

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
KUMASI, GHANA**

**Impact of relocating utility services during road construction: the management
of issues when they arise**

by

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**A Thesis submitted to the Department of Building Technology,
College of Art and Built Environment**

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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DECLARATION

I hereby declare that this submission is my own work towards the attainment of Master of Science in Construction Management, and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Road construction involve huge capital outlay, usually, tax payers' money (be it donor funded or government funded). Thus prudence is required in its usage. This can be done by ensuring that road projects are designed and implemented efficiently with no extra costs and delays. Utilities present on a right-of-way is one source of additional cost and delay to project implementation, since relocation is often required. This research aimed at analyzing the impact of utility services relocation have on road construction. The research objectives were: to identify challenges of managing utility relocations in road projects, to examine the impact level of utility relocation on road projects and to examine the relationship of time slippage, change orders and cost overruns of road projects with utility relocations. The research made use of structured questionnaire survey and desk study of selected road projects. The statistical tools used in the analysis comprised descriptive statistics, One-Sample T test and Relative Importance Index. Findings of the study indicated that average cost increment on utility budget due to utility relocation was 117%, while time slippage level averaged 17.14%. The study recommends the establishment of strong and supportive institutions, effective coordination and communication among stakeholders, legal and regulatory framework on right of way management, investment in technological tools and softwares and the use of design – build method of contracting.

Key words: Utility relocation, right of way management, road construction, utilities, road agencies.

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LIST OF ABBREVIATIONS

PROW	Public right of way
ROW	Right of way
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
DOT	Department of Transport
FHWA	US Federal Highway Authority
MRH	Ministry of Roads and Highways
GHA	Ghana Highway Authority
DFR.....	Department of Feeder Roads
DUR	Department of Urban Roads
VRA.....	Volta River Authority
ECG.....	Electricity Company of Ghana
RII.....	Relative Importance Index
ECT.....	Engineering Coordinating Team
MMDAs.....	Metropolitan/Municipal & District Assemblies

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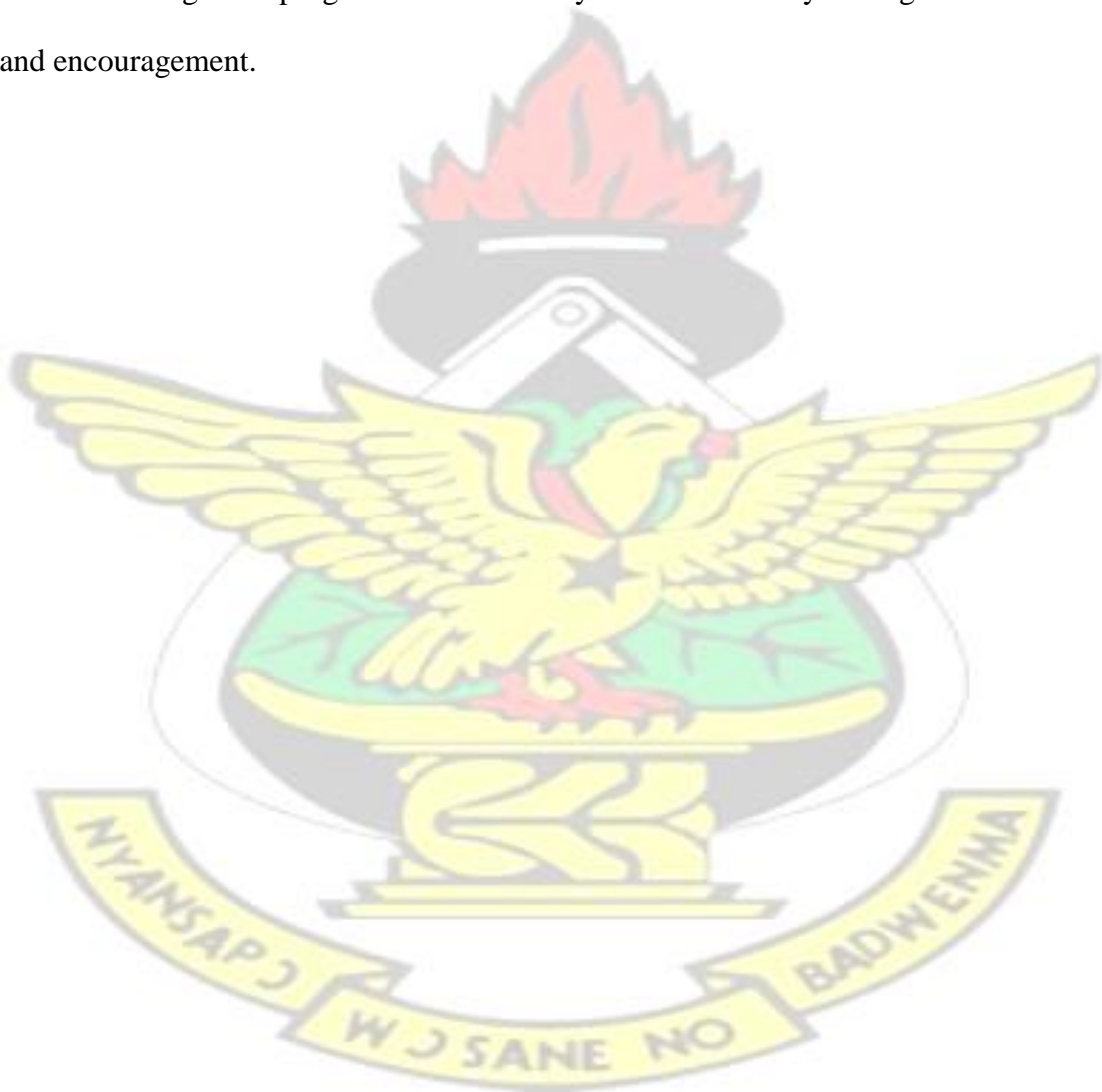
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DEDICATION

To God's glory this research work is dedicated to the memory of my late Dad, Mr. Martin Guo Cheyuo. Secondly to my lovely wife Amata Dong-baeguo and our two daughters Arabel-Mary and Ascension whose patience, love, support and prayers has seen me through this programme. Also to my Mum and all my siblings for their love and encouragement.



CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Ghana's transport sector has a vision to provide "an integrated, efficient, cost-effective and sustainable transportation system responsive to the needs of society, supporting growth and poverty reduction and capable of establishing and maintaining Ghana as a transportation hub of West Africa" (Ministry of Roads and Highways, 2014). In order to realize the vision of the transport sector, the road sub-sector has a mission to "provide leadership and an enabling environment for the development and maintenance of Ghana's road transportation system through effective policy formulation, market regulation, asset management and service provision" (Ministry of Roads and Highways, 2014). Road infrastructure is very important for the socioeconomic development of every nation and hence is always one of the key areas of attention for every government.

Considering the crucial role that roads play in the economy, their capital intensive and publicly funded nature and the diverse stakeholders involved, it is desirable that roads are constructed timely and cost efficiently to ensure the needed benefits to the public and value for money to the taxpayer. Nonetheless, road construction is often plagued with unexpected and usually unbudgeted events that sometimes undermine the timely and efficient delivery of projects.

One such event is utility presence on the public right-of-ways. The right-of-way is a public resource that is used by both public road agencies and utility service providers to provide services to the general public. Ghana's public right of ways serve a dual purpose of accommodating road infrastructure as well as public utilities as stated in Section 2, sub-clause 2 of Ghana's Lands (Statutory Way Leaves) Act-1963 (Act 186).

Devaney (2001) pointed out public interest and cost considerations as reasons for co-location of road infrastructure and public utilities.

However, studies by Sturgill et al.(2015) maintained that “utilities located within and near right of ways present challenges to road agencies in terms of coordinating the reconfiguration of those facilities to accommodate highway system improvements. Construction and maintenance operations that improve road infrastructure in turn, affect, and require, relocation or protection of utility infrastructure that share space with road infrastructure”.

Utility relocation is a key determinant of the time and cost performance of road projects. Ellis and Thomas (2002) stated that utility relocations is one of the primary causes of delays in road construction. Studies by Thomas (1985) cited in Ellis & Thomas (2002) shows that averagely, 31% to 55% of all highway projects slip behind schedule by an average of 44%.

1.2 PROBLEM STATEMENT

The issue of utility relocations in road construction and improvements is a global and a fast growing problem (Sterling et al 2009, Mohamed & Khogali 1999). Population growth and fast urbanization in recent times has resulted in high demand for services. For instance, in 1900, only 13% of people out of an estimated world population of about 1.6 billion lived in urban centers. However, by May, 2007, with an estimated world population of about 6.6 billion, 50% of this populace were said to be urban dwellers (Wimberley & Kulikowski, 2007) as cited by Sterling et al. (2009). The increasing demand for utilities coupled with aging of existing ones that need renewal, means that utility relocations on road projects will continue to occur.

The most popular yardstick for measuring project success remains its cost, time and quality performance. The achievement of this objective however, remains a mirage for

most road projects in Ghana. The reason being the high risks associated with road construction, among which, is the risk of utility presence in the right-of-way.

Road construction is disruptive to businesses, inconvenient and hazardous to the public, and causes congestion and traffic. Delays from utility relocation deprive the public of the potential benefits of the completed project. This can cause public annoyance and bring about disputes and perhaps sabotage of the project. These factors demonstrate a clear need for a study into effective ways of managing utility relocations during road construction.

1.3 AIM AND OBJECTIVES

The aim of the research was to investigate and analyze the impact of utility services relocation on road construction. To achieve this aim, the following objectives were advanced:

1. To identify challenges of managing utility relocations in road projects;
2. To examine the impact level of utility relocations on road projects; and
3. To examine the relationship of time slippage, change orders and cost overruns of road projects with utility relocations.

1.4 RESEARCH QUESTIONS

From the preceding objectives, the following research queries can be raised to provide answers to the objectives:

1. What are some of the challenges in managing utility relocations?
2. What is the impact level of utility relocation on road projects?
3. What relationship exists among the number of utility change orders, time and cost performance of road projects?

1.5 JUSTIFICATION

The negative impacts arising from utility relocations have both economic and political ramifications. Such occurrences affect all stakeholders of the project; owner's capital and administrative cost increases, project contractor's direct cost increases, businesses losses and additional costs to the general public.

