 2010. *Development of a Multiskilling Life Cycle Model,* Norwich: Health and Safety Executive.

Irene, L., 2009. Multiskilling in Construction – A Strategy For Stable Empoyment. *Technological and Economic Development of Economy,* 15(4), p. 540–560.

Jaskowski, P., 2013. Scheduling Constration Projects With Multi-Skilled Resources. *International Journal of Arts & Sciences,* 6(3), p. 347–353.

Kagona, J., Shukla, J. & Oduor, J., 2015. The Effect of Employee Training on Project Performance: A Case of The Girl Child Catch Up Project of the International Education Exchange. *Journal of Marketing and HR,* 1(1), pp. 33-40.

Kaymaza, K., 2010. The Effects of Job Rotation Practices on Motivation: A Research on Managers in the Automotive Organizations. *Business and Economics Research Journal,* 1(3), pp. 69-85.

Keller, G., 2012. *Managerial Statistics Abbreviated.* 9th ed. UK/Europe/Middle East/Africa: South Western - Cengage Learning.

Kepha, O., Assumptah, K. W. & Dismaso, O., 2014. The Influence of Training and Development on the Performance of Employees in Research Institutes in Kenya. *International Journal of Science and Research,* 3(5), pp. 139-146.

Kim, J., Kang, C. & Hwang, I., 2012. A Practical Approach to Project Scheduling: Considering the Potential Quality Loss Cost in the Time–Cost Tradeoff Problem. *International Journal of Project Management,* 30(2012), p. 264–272.

Kothari, C., 2008. *Research Methodology : Methods & Techniques.* 2 ed. New Delhi: New Age International (P) Ltd.

Kuhn, T. S., 2012. *The structure of scientific revolutions,,* Chicago: University of Chicago press.

Lee, B. & Nam, J., 2013. What Drives Korean Firms to Downsize Under the Global Financial Crisis?. *Asian Pacific Business Review,* 19(2), pp. 171-185.

Leedy, P. & Ormrod, J., 2013. *Practical Research Planning and Design.* 10 ed. New York: Pearson Education Inc.

Lill, I., 2009. Multiskilling in Construction a Strategy for Stable Employment. *Technological and Economic Development of Economy ,* 15(4), pp. 540-560.

Liu, S. & Wang, C., 2012. Optimizing Linear Project Scheduling With Multi-Skilled Crews. *Automation in Construction,* 24(2012), p. 16–23.

Long, J. S. & Freese, J., 2014. *Regression Models for Categorical Dependent Variables Using Stata..* 3 ed. College Station: TX: Stata Press.

Mackey, A. & Gass, S. M., 2016. *Second Language Research: Methodology and Design.* 2nd ed. New York: Routledge Taylor and Francis Group.

Makholwa, A., 2010. Ageing Workforce a Worry. *Finweek*, 24 June.

Mateus, A. D., Allen-Ile, C. & Iwu, C., 2014. Skills Shortage in South Africa: Interrogating the Repertoire of Discussions. *Mediterranean Journal of Social Sciences,* 5(6), pp. 63-68.

Maylor, H., 2010. *Project management.* 4 ed. Harlow: Pearson Education Limited.

Mir, F. A. & Pinnington, A. H., 2014. Exploring the Value of Project Management: Linking Project Management Performance and Project Success. *International Journal of Project Management,* 32(2014), p. 202–217.

Morita, H., 2005. Multi-skilling, Delegation and Continuous Process Improvement: A Comparative Analysis of US–Japanese Work Organizations. *Economica ,* 72((2005)), p. 69–93.

Mossa, G. et al., 2016. Productivity and Ergonomic Risk in Human Based Production Systems: A job-Rotation Scheduling Model. *International Journal of Production Economics,* 171(4), p. 471–477.

Motsoeneng, L., Schultz, C. & Bezuidenhout, A., 2013. *Skills Needed by Engineers in the Platinum Mining Industry in South Africa,* Pretoria: Mining Qualifications Authority, South Africa.

Nwaogazie, I., Augustine, O. & Henshaw, T., 2016. Multi-Skilling In Constraction Industry and Dual Skill Labour Strategy: A Case of Constraction Companies in Port Harcourt. *International Journal of Civil Engineering and Technology,* 7(4), p. 208–222.

Puttick, G., 2008. Multi-Skilling Overcomes Labour Shortages. *Analysis Management* , 14 March, p. 1.

Qin, S., Liu, S. & Kuang, H., 2016. Piecewise Linear Model for Multiskilled Workforce Scheduling Problems considering Learning Effect and Project Quality. *Mathematical Problems in Engineering,* 2016(ID3728934), p. 11.