Road construction involve huge capital outlay, usually tax payers' money, which could be used to develop other equally important sectors of the economy. Ghana is a developing country, with many sectors of the economy still under-developed, hence it is imperative that the tax payers' money of the nation be spent judiciously for the benefit of all sectors. The output of this research will give an enlightenment to road actors about the impact utility service relocation have on road construction and position them in a better way to be able to deal with utility issues to avert these negative impacts.

1.6 METHODOLOGY

An extensive review of existing literature on utility relocation was first conducted through books, internet searches, academic journals and previous thesis to establish a theoretical framework on the subject. Closed ended questionnaire, coupled with desk study of some selected projects were used to gather primary data. Through descriptive statistics, Relative Importance Index (RII) and one sample test, data gathered were evaluated to identify the challenges of managing utility relocations and examine the impact level of utility relocation on road construction. Deductions and recommendations were advanced through the study findings.

1.7 SCOPE OF STUDY

The research was limited to utility issues during construction and does not cover post construction utility issues. The study examined the impact of utility relocation on road construction with respect to time and cost only. Geographically the research scope was

limited to the Brong-Ahafo region of Ghana. Brong Ahafo is in the middle belt of the country. It is economically vibrant and is said to host one of the biggest markets in West Africa. As such it attracts all manner of people and businesses from the south, the north and neighbouring countries.

1.8 ORGANIZATION OF STUDY

The research is structured as follows:

- **Chapter 1: Introduction.** The chapter offers an overview of the impact of relocating utility services during road construction and outlines the research proposal.
- **Chapter 2: Literature review.** This chapter explored existing literature on utility relocations during road construction; the type of utility conflicts, utility management challenges and impacts.
- **Chapter 3: Research methodology.** The procedures employed to achieve the objectives of the study are defined in this chapter.
- **Chapter 4: Results and discussion.** In this chapter data gathered is analyzed and results discussed.
- **Chapter 5: Conclusions & recommendations.** This section reviews how the study objectives were achieved, as well as presents conclusions and recommendations.

CHAPTER TWO LITERATURE REVIEW

2.1 INTRODUCTION

This section explored available literature on utility relocations in road projects to present a theoretical framework for the study and a background to the research objectives. The literature review presents perspectives of some researchers on the issue of utility relocations in road construction; the conflicts, impacts and some ways of expediting relocations to obtain efficiency in project delivery.

2.2 PROJECT PERFORMANCE ASSESSMENT

Every project has some defined goal(s) that serve as a yardstick upon which success and/or failure is measured. When it comes to project performance measurement, the construction industry is not unified on the key success indicators. Barkley & Saylor (1994) considered project performance based on time, cost and quality, also known as the „iron triangle“. Schwalbe (2006) examined project performance based on scope, time and cost. Kumaraswamy et al. (1996) and Tam et al. (2000) listed the following as key performance indicators of a project:

- Cost;
- Time;
- Quality;
- Customer satisfaction;
- Technology transfer;
- Health and safety;
- Environmental performance;
- Commercial value; and
- Actors“ satisfaction

However this study explores the impact of utility relocations on the time and cost performance aspects of road projects.

2.3 USAGE OF THE PUBLIC RIGHT OF WAY

Devaney (2001) defines right-of-way as “land and facilities that are maintained and regulated as public rights-of-way and used for direct and indirect services that they provide, such as the mobility of people and products; water supply and wastewater treatment; energy and communication systems”.

For the purposes of this research, public right-of-way (PROW) shall refer to land legally granted or reserved for public roads and related infrastructure and/utility services development. The use of land for the purposes of public roads has been undisputed since time immemorial (Devaney, 2001).

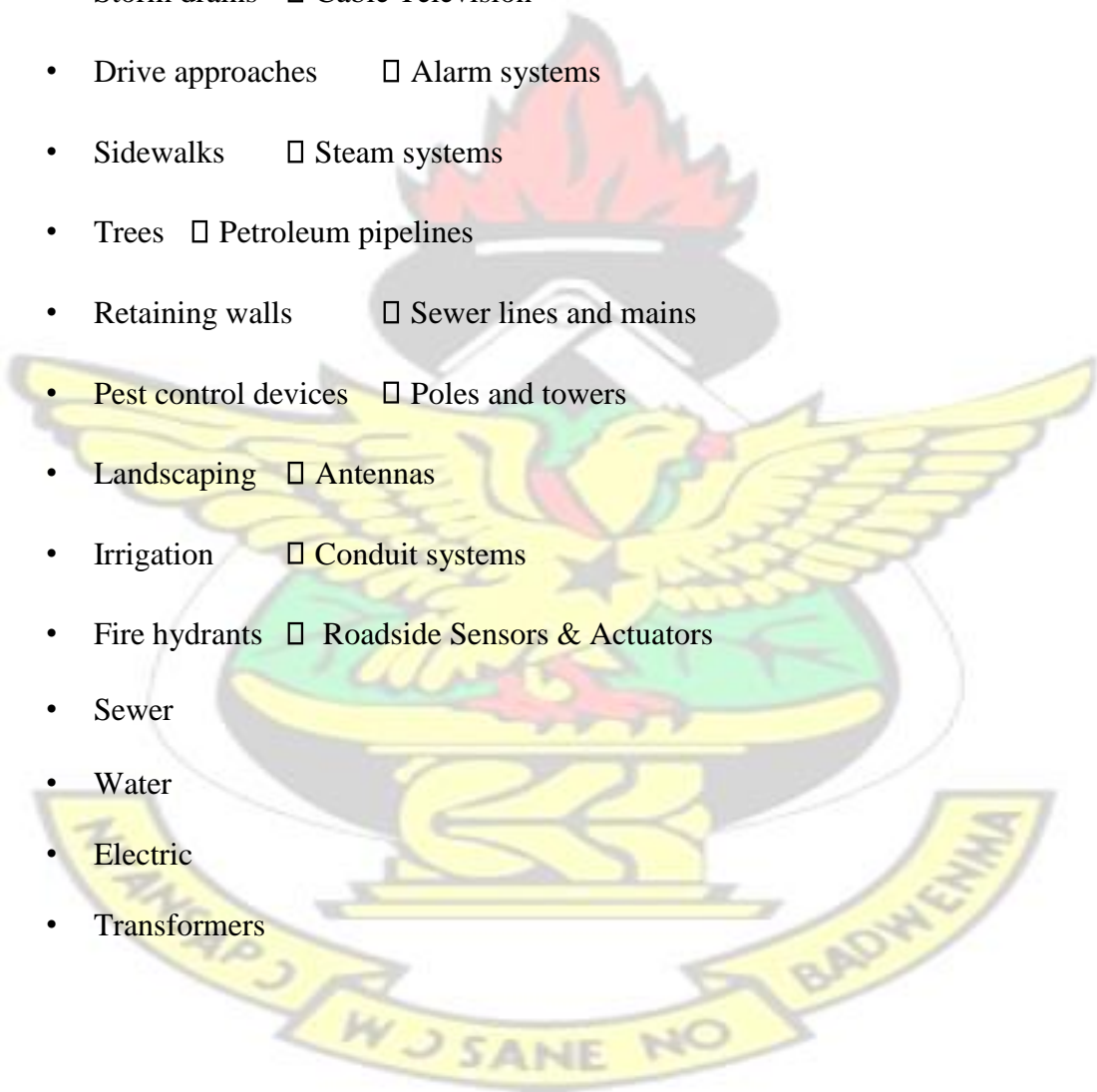
Many authors agree on the need to locate utilities within the public right-of-way, perhaps for economic considerations (Devaney, 2001; Sterling et al. 2009). State laws in most countries provide at least minimum legislation on utility accommodation within right-of-ways (Quiroga et al, 2012). In Ghana, co-location of public roads and utilities is recognized and backed by law (Ghana Lands Act-1963, Act 186 s 2, ss 2).

While it may be legal and convenient to locate utilities within the public right-of-way, their presence nevertheless present some challenges to the effective management of the state right-of-ways. To mitigate the negative effects of utility presence on right-ofways, some countries have enacted laws or through state agencies, regulatory policies, industry standards and work specification guides have been introduced.

As per Devaney (2001), the recognized state organ that plans, manages and control local rights-of-way, is local government. According to the author, laws alone do not suffice in tackling a multifaceted issue like utility relocations. These must be backed by broad stakeholder participation and efficient planning, technical engineering, operations and maintenance.

A typical urban public right-of-way as per Devaney (2001) has some of the following:

- Pavement □ Fire alarm
- Markings of pavement □ Police signals
- Street Light □ Railroad Signals
- Traffic control devices □ Gas
- Signage □ Telephone
- Curbs & gutters □ Terminal equipment
- Storm drains □ Cable Television
- Drive approaches □ Alarm systems
- Sidewalks □ Steam systems
- Trees □ Petroleum pipelines
- Retaining walls □ Sewer lines and mains
- Pest control devices □ Poles and towers
- Landscaping □ Antennas
- Irrigation □ Conduit systems
- Fire hydrants □ Roadside Sensors & Actuators
- Sewer
- Water
- Electric
- Transformers



2.4 UTILITY CONFLICTS AND IDENTIFICATION

Since the right-of-ways are shared with utilities, there is no doubt of some form of interference with one utility or the other during road construction. Studies by Quiroga et al. (2012) identified the following as potential utility conflicts that may exist on most transportation projects:

- Intrusion with utility facilities and transportation;
- Project features (existing or proposed);
- Phasing of construction activities;
- Conflict between proposed designs and existing utility facilities;
- Nonconformity of utility services with utility accommodation policies; and □
Nonconformity of utility services with safety guidelines

Proper identification, location and characterization of a conflicting utility is essential in avoiding delays and cost overruns in road projects (Sterling et al, 2009). When utilities are properly located and characterized early enough through efficient coordination and communication, the relocation process is quickened. Sterling et al, (2009) identified the following as reasons for locating and characterizing utilities:

- Eradicating needless relocation of utilities;
- Getting early information for project design, implementation, and material record needed for relocations;
- Enabling informed judgment between betterment, removal or replacement against restoration of utility services based on their state and / location;
- Ensuring safety of construction workers and the public;
- Preserving vital utility services; and

- Minimizing pavement destruction during utility enhancement or overhaul

2.5 CHALLENGES OF MANAGING UTILITY CONFLICTS

The challenges to effective management of utility conflicts on road projects according to Quiroga et al. (2015), can be summarized into two main factors which has to do with i) utility identification and characterization methods and ii) inefficient implementation strategies to resolving those conflicts. Quiroga et al. (2015) noted that such inadequacies could lead to problems like:

- Distractions upon sudden encounter with utility systems during construction;
- Destruction of utility systems which can cause interruptions in service provision, injure the environment, and may be hazardous to the construction workforces and the general public;
- Prolonged project design phase and increased project cost arising from expensive offers, change orders and/or destruction or delay claims, redesign, and law suits from affected stakeholders;
- Unintended environmental remedial actions; and
- Ineffectiveness in project delivery and needless utility relocations arising due to poor or inadequate location and characterization of existing utility services to inform alternative utility conflict resolution strategies.