Rajendra, J., 2016. *Accountability of Multi Skilling In Enrichment of Career Planning of Organization And Employee in The Global Scenario,* India: MIT- SOM PGRC KJIMRP National Research Conference.

Render, B., Stair, R., Hanna, M. & Hale, S., 2015. *Quantitative Analysis for Management.* 12 ed. Harlow: Pearson Education Limited.

Saravani, S. R. & Abbasi, R., 2013. Investigating the Influence of Job Rotation on Performance by Considering Skill Variation and Job Satisfaction of Bank Employees. *Tehnički vjesnik,* 20(3), pp. 473-478.

Saunders, M., Lewis, P. & Thornhill, A., 2009. *Research Methods For Business Students.* 5 ed. Harlow: Pearson Education Ltd.

Sekaran, U. & Bougie, R., 2013. *Research Methods For Business.* 6 ed. West Sussex: Wiley and Sons Ltd.

Singh, V. & Shah, S., 2014. Impementing Kaizen in A Job Shop Industry Through Multi-Skilling of Labour. *International Journal of Emerging Technology and Advanced Engineering,* 4(3), pp. 289-291.

Srinivasan, I. A., 2014. The Impact of Multi-Skilling on an Outsoourced Environment. *International Journal of Advance Research,* 2(1), pp. 1-18.

Stratton, S. J., 2015. Assessing the Accuracy of Survey Research. *Prehospital and Disaster Medicine; Cambridge,* 30(3), pp. 225-226.

Suresh, K. & Chandrashekara, S., 2012. Sample Size Estimation and Power Analysis For Clinical. *Journal of Human Reproductive Sciences,* 5(1), pp. 7-12.

Sushil, S., 2014. Role of Job Enrichment and Job Enlargement in Work Life Balance. *Global Journal of Finance and Management.,* 6(3), pp. 239-244.

Tancott, G., 2014. Addressing the skills shortage. *Infrastructure News and Service Delivery*, 14 May.

Tarus, B. K., 2014. Effects of Job Rotation Strategy on High Performance Workplace, in Lake Victoria North Water Services Board, Kenya. *International Journal of Business and Management,* 9(11), pp. 139-146.

Tavakol, M. & Dennick, R., 2011. Making sense of Cronbach's alpha. *International Journal of Medical Education,* 2(2011), p. 53–55.

Testa, B., 2010. Multiskilled Employees Sought as Versatility Becomes a Workplace Virtue. *workforce*, 20 September, pp. 1-3.

Zaid, M. A., 2015. *Correlation and Regression Analysis.* 1 ed. Ankara: The Statistical, Economic and Social Research and Training Centre for Islamic Countries.

Zar, J., 2014. *Spearman Rank Correlation,* Illinois: Research Gate.

Zha, H. & Zhang, L., 2014. Scheduling Projects with Multiskill Learning Effect. *The Scientific World Journal,* 2014(731081), p. 7.

8 APPENDICES

8.1 APPENDIX 1: RESEARCH QUESTIONNAIRE

Title:

THE EFFECT OF USING MULTI-SKILLED WORKFORCE ON THE FLEXIBILITY OF PROJECT RESOURCE SCHEDULING AND PROJECT COSTS: ESKOM PTM CENTRAL GROUP PROJECT EXECUTION DEPARTMENT

I, **Thulisile Manyi**, an MBA student at UKZN GSB&L, invites you to participate in the research study I am conducting about; *The Effect of Using Multi-Skilled Workforce on the Flexibility of Project Resource Scheduling and Project Costs: Eskom PTM Central Group Project Execution Department.*

The survey will take approximately 15 minutes to complete. Your time in this regard will be highly appreciated. Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. The results of this questionnaire will be used for academic purposes and your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. If you have questions at any time about the survey or the procedure, you may contact me on 0783934358 or ManyiT@eskom.co.za.

Thank you very much for your time and support. Please give consent to complete the electronic survey by clicking on the *'I Agree'* checkbox.

Personal Demographic Information:

What gender group do you belong to?

Male 1	Female 2

b. What race group do you belong to?

Black 1	White 2	Indian 3	Coloured 4

c. What age group do you belong to?

21 to 30 years 1	31 to 40 years 2	41 to 50 years 3	51 to 63 years 4

d. What band within the organisation do you belong to?

T11 1	T12 2	T13 3	S&M Band 4

e. What is your level of experience in projects environment?

< 5 Years 1	6 – 10 Years 2	11 – 15 Years 3	>15 Years 4

f. What is your educational level?

Matric/ equivalent 1	Diploma/equivalent 2	Degree/ equivalent 3	None 4

g. Do you belong to a professional body? For example ECSA, SAIEE, PMSA etc.

Yes 1	No 2

Please select the box that best describes how you feel about each statement:

Objective 1: Evaluating the influence of multi-skilled workforce on project scheduling flexibility

1.1 Multi-skilled workforce helps improve project labour resource availability.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

1.2 Multi-skilled workforce improves project labour resource utilization

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

1.3 The use of multi-skilled workforce could smoothen rescheduling of labour resources from one project to another in multiple project environments such as Eskom PTM.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

1.4 Workforce multi-skilling helps cushion against unforeseen project schedule changes.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Objective 2: Evaluating the relationship between multi-skilling and project costs

2.1 The use of multi-skilled workforce can help cut project labour costs for Eskom PTM Central Group by reducing the number of labour workforce required per project.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

2.2 Multi-skilled workforce strategy will help Eskom PTM Central Group reduce project transport costs

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

2.3 Provided that a multi-skilled employee begins a project from start to finish, the experience gained from the whole project can help provide critical input feedback on lessons learnt and possible ways to reduce costs on future projects.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

2.4 Multi-skilled workforce lack of skill specialization can drive up project costs by means of defects resulted due to lack of expert knowledge.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Objective 3: Evaluating the effect of multi-skilling on project duration

3.1 The use of multi-skilled workforce will not reduce job activity duration because the job is not performed by specialist personnel.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

3.2 Multi-skilled workforce utilization allows project managers control over activity sequencing meaning rearrangement of tasks to suit project time lines or targets.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

3.3 Multi-skilled workforce tend to take longer to finish an activity, but the time lost on activity duration compensates for idle time that a specialist would have spent waiting for the next specialist job (specialist idle time cost).

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Objective 4: Evaluating the effect of adopting multi-skilling strategy at Eskom PTM Durban

4.1 Objective 4(a): Assessing Eskom PTM Central Group Project Resources:

4.1.1 Eskom PTM Central Group project resources are adequately qualified (educated) in their respective field of specialisation.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.1.2 Project Support Services show extensive experience in managing projects.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.1.3 Eskom PTM Central Group project resources demonstrate knowledge in the execution of activities.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.1.4 Eskom PTM Central Group project resources are competent in terms of skills, technical knowledge, experience and proficiency in the execution of projects.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.1.5 However, project resources cannot perform activities across disciplines because departments are divided into specialist skills e.g. Protection, Tele-control, and Metering.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.1.6 Project management resources can negotiate project scope, time, cost and quality effectively with clients to meet in house business objectives.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.1.7 Project management resources are effective at managing risks from both financial and technical standpoint.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Objective 4(b): Evaluating the effect of adopting multi-skilling strategy at Eskom PTM Durban; assessing adoption of multi-skilling and job redesign

4.2.1 Multi-skilling will encourage project resource learning from each other's past experiences.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.2.2 Multi-skilling will help Eskom PTM Central Group benchmark them-selves against best practice of the organization to uplift skillset and competency levels across all fields of work.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.2.3 The use of multi-skilling at Eskom PTM will allow project resources to be easily scheduled between multiple projects.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.2.4 Multi-skilled workforce will help increase project resource utilisation across all projects at Eskom PTM Central Group.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.2.5 Using multi-skilling workforce as strategy will help improve cost recoveries, because the longer employees are scheduled on multiple projects, the more each section can generate cost recoveries against projects.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.2.6 On-job training can be used to facilitate multi-skilling at Eskom PTM Central Group

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.2.7 After on job training, job rotation can be used as one of other means to help facilitate multi-skilling.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.2.8 To support multi-skilling over and above on-job training and job rotation, managers can to set aside an adequate training budget for project resources to attend technical training on specific equipment.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

4.2.9 A well-executed change management process can help land multi-skilling strategy effectively at Eskom PTM Central Group.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	2	3	4	5

Thank you so much for your time

8.2 APPENDIX 2: GATE KEEPER LETTER

Eskom

Dr Rosemary Sibanda
Graduate School of Business and Leadership
University Of KwaZulu-Natal
Westville Campus
Durban
3630

Date:
07 March 2017

Enquiries:
Tel +27 31 240 7930

RE: PERMISSION TO CONDUCT RESEARCH

This letter serves to confirm that I, Etienne Diener, Eskom PTM Durban Section manager hereby acknowledge and approve the research of Thulisile Manyi within the company for the completion of his MBA degree.
Yours sincerely