2.6 IMPACT OF UTILITY ISSUES ON ROAD PROJECTS

Utility conflicts in road projects affect the time and cost aspects of the project. In terms of costs, Jones (1999) cited in Mohamed & Khogali (1999) identified three types of costs associated with utility works in projects as follows:

1. Direct Costs: these include costs for consultancy, planning, design, procurement, relocating of existing services and restorations;
2. Indirect Costs: these cover costs associated with a reduced lifespan of roads, high pavement preservation requirements, destruction to adjoining chattels and business losses; and
3. Social Costs: which are costs arising from associated hazards of utility relocation to society such as pollution (land, air, dust, noise, and vibration), the loss of service, traffic congestion and increased accidents.

A report by Quiroga et al. (2007) observed that, utility relocation constituted about 19% of ROW acquisition costs in recent years for completed road projects at Texas Department of Transport. In a similar study, Ellis and Thomas (2002) found out that average time growth on road projects was about 25% of the planned duration, while the average cost overrun was 2.1% of contract sum.

2.7 UTILITY RELOCATION, TIME AND COST GROWTHS CORRELATION

Sturgill et al. (2015) developed a predictive module that shows how utility relocations relate with time growth and cost overrun. In this report, a post-construction review of 35 projects that experienced utility-related problems was carried out and an attempt made to statistically establish the trends among the variables using R-squared technique. The figures below show graphical representation of the linear relationships among these variables.

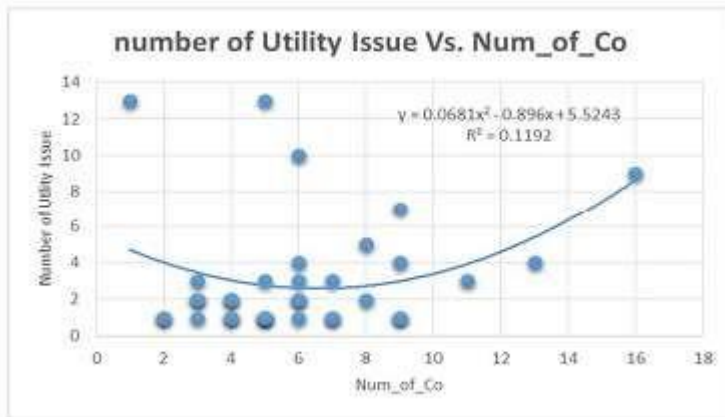


Figure 2.1: Number of utility issues versus number of change orders

Source: Sturgill et al. (2015)

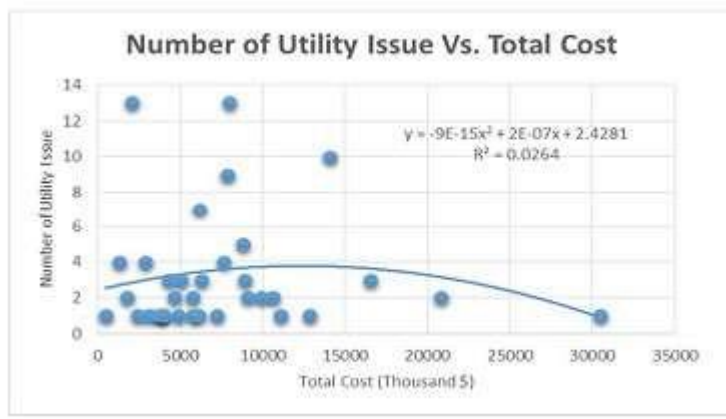


Figure 2.2: Number of utility issues versus Total cost

Source: Sturgill et al. (2015)

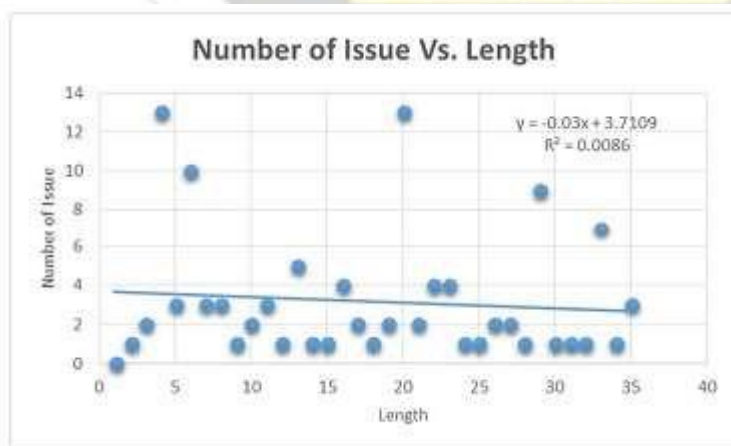


Figure 2.3: Number of utility issues versus project length

Source: Sturgill et al. (2015)

2.8 UTILITY MANAGEMENT PRACTICES

Sterling et al.(2009) observed that the development process and operations of transport systems and utility systems are closely connected. Closer coordination and collaborations between owners/managers of the two systems is required to foster speedy utility relocation. The report stressed the need for an improved stakeholder engagement mechanism in project development in order to minimize time slippage and cost overruns, unintended destruction to service systems, and destruction to roadways arising from uncoordinated engineering.

The essence of effective stakeholder engagement was shared by many authors. A survey report by the American Public Works Association (APWA) and ASCE (1974), cited in Quiroga et al. (2015) also emphasized this point. The report noted that cooperation, coordination, compromise, and compulsion (i.e. four Cs) was one way to tackle the problem of utility conflict on the right of ways. Cooperation among all stakeholders (road agencies, utility owners and other regulatory and governmental agencies) and the willingness sometimes to Compromise were found to be crucial in ensuring effective Coordination. Left on their own, the needed communication, cooperation and coordination expected of stakeholders to ensure effective project development is lacking in most cases. Therefore, governmental Compulsion through laws and regulations was deemed important in buttressing the efforts of stakeholder cooperation, compromise and coordination, in order to protect the public interest. There are some administrative and institutional challenges that sometime hamper the effective management of utility conflicts within road projects. Quiroga et al. (2012) stated some of these challenges as follows:

- Limited project resources: Limited resources may compel transport agencies to prioritize the actual pavement works over utility issues and cut down on investment in utility issues;
- Uncertainty of transportation project: Utility owners often show little interest in utility coordination at the early stages of project development until later stages of design due to this uncertainty; and
- Availability and quality of existing utility facility data: Inadequate or unupdated information and documentation about the location and characteristics of conflicting existing utility infrastructure.

In spite of the many challenges, various State transport agencies have made strides in managing utility issues within projects. Many researchers have studied the subject area and have presented diverse reports on what constitute best practices in utility management. For instance, US Domestic Scan program, (2006) among three states; Florida, Texas and Minnesota aimed at classifying, recording and publishing state-of-the-art and cost effective right-of-way acquisition and utility relocation practices, shared the following as common traits among the three States studied:

- Dedication to establishment of supportive organizational milieu;
- Emphasis on procedure;
- Use of technical tools; and
- Openness to new ideas and techniques.

2.8.1 Supportive organizational milieu

US Domestic Scan program, (2006) noticed that a supportive organizational milieu played a key role in the success story of the agencies reviewed. According to this report,

such a supportive institutional environment bore the following characteristics across all states and agencies visited:

- A team approach – the Scan team observed that a team approach to utility management promotes collective ownership of the project and encourages all parties involved to navigate around problems;
- Upper management support – In all three states, it was found that upper management did not only delegate authority to lower ranks, but backed it with the needed financial resources to accomplish the assigned tasks. This act also served as a motivator to the staff by creating a “can-do” attitude among team members in the pursuit of the project goals;
- Disposition to innovate and accept risks – the freedom for staffs of right of way and utilities to try new techniques and to innovate was found to have contributed significantly to success;
- Provision of enough logistics – Every state prioritized utility issues by providing logistics like competent staff, cutting-edge technical tools, and monetary resources, needed for the functions of ROW acquisition and utility relocation; and
- Commitment to monitor and improve performance – it was also observed that these states reviewed had developed tools and procedures (with identifiable performance indicators) that enable them to track, monitor and evaluate performance with regard to utilities.

2.8.2 Emphasis on Procedure

The essence of a precise, distinct, but flexible procedure was seen as crucial to tackling the issue of utilities on right-of-ways (US Domestic Scan program, 2006). Such a

process according to the authors of the aforementioned study, was found to be characterized by the following:

- Cross-disciplinary approach – the research findings also showed that the States understudied took clear steps to involve people with diverse expertise in the project development process from the early stages. Such disciplines included staffs from design, right of way, utilities, environmental, and construction departments. This approach did two things: i) it enabled early identification and addressing of critical issues during design hence eliminating delays and increased expenses ii) it created an invigorating work environment where staffs felt responsible for ensuring project success;
- Early involvement of stakeholders – all the States endeavoured to engage external stakeholders as early as practicable. These stakeholders included: community members, utility owners, affected private property and business owners, and resource agencies. This process created trust and enabled the implementation of projects with less negative impacts;
- Explicit, written procedures – State DOTs were also observed to have written and explicit procedures about stakeholder coordination process.

Written procedures also helped capture institutional knowledge as well as provide opportunity for process auditing;

- Incentives to maintain staff continuity – States also instituted incentive packages to maintain staffs on projects, especially for complex and high-visibility projects;

- Delegated decision-making authority – States eliminated hierarchical decision-making delays by delegating certain decision making functions to the lowest level possible. This helped to keep right of way acquisition and utility relocation within the time scheduled;
- Conflict resolution – disputes among stakeholders can cause costly delays on projects. These three States avoided conflicts by using conflict management techniques such as “escalation ladder” and “white paper” methods for disputants to elevate disagreements and disharmony to management. These techniques aided speedy conflict resolution without the involvement of top management;
- Co-location of major participants – delays were minimized and communication aided by co-locating transport agency staffs, designbuild consultant, staff of ROW, and FHWA representatives;
- Focus on schedule adherence – State DOTs operated a system that did not tolerate delays at any level for any reason. Other team members were made to work up to compensate for any delays that occurred at any level; and
- Design-build – the scan team suggested the use of design-build method of contracting, where permissible by state law, to accelerate project development.

2.8.3 Technical Tools

Findings by US Domestic Scan program, (2006) showed that each state invested in state-of-the art tools that facilitated effective project administration, property and

services management, and stakeholder education. Some examples of these tools according to US Domestic Scan program, (2006) include:

- Tools for managing property – these comprised GIS-based tools that are designed in a way that allows the tracking of the status of individual properties during acquisition, implementation as well as the operations stage;
- Data management – the Scan findings also showed that the states invested in staffs, data filing structures, tools, automated monitoring, as well as staff development;
- Electronic field data entry – another vital system that was seen to be helpful was the electronic data management systems where original data once entered was passed on to the State's electronic data system;
- Visualization and animation technology – these tools have proven to be helpful especially in educating utility owners and the public. They are able to model road design proposals relative to existing structures and utility services thus facilitating impact assessment and alternative design solutions;
- Web sites – these served to inform stakeholders thus facilitating enhanced stakeholder coordination and engagement as well as aid the processing of documents; and
- Ecological considerations – environmental issues are a component of right-of-way development, and require collaboration with other design staff to ensure speedy process. Technical tools that consolidate environmental data was found to be helpful.

2.8.4 Other Techniques

Other techniques cited in US Domestic Scan program, (2006) that were used to improve the utility conflict resolution process include:

- Incentive acquisition and relocation payments to the property owner;
- Advance acquisition payments to assist local governments in making property advanced purchases of ROW parcels;
- Appraisal waiver and appraisal review;
- Utility reimbursements;
- Employment of subsurface utility; and
- Design mitigation strategies and value engineering.

Various studies by Quiroga et al. (2015); Sturgill et al. (2015) and US Domestic Scan program, (2006) have suggested the following as innovative practices in managing utility issues on right-of-ways during highway developmental schemes:

- Right of way considerations should form part of project planning and scheduling;
- Activities pertaining to ROW utility relocations should be done concurrently, if feasible with the core activities of road development;
- As much as possible, decision-making powers concerning the road development should be given to staffs directly involved in project execution rather than retained at top management levels;
- Encourage an all-inclusive environment in which decisions affecting any functional units receive the active participation by such units;
- Create an environment that promotes staff development in other

disciplines beyond their traditional core job competencies;

- Give advance notices to service providers concerning all project development in the ROW and create a forum to engage and educate service providers on these developments;
- Notify service providers early and give them enough time ahead of project development to relocate their systems;
- Form local teams to coordinate all utility issues on the ROW;
- Institute utility destruction prevention measures by establishing one-call centers to collate notifications of proposed excavations on the ROW;
- Promote joint use of facilities and consider establishing utility corridors to accommodate ducts of buried utilities;
- Disseminate road development proposals and schedules to all relevant stakeholders;
- Meet with and engage service providers regularly on future project development and construction activities;
- Inform service providers of road developments ahead of the design stage;
- Pass schematic road design details to service providers for comment in the course of the project design;
- Perform an impact assessment of road development proposals on services and other structures on the right of way;
- Engage with service providers prior to the commencement of every key stage of a highway project, including planning, design, and construction;

- Determine and resolve utility conflicts prior to implementation;
- Allocate a focal person at the agency to work with service providers on a project from inception to completion;
- Publicize on the annual basis, maps of city, province, state highway agency, and utility projects;
- Publicize details of construction programs as well as details of project managers and other key implementation staff of road projects;
- Planning for utility services should be done in conjunction with other public planning efforts;
- Utility companies should furnish to transport agencies plans showing updates of their utility systems every 2 to 5 years;
- Endeavour to reduce the effect of utility facilities on routes with high traffic volumes, few alternative routes, or limited right of way;
- Early design involvement;
- Fiscal incentives/disincentives for expedient relocation;
- Incorporation of utility corridors;
- Increased utilization of Subsurface Utility Engineering to promote utility avoidance;
- The use of utility relocation management software;
- Offering utility relocation design and construction services via state-wide contracts;
- Establishing term utility agreements;

- Clearing right-of-way prior to utility relocations
- Providing a loan program to help finance utility relocations;
- Exploring the four C's (communication, cooperation, collaboration, coordination);
- Adopting trenchless technologies to expedite utility relocations;
- Use of advanced sensing technologies to improve the accuracy of locating existing utility lines;
- Development of utility conflict matrices; and
- Use of Civil Information Models for improved visualization of utility conflicts in 3D CAD models.

CHAPTER THREE RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter presents the research approaches that were employed to achieve the set objectives. The aim of the research was to analyze the impact of utility services relocation on road construction.

The following were the research objectives:

1. To identify challenges of managing utility relocations in road projects;
2. To examine the impact level of utility relocation on road projects; and
3. To examine the relationship of time slippage, change orders and cost overruns of road projects with utility relocations.

3.2 RESEARCH DESIGN

The research employed descriptive research design approach to solve the research problem. Primary data collection instruments were questionnaire survey and desk study of project records.

3.2.1 Target Population

The research was designed to be conducted among technical staff of road agencies, utility companies, Engineering consultants and road contractors. Reference to the 2009-2010 review report of the Ministry of Roads and Highways (See appendix C) indicated that technical staff from the three road agencies spread across the country was about 905: Ghana Highway Authority – 429, Department of Feeder Roads – 304, Department of Urban Roads – 172; the total number of road contractors with minimum of B4 classification or better (and in good standing as of January 2016) obtained from the Ministry of Roads and Highways website was 2020; the utility companies involved include: 1) Water: Ghana Water Company Ltd; 2) Electricity:

VRA, GRIDCO and ECG; and 3) Telecommunication companies: MTN, Vodafone, Tigo, Airtel, Glo and Expresso.

3.2.2 Sample and Sampling Technique

Given that the above population of potential respondents is spread across the country and that time and resource constraints will not permit data collection from all of them, the Brong-Ahafo region was chosen for the research. This region was chosen because it lies within the middle belt of the country and is a business hub, not only for Ghana, but other neighbouring West African countries like Burkina Faso, Niger, Ivory Coast, Togo, Benin etc. Again the region has 27 administrative assemblies, which represent the second largest in the country. This suggests that the region is relatively more

urbanized and likely to be experiencing more utility – road conflicts than other regions. The large number of administrative capitals also suggests that the region receives a substantial budgetary allocation for road infrastructural development. According to Israel (1992), the size of sample used for a research depends on factors such as the purpose of the study, the population characteristics and size, precision and confidence levels required, degree of variability in the measured attributes. According to Israel (1992), the sample size of a study can be determined using one of the following: i) figures in published list, ii) sample size of similar studies, iii) population census for smaller samples, and iv) formulas. The sample size in this study was purposively selected using judgmental sampling technique. Purposive sampling is a form of nonprobability sampling. In selecting the sampling units to be studied, the judgmental method of sampling relies solely on the judgment of the researcher. Smith (1983) cited in Israel (1992) suggested that researchers can select sample units on purpose based on the characteristics or attributes that are relevant to the study. Since utility issues are more prominent in urban settlements, the study concentrated on the Municipal centers of the region that have the presence of at least one of the three road agencies (GHA, DFR or DUR). Based on this criteria, Techiman, Sunyani and Goaso Municipalities were selected for the study. Since the target population is large and from different backgrounds (Road agencies, utility companies, contractors and consultants), priority was given to sample units with the needed technical capability relevant to the study rather than proportionality. Hence the study targeted the technical staff in these agencies as shown in Table 3.1 below. Contractors and Consultants selection was based on the number who had ongoing construction works or consultancy services within the chosen municipalities of the region at the time. By this criteria, a sample size of 60 respondents was thus obtained.

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Table 3.1: Sample size

Brong- Ahafo Region					
Agency /					
No Designation Techiman – Sunyani - Sunyani- Goaso - Total municipal municipal					
Regional municipal					
1	Road Agencies				
i	GHA				
	a) Reg. Director / MRE	1	1		2
	b) Engineers	1	6		7
	c) Quantity Surveyors	1	2		3
	GHA Total	3	0	9	0
ii	DFR				
	a) Reg. Director / MRE		1		1
	b) Engineers		2		2
	c) Quantity Surveyors		2		2
	DFR Total	0	0	5	0
iii	DUR				
	a) Reg. Director / MRE	1	1	1	1
	b) Engineers	2		3	
	c) Quantity Surveyors	1	1	4	1
	DUR Total	4	2	8	2
2	Utilities				
	a) GWCL	5		3	
	b) VRA/Gridco	3		3	
	c) Telecom	2		2	
	Utilities Total	10	0	8	0
3	Consultants	2	1		3
4	Contractors	2		4	6

3.2.3 Structure of Questionnaire

In order to achieve the study objectives, a well-structured questionnaire was developed and administered to respondents to gather primary data. These questions were piloted by giving five (5) questionnaire to five (5) potential respondents. Feedback from the piloting exercise was then used to fine-tune the questionnaire for administration. The survey questions were sectionalized as follows:

The first part contained five (5) questions which sought general information about the respondents. These included their company or agency name, their role, type of activities, area of expertise and number of projects executed involving utility conflict within the last ten (10) years. These questions sought to establish the credibility of information provided by respondents. The second part focused on utility challenges and impact level on projects and covered questions six (6) and (7).

Question 6 sought to identify some challenges in managing utility relocations during road construction, using the following likert scales: 1. Strongly disagree 2. Disagree 3. Not sure 4. Agree 5. Strongly agree

Individual utility issues have different impact levels on road construction. Question 7 sought to gauge respondents' rating level of the impacts of some identified utility issues on road construction on a scale of 1 to 5: 1 being least negative impact and 5 being most negative impact. A detailed format of the questionnaire is presented in

Appendix A.

3.2.4 Distribution of Questionnaires

The questionnaires were self-administered. Respondents were accorded some time to study and complete the questionnaire. Phone calls were made to remind and encourage respondents to complete and return the questionnaire.