[redacted]

Etienne Diener

Section Manager – Maintenance and Commissioning
Eskom
PTM Central Group
Group Technology – Asset Management

Group Technology
PTM
Cnr Langenhoven and Visagie Streets eMalahleni 1035
PO Box 197 eMalahleni 1035 SA
www.eskom.co.za
Eskom Enterprises SOC Limited Reg No 1999/002761/07

1923-2013

8.3 APPENDIX 3: ETHICAL CLEARANCE APPROVAL LETTER

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

25 April 2017

Mr Thulisile Manyi (215080352)
Graduate School of Business & Leadership
Westville Campus

Dear Mr Manyi,

Protocol reference number: HSS/0344/017M
Project title: The effect of using Mulit-Skilled Workforce on the flexibility of Project Resource Scheduling and Project Costs: Eskom PTM Central Group Project Execution Department

Full Approval – Expedited Application
In response to your application received on 13 April 2017, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and FULL APPROVAL for the protocol has been granted.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

[redacted]

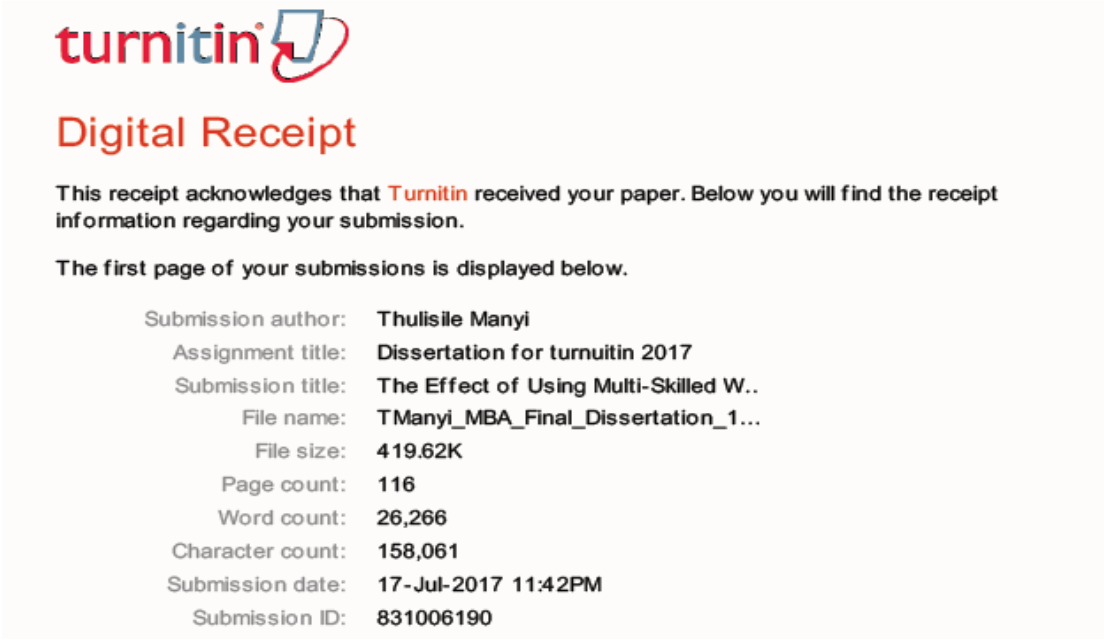
Dr Shenuka Singh (Chair)

/ms

Cc Supervisor: Dr Rosemary Sibanda
Cc Academic Leader Research: Dr Muhammad Hoque
Cc School Administrator: Ms Zarina Bullyraj

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

8.4 APPENDIX 4: TURNITIN REPORT



turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Thulisile Manyi
Assignment title:	Dissertation for turnuitin 2017
Submission title:	The Effect of Using Multi-Skilled W..
File name:	TManyi_MBA_Final_Dissertation_1...
File size:	419.62K
Page count:	116
Word count:	26,266
Character count:	158,061
Submission date:	17-Jul-2017 11:42PM
Submission ID:	831006190

The Effect of Using Multi-Skilled Workforce on the Flexibility of Project Resource Scheduling and Project Costs: Eskom PTM Central Group Project Execution Department

ORIGINALITY REPORT

4%	1%	0%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Witwatersrand Student Paper	1%
2	Submitted to Mancosa Student Paper	1%
3	epsl.asu.edu Internet Source	1%
4	Submitted to American University in Cairo Student Paper	1%

EXCLUDE QUOTES	ON	EXCLUDE MATCHES	< 1%
EXCLUDE BIBLIOGRAPHY	ON		