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3.2.5 Desk Study

A desk study of some selected road projects was undertaken to answer the research question “How does utility relocations influence the number of change orders on road projects and the time and cost performance of these projects?”. To achieve this objective, Seven (7) road projects from the Brong-Ahafo Regional Department of Urban Roads, relevant to the subject matter, were thoroughly assessed. Since urban settlements are more likely to experience utility conflicts, projects from the Department of Urban Roads were chosen. To get a representative data across the region, efforts were made to get an Urban Roads project (ongoing or completed) with utility issues, in each of the nine (9) municipalities of the region. By this criteria seven projects were arrived in seven (6) municipalities namely Sunyani, Goaso, Dormaa, Nkoranza, Kintampo and Odumasi. Three of these projects were completed, while the remaining four were at various stages of completion at the time of the study. The projects include:

1. Rehabilitation of Penkwase - Military barracks - Sunyani
2. Outer Ring Road Ph 2 - Sunyani
3. Construction of Goaso Town Roads - Goaso
4. Rehabilitation of Dormaa - Ahenkro Town Roads - Dormaa
5. Rehabilitation of Nkoranza and Kintampo Roads
6. Rehabilitation of Odumasi Town Roads - Odumasi
7. Construction of Sunyani bypass - inner ring road - Sunyani

3.3 DATA ANALYSIS

Data from respondents was analyzed quantitatively using statistical package for social sciences (SPSS) version 17 coupled with Microsoft excel. Descriptive Statistics, Relative Importance Index (RII), One Sample T Test and Correlation Test were the main tools employed to analyze the data.

3.3.1 Descriptive Statistics

Descriptive Statistical tools used in this research were mainly frequencies and percentages, displayed either in tables or graphically in charts. These analytical tools were employed to analyze background information of respondents and also the desk study results.

3.3.2 One Sample T Test

The One sample T Test was used to analyze challenge factors in managing utility relocations. According to Ahadzie (2007), the One sample T Test is usually used to establish how significantly deviant a sample mean is from a hypothesized mean. A typical hypothesis of a single-sample test is set as follows:

Ho: $U = U_0$

Ha: $U <, > U_0$

Where, Ho denotes the null hypothesis, Ha denotes the alternative hypothesis and U_0 denotes the hypothesized or population mean. In a typical one-sample-test, the mean of the test group, degree of freedom for the test (which approximates the sample size), the t value (which is an indication of the strength of the test) and the p value (which is the probability value that the test is significant) are commonly reported (see for instance Ahadzie, 2007; Field, 2005; Hair et al. 1998; Reymont and Joreskog, 1993).

For each attribute, the null hypothesis was that the attribute was unimportant (Ho: $U = U_0$) and the alternative hypothesis was that the attribute was important (Ha: $U > U_0$), where U_0 is the population mean. Thus U_0 represent the critical rating above which the attribute is considered important. Given that the rating scale adopted ascribed higher ratings of 4 and 5 to agree and strongly agree attributes respectively, U_0 was fixed at an appropriate level of 4 (see for instance Ahadzie, 2007 & Ling, 2002). The

significance level was also set at 95% in accordance with conventional risk levels (see for instance Ahadzie, 2007 & Ling, 2002). That is, based on the five-point Likert rating scale, a utility challenge was deemed critical or important if it had a mean of 4 or more. Where two or more attributes have the same mean, the one with the lowest standard deviation was assigned the highest importance ranking (see for instance Ahadzie, 2007; Field, 2005; Shen and Liu, 2003). Attributes with standard deviations less than (1.0) indicate little variability in data as well as consistency in agreement among respondents (see for instance, Field, 2005; Steven, 1996).

3.3.3 Relative Importance Index (RII)

The Relative Importance Index (RII) was used to analyze data for question no. 7.

$$\text{Relative Importance Index} = \frac{\sum W}{AN}$$

Source: Badu et al, 2013

Where, W = weighting of scores by respondents (score scale is from 1 to 5)

Therefore, W = score X no. of responses

A = highest score; 5 in this case

N = Total number of respondents = 40

3.3.4 Correlation Test

To investigate the strength of relationship among the variables of study namely: cost and time growths with number of utility change orders, a correlation test was run among these variables using the Microsoft Excel correlation coefficient formula below:

$$\text{Correl}(X, Y) = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$$

Where x and y represent the variables, while \bar{x} and \bar{y} represent the means of the variables.

The coefficient values are indicative of the strength of the correlation between two variables. At a significance level of 5%, two variables have strong correlation if the resulting coefficient is 0.05 or more.

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CHAPTER FOUR RESULTS AND DISCUSSION

4.1 INTRODUCTION

Analysis of data gathered from the questionnaire survey and desk study of selected projects is the subject matter of this chapter. The chapter is ordered into two sections. The first section discusses results from the questionnaire survey, while the second section discusses results from the desk study. Data from the questionnaire survey is categorized into two parts; the first part deals with general information about the respondents and the second part focuses on the analysis and discussion of their responses on the research topic. Sixty (60) questionnaires were sent out and forty (40) were returned, representing a response rate of 66.67%. In addition, seven (7) road projects, both completed and ongoing were reviewed to assess the impact of utility relocation on those projects. These results form the basis of analysis and discussion in this chapter.

4.2 SECTION 1: SURVEY RESULTS

4.2.1 Part 1: General Information about Respondents

This section presents results about the background of respondents of the survey. Information sought from respondents included: their company/agency name, the role they play in it, the type of activities engaged in by the company, their areas of expertise and the number of road projects with utility conflict they have been involved in over the last ten (10) years. The purpose of this part of the survey was to ensure that relevant stakeholders with the requisite experience in road construction and utilities participate in the survey, thus giving credibility to the survey.

4.2.1.1 Company Backgrounds of Respondents

Responses were obtained from diverse stakeholders involved in the road construction process. These include Ghana Highway Authority (GHA), 22.5%; Department of Urban Roads (DUR), 27.5%; Department of Feeder Roads (DFR), 5%; Municipal Assembly, 5%; Ghana Water Company Limited (GWCL), 12.5%; VRA/GRIDCO, 7.5%; Tigo, 2.5%; MTN, 2.5%, Alexiboam Co. Ltd, 2.5%; Cottage Construction, 2.5%; Resource Access Ltd, 7.5%; Ragirol Ltd, 2.5%. The essence of involving these diverse stakeholders was to get balanced and representative views from relevant stakeholders on the subject matter. See Table 4.1 and Figure 4.1.

Table 4.1: Company backgrounds of respondent

<i>Agency</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
<i>GHA</i>	9	22.5	22.5	22.5
<i>DUR</i>	11	27.5	27.5	50
<i>DFR</i>	2	5	5	55
<i>Municipal Assembly</i>	2	5	5	60
<i>GWCL</i>	5	12.5	12.5	72.5
<i>VRA/GRIDCO</i>	3	7.5	7.5	80
<i>Tigo</i>	1	2.5	2.5	82.5
<i>MTN</i>	1	2.5	2.5	85
<i>Alexiboam Co. Ltd</i>	1	2.5	2.5	87.5
<i>Cottage Construction</i>	1	2.5	2.5	90
<i>Resource Access Ltd</i>	3	7.5	7.5	97.5
<i>Ragirol Ltd</i>	1	2.5	2.5	100
<i>Total</i>	40	100	100	

Source: Field survey, 2016

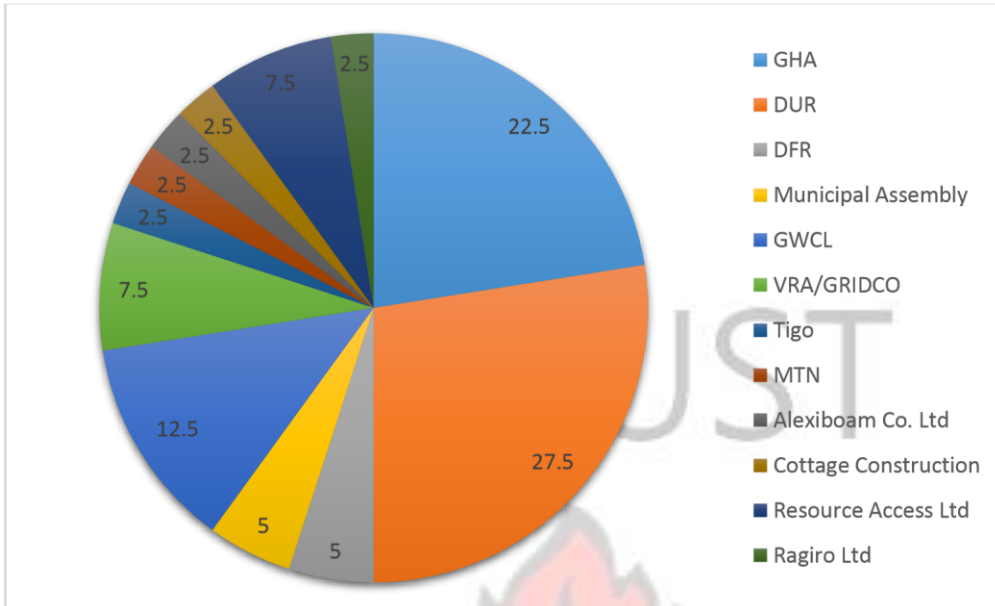


Figure 4.1: Company backgrounds of respondents *Source: Field survey, 2016*

4.2.1.2 Role of Respondents in their Companies

Respondents were asked to indicate their role within their various companies and agencies. From the survey, 30% of the respondents were Quantity Surveyors, 42.5% Engineers, 5% Project Managers, while 22% represent respondents with various designations. See Table 4.2 below. Engineers, Quantity Surveyors and Project Managers (be they from client or contractor's side) are usually the key professionals involved in road project planning, design and execution. The findings show that majority responses (cumulative percentage of 77.5%) came from these key professionals, thus increasing the credibility of the survey.

Table 4.2: Role of respondents in their companies

<i>Role</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
<i>Quantity Surveyors</i>	12	30	30	30
<i>Engineers</i>	17	42.5	42.5	72.5
<i>Project Managers</i>	2	5	5	77.5
<i>Others</i>	9	22.5	22.5	100
<i>Total</i>	40	100	100	

Source: Field Survey, 2016

4.2.1.3 Work Classification and Expertise Areas of Respondents

Questions 3 and 4 respectively sought to categorize the type of activities and the areas of expertise of the respondents. This was done to ensure that trends of views could be traced to particular groups of stakeholders. From the survey results, four basic categories of work groups were identified: 55% of respondents were from road agencies, 25% from Utility Companies, 15% were General Contractors and 5% were Consultants (see Table 4.3 below). By way of expertise, the results show that 72.5% are involved in road works, 7.5% in electricity, 15% in water and 5% in telecom as depicted in Table 4.4 below.

Table 4.3: Classification of respondents

<i>Class of respondent</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
<i>road agency</i>	22	55	55	55
<i>utility provider</i>	10	25	25	80
<i>general contractor</i>	6	15	15	95
<i>Consultant</i>	2	5	5	100
<i>Total</i>	40	100	100	

Source: Field survey, 2016

Table 4.4: Area of expertise of respondents

<i>Area of expertise</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
<i>road works</i>	29	72.5	72.5	72.5
<i>Electricity</i>	3	7.5	7.5	80
<i>Water</i>	6	15	15	95
<i>Telecom</i>	2	5	5	100
<i>Total</i>	40	100	100	

Source: Field survey, 2016

4.2.1.4 Respondents' Experience Level with Utility Relocations

In question 5, respondents were to indicate the number of road projects they had been involved in that conflicted with utilities over the last 10 years. Respondents' experience with utility conflicts in road construction will invariably affect how abreast they are with utility relocation issues and ultimately determine the quality of responses they give to the questions. From the survey, 20% of the respondents have had a road and utility conflict experience level of 0-5 projects, 30% had an experience level of 6-10 projects, 27.5% of them had 11-20 projects experience level, 15% had 21-50 projects experience, while 7.5% had experience level of above 50 projects. The responses indicate that majority of the respondents have fairly experienced utility relocations, as about 80% of them have experienced 6 or more road projects involving utility conflicts (See Figure 4.2 below) and hence can contribute meaningfully to the study objective.

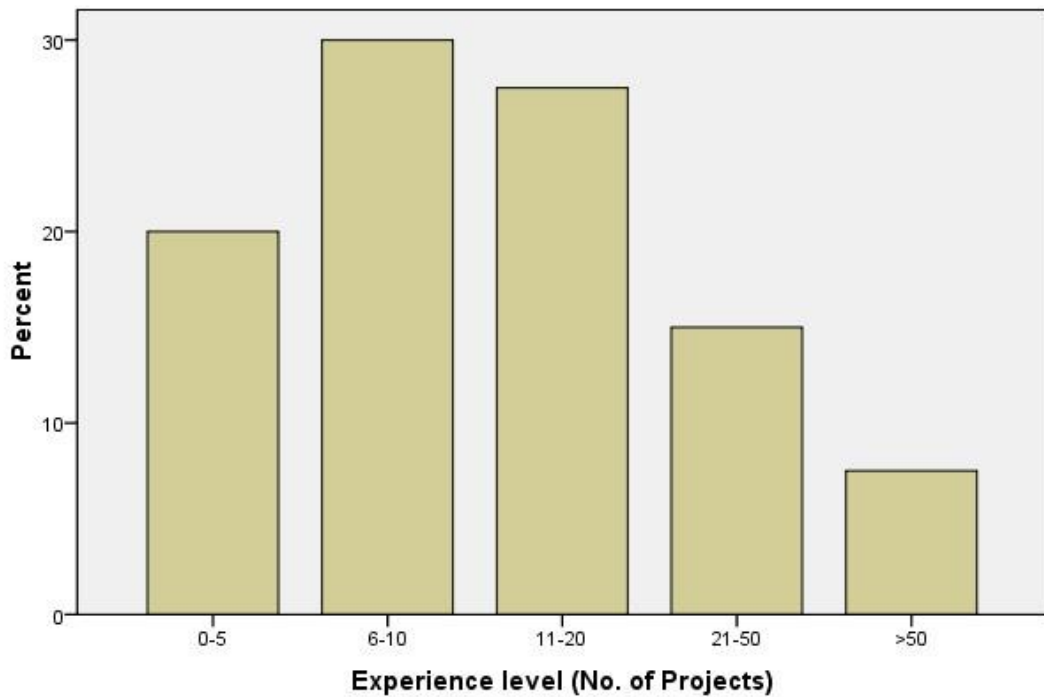


Figure 4.2: Respondent's road and utility conflict experience level within the last 10 years

4.2.2 Part 2: Utility Challenges and Impacts on Projects

This section presents findings from the survey geared towards finding answers to the following research questions:

1. What are some of the challenges in managing utility relocations?
2. Which utility issues impact negatively the most on road projects?

Questions 6 of the survey responds to the first research question, while question 7 answers the second research question.

4.2.2.1 Challenges of Managing Utility Relocations

The aim of this question was to elicit views from respondents on the challenges of relocating utilities during construction. To this end, sixteen utility challenges identified from literature were presented and respondents were to score them on a five-point likert

scale (1 = strongly disagree 2 = disagree 3 = not sure 4 = agree 5 = strongly agree) according to the extent to which they agree with the factors.

The responses were analyzed using the One-Sample T Test, with a Test value (T) of 4 and at a confidence level of 95%. The results are shown in Tables 4.5 and 4.6. The mean value for each attribute together with the associated standard deviations as well as the attribute rankings are shown in Table 4.5. In Table 4.6, the significance level of the various factors have been shown.

From the results in table 4.5 below, the following utility challenges had standard deviations below 1.0, thereby attaining relative significance in agreement among respondents:

- *Delays in starting utility identification and relocation work*
- *Phasing of construction and utility relocation work out of sequence*
- *Shortage of labour and equipment for contractor*
- *Late involvement of utility companies*
- *Rework required/change orders*

Majority of the utility challenges did not receive wide level agreement among the respondents. This is perhaps because the respondents had multifarious backgrounds and probably interpreted the variables in their own ways resulting in the variability in agreement.

From Table 4.5 however, the Ten (10) topmost utility challenges (in descending order of importance) during road construction are:

1. *Lack of training of stakeholders on utility issues*
2. *Lack of use of technological tools and software for visualization, identification and management of utility issues*

3. *Delays in starting utility identification and relocation work*
4. *Late involvement of utility companies*
5. *Slow response from utility companies to requests to locate and mark underground utilities*
6. *Delays in obtaining rights of way for utility*
7. *Low prioritization of utility relocations by utility companies*
8. *Rework required/change orders*
9. *Lack of resources (finance and personnel)*
10. *Short time frame for road agencies to plan and design project*

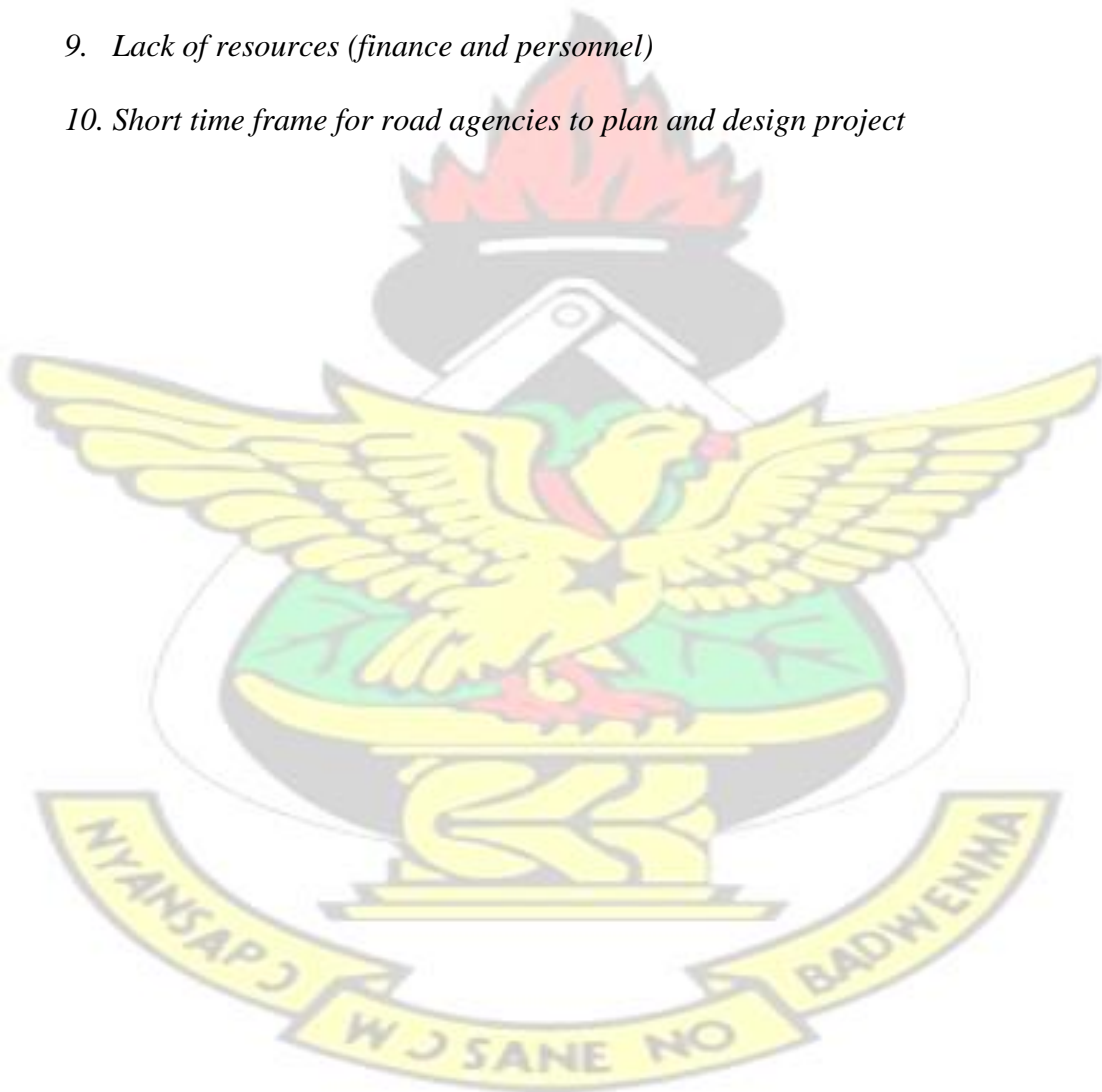


Table 4.5: Results of T-test showing mean, standard deviation and rankings*One-Sample Statistics*

<i>Challenges</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>Ranking</i>
<i>Lack of resources (finance and personnel)</i>	3.40	1.464	9th
<i>Short time frame for road agencies to plan and design project</i>	3.30	1.224	10th
<i>Low prioritization of utility relocations by utility companies</i>	3.53	1.396	7th
<i>Increased workload on utility relocation crews</i>	2.90	1.172	15th
<i>Delays in starting utility identification and relocation work</i>	3.80	.966	3rd
<i>Phasing of construction and utility relocation work out of sequence</i>	2.95	.846	14th
<i>Lack of 'as-built' drawings</i>	3.15	1.189	12th
<i>Delays in obtaining rights of way for utility</i>	3.63	1.254	6th
<i>Shortage of labour and equipment for contractor</i>	2.00	.961	16th
<i>Project design changes required changes to utility relocation</i>	3.15	1.231	13th
<i>Late involvement of utility companies</i>	3.70	.853	4th
<i>Slow response from utility companies to requests to locate and mark underground utilities</i>	3.65	1.189	5th
<i>Rework required/change orders</i>	3.45	.876	8th
<i>Inadequate coordination or sequencing among utilities using common poles/ducts</i>	3.28	1.320	11th
<i>Lack of training of stakeholders on utility issues</i>	4.13	1.223	1st
<i>Lack of use of technological tools and software for visualization, identification and management of utility issues</i>	3.85	1.369	2nd

Source: Field Survey 2016

Table 4.6: Results of One-sample Test showing test significance

<i>Challenges</i>	<i>Test Value = 4</i>	
	<i>Sig. (2-</i>	<i>Mean</i>
		<i>95% Confidence Interval of the Difference</i>

	<i>T</i>	<i>Df</i>	<i>tailed</i>)	<u><i>Difference</i></u>	<u><i>Lower</i></u>	<u><i>Upper</i></u>
<i>Lack of resources (finance and personnel)</i>	-2.592	39	.013	-.600	-1.07	-.13
<i>Short time frame for road agencies to plan and design project</i>	-3.618	39	.001	-.700	-1.09	-.31
<i>Low prioritization of utility relocations by utility companies</i>	-2.152	39	.038	-.475	-.92	-.03
<i>Increased workload on utility relocation crews</i>	-5.934	39	.000	-1.100	-1.47	-.73
<i>Delays in starting utility identification and relocation work</i>	-1.309	39	.198	-.200	-.51	.11
<i>Phasing of construction and utility relocation work out of sequence</i>	-7.851	39	.000	-1.050	-1.32	-.78
<i>Lack of 'as-built' drawings</i>	-4.523	39	.000	-.850	-1.23	-.47
<i>Delays in obtaining rights of way for utility</i>	-1.891	39	.066	-.375	-.78	.03
<i>Shortage of labour and equipment for contractor</i>	-	39	.000	-2.000	-2.31	-1.69
<i>Project design changes required changes to utility relocation</i>	13.166 -4.367	39	.000	-.850	-1.24	-.46
<i>Late involvement of utility companies</i>	-2.223	39	.032	-.300	-.57	-.03
<i>Slow response from utility companies to requests to locate and mark underground utilities</i>	-1.862	39	.070	-.350	-.73	.03
<i>Inadequate coordination or sequencing among utilities using common poles/ducts</i>	-3.473	39	.001	-.725		-.30
<i>Lack of training of stakeholders on utility issues</i>	.646	39	.522	.125	-.27	.52
<i>Lack of use of technological tools and software for visualization, identification and management of utility issues</i>	-.693	39	.492	-.150	-.59	.29
<i>Rework required/change orders</i>	-3.973	39	.000	-.550	-.83 -1.15	-.27

Source: Field Survey 2016

4.2.2.2 Impact Level of Utility Issues on Road Construction

Question 7 of the survey asked respondents to indicate the impact level of utility related issues identified from literature, on road construction. Respondents were to use a numerical scale of 1 to 5 (1 being least negative and 5 being most negative). Responses from the survey were analyzed using relative importance index and the results are presented in Table 4.7 below.

From the results the topmost utility issue with the most impact to road construction is *Failure to identify and characterize utility conflicts*. This variable attained a mean score of 3.8 with an RII of 0.76. The finding here is validated by the finding in question 6, which showed that road agencies and utilities rarely used technological tools to identify and characterize underground utilities. This impacts negatively on the cost and time schedule of the project, as the real nature of the utility, its time and cost requirement to relocate will only be known during actual construction.

Changes in utility relocation plans due to late project design changes ranked second with a Mean and RII of 3.532 and 0.706 respectively. This is also validated by the finding in question 6, where rework/change orders is among the ten topmost utility challenges identified. Changes in utility plans caused by late project design changes cause delays and cost overruns in projects.

Inadequate identification of utility cost reimbursement eligibility ranked third with a mean of 3.475 and an RII of 0.695. *Not updating utility relocation estimates at regular intervals during the project development process* ranked fourth, with mean 3.450 and RII of 0.690. The results also pointed out that respondents agreed that the form of contract used in procuring the project poses difficulties in identifying and resolving

utility issues, since *Design-bid-build and Lump sum projects* (commonly used to procure public works in Ghana) respectively ranked fourth and fifth.

The next four topmost issues with much impact include: *difficulty conducting utility coordination activities with State-owned utilities, difficulty conducting utility coordination activities with franchised utilities, difficulty identifying and resolving utility issues for design-build projects, not identifying utility conflicts during bidding and construction.*



Table 4.7: Impact level of utility issues

<i>Code No.</i>	<i>Issue</i>	<i>Mean</i>	<i>RII</i>	<i>Rank</i>
2.0	<i>Not identifying utility conflicts during:</i>			
2.1	<i>Planning, feasibility studies, and programming</i>			
2.2	<i>Preliminary/conceptual design</i>			
2.3	<i>Environmental process</i>			
2.4	<i>Design</i>			
2.5	<i>Bidding and construction</i>			
3.0	<i>Difficulty getting utility owners to participate in discussions during:</i>			
3.1	<i>Planning, feasibility studies, and programming</i>			
3.2	<i>Preliminary/conceptual design</i>			
3.3	<i>Environmental process</i>			
3.4	<i>Design</i>			
3.5	<i>Bidding and construction</i>			
4.0	<i>Difficulty conducting utility coordination activities with:</i>			
4.1	<i>State-owned utilities</i>			
4.2	<i>Franchised utilities</i>			
4.3	<i>Other utility operators</i>			
1.0	<i>Staffing problems due to:</i>			
1.1	<i>Difficulty hiring and retaining staff with adequate utility coordination experience</i>	3.150	0.630	13th
1.2	<i>Difficulty providing training opportunities in utility issues</i>	3.200	0.640	11th
1.3	<i>Utility staff turnover</i>	3.000	0.600	17th
		2.975	0.595	18th
		3.175	0.635	12th
		3.050	0.610	16th
		3.300	0.660	7th
		3.250	0.650	9th
		3.225	0.645	10th

	3.175	0.635	12th	3.050	0.610	16th	3.125	0.625	14th
							<u>3.100</u>	<u>0.620</u>	<u>15th</u>
		3.325		0.665	6th	3.300	0.660	7th	
							<u>3.150</u>	<u>0.630</u>	<u>13th</u>
5.0	<i>Inadequate utility relocation cost estimates due to:</i>								
5.1	<i>Failure to identify and characterize utility conflicts</i>						3.800	0.760	1st
5.2	<i>Not updating utility relocation estimates at regular intervals during the project development process</i>						3.450	0.690	4th
5.3	<i>Inadequate identification of utility cost reimbursement eligibility</i>						3.475	0.695	3rd
5.4	<i>Changes in utility relocation plans due to late project design changes</i>						3.532	0.706	2nd
6.0	<i>Difficulty identifying and resolving utility issues for:</i>								
6.1	<i>Design-bid-build projects</i>						3.450	0.690	4th
6.2	<i>Design-build projects</i>						3.275	0.655	8th
6.3	<i>Lump sum projects</i>						3.425	0.685	5th

Source: Field survey, 2016

4.3 SECTION 2: DESK STUDY OF SELECTED ROAD PROJECTS

This section presents results from a desk study by the researcher, of selected road projects from Brong-Ahafo Regional Department of Urban Roads. The focus here was to examine utility relocation issues on projects and analyze their effects on the cost and time performance of these projects. Seven (7) projects (both completed and ongoing) were purposively selected and reviewed and the findings are presented in Table 4.8 below.

Table 4.8: Analysis of impact of utility issues on cost and time performance of selected roads

No	Project	Scope (Length-km)		Cost (GH¢ 000)		Time (months)		Project Status	No. of utility related change orders	Utility relocation impacts				Utility Contr. to cost / time growth	
		Plan	Accom.	Budget	Actual	Plan dur.	Accom. dur.			Add. Time reqmt by utilities-mth	BOQ utility budget (GH¢ 000)	Utility cost to date (GH¢ 000)	Utility contr. to extra cost (GH¢ 000)	% Cost growth	% Time growth
1	Rehabilitation of Penkwase - Military barracks, Sunyani	4.05	4.05	5,429.00	7,308.00	10	43	100.00%	1	7	18	920.17	902.17	411%	70.00%
2	Outer Ring Road Ph 2, Sunyani	12.6		31,444.56		18		60.00%	0	0	23	63	40	174.00%	0.00%
3	Construction of Goaso Town Roads	4	4	6,123.21	6,123.21	12	12	100.00%	1	3	12	21.5	9.5	79.00%	25.00%
4	Rehabilitation of Dormaa - Ahenkro Town Roads	5		7,408.00		12		50.00%	1	3	50	32.84	-17.16	-34.00%	25.00%
5	Rehabilitation of Nkoranza and Kintampo Roads	12		15,390.37		18		70.00%	0	0	10	24.73	14.73	147.00%	0.00%
6	Rehabilitation of Odumasi Town Roads	4.45		2,869.44	3,649.37	12		100.00%	0	0	12.5	8.24	-4.26	-34.00%	0.00%
7	Construction of Sunyani bypass - inner ring road	9.3		21,004.75		18		60.00%	0	0	12.2	57.34	45.14	370.00%	0.00%

<i>Average</i>	<i>117.0%</i>	<i>17.14%</i>
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Source: Desk study of DUR Brong-Ahafo Regional road projects, 2016



4.3.1 Utility Issues – Cost Relationship

All the projects reviewed, showed an increase in expenditure on utilities from what was budgeted for in the contract. The average utility cost increment over budget was found to be 117%. There was however an outlier of 5012% increment on the *Rehabilitation of Penkwasi – Military barracks road*. Details of individual significant cost growths include: *Outer Ring road* where utility cost increased by 174% from budget, *Rehabilitation of Nkoranza and Kintampo Roads* - 147%, and *Construction of Sunyani Bypass* - 370% (cf Table 4.8, Figures 4.3 and 4.4). In a related study by Quiroga et al. (2007) in Texas, it was observed that, utility relocation constituted about 19% of ROW acquisition costs. The degree of relationship between the „number of utility change orders“ and „cost growth“ was further explored using correlation analysis as shown in Table 4.9 below, yielding a coefficient of 0.438. The result indicate that there is strong relationship between the number of utility issues and cost growth in road projects. Identifying and characterizing utilities during the planning and design stage is generally a problem in Ghana due to „*Lack of use of technological tools and software for visualization, identification and management of utility*“ (as agreed by respondents in question 7, where this factor was ranked as the second topmost challenge in managing utilities). Consequently most utility issues, especially buried utilities go unnoticed during initial planning and design and are only detected during execution, thus leading to additional cost to the project. In question 7, respondents also acknowledged „*Inadequate utility relocation cost estimates due to failure to identify and characterize utility conflicts*‘ as having the topmost negative impact on road projects.

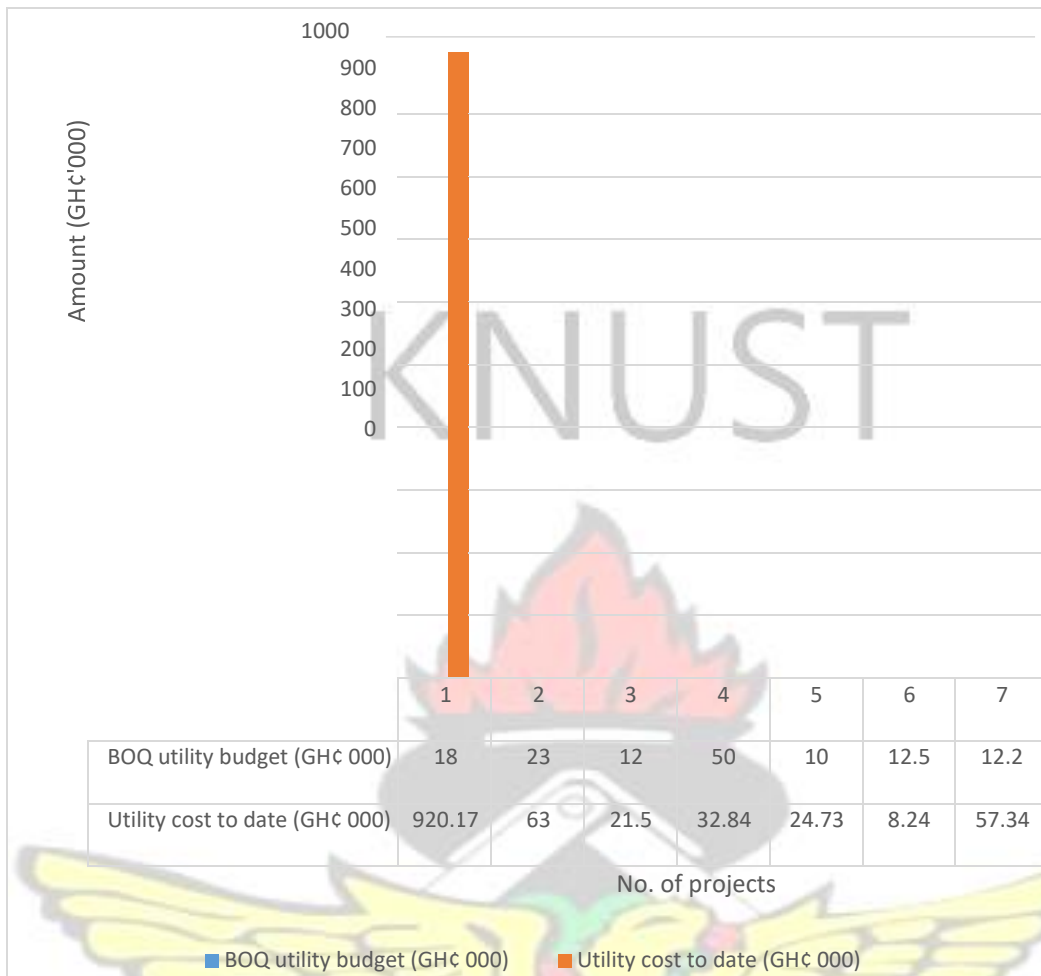


Figure 4.3: Utility Cost growth pattern on selected road projects

Source: Desk study, 2016

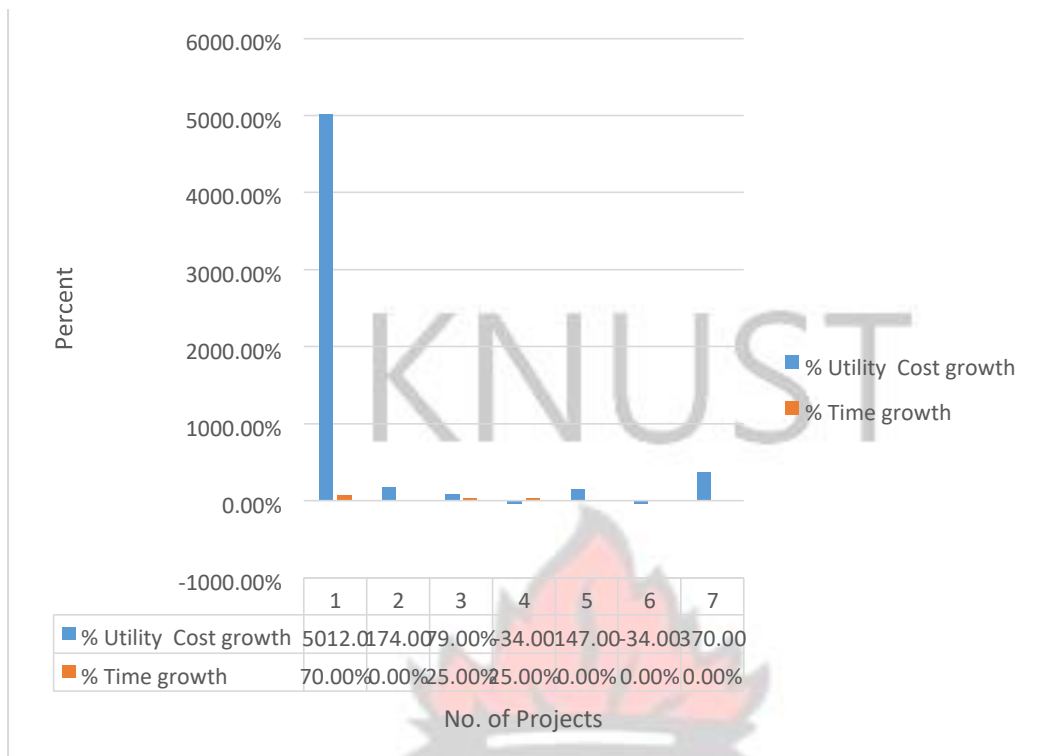


Figure 4.4: Utility contribution to Cost and time growth on selected road projects

Source: Desk study, 2016

4.3.2 Utility Issues – Time Relationship

From the study, overall average time growth due to utilities was found to be 17.14%. It was observed that on three of the projects namely *Rehabilitation of Penkwasi – Military barracks road*, *Construction of Goaso Town Roads* and the *Rehabilitation of Dormaa-Ahenkro Town Roads*, the various contractors executing those projects wrote to the Project Manager for extension of time due to delays caused by utility relocations and were granted 7, 3 and 3 months respectively. This led to time growth of 70% for *Rehabilitation of Penkwasi – Military barracks road* and 25% each for *Construction of Goaso Town Roads* and the *Rehabilitation of Dormaa-Ahenkro Town Roads* (cf Table 4.8 and figure 4.4 above). A study by Ellis and Thomas (2002) found out that average time growth on road projects was about 25% of the original contract time. From Table 4.9 below there is a strong correlation of 0.819 between „utility

change orders“ and „time growth“. Utility issues, when they occur always delay projects. Project durations are often based on the amount of work to be executed; the unexpected utilities to be relocated, do not only add to the volume of work to be carried out, but the bureaucratic process of relocation further worsens the situation. „*Low prioritization of utility relocations by utility companies*‘ and ‘*Slow response from utility companies to requests to locate and mark underground utilities*‘ (as agreed by respondents in question 6 of the questionnaire survey) are among the topmost challenges confronting utility relocation management.

Table 4.9: Utility change orders, time slippage and cost overruns correlation

<i>Utility change order - cost growth</i>	<i>Utility change order - time growth</i>
0.438	0.819

Source: Desk study, 2016

4.3.3 Utility Issues – Change Order Relationship

The desk study also revealed that the number of approved change orders issued directly as a result of utility relocations in the right-of-way was three (3). These occurred on the *Rehabilitation of Penkwasi – Military barracks road, Construction of Goaso Town Roads and the Rehabilitation of Dormaa-Ahenkro Town Roads.*

CHAPTER FIVE CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The research aimed at investigating and analyzing the impact of utility service relocation during road construction. A methodological approach comprising literature review and subsequent questionnaire survey and desk study of some selected road projects were undertaken. The results of the primary data and analysis thereof were presented in the previous chapter. This chapter summarizes the findings of the study in the context of the set objectives and shows how the broader research aim has been achieved. The chapter also concludes on the findings and offers recommendations as well as the limitations of the study.

5.2 REVIEW OF OBJECTIVES

The aim of the research as has been stated earlier, was to investigate and analyze the impact of utility services relocation on road construction.

To be able to achieve this objective, the following objectives were set:

1. To identify challenges of managing utility relocations in road projects;
2. To examine the impact level of utility relocation on road projects; and
3. To examine the relationship of time slippage, change orders and cost overruns of road projects with utility relocations.

This section reviews the study objectives in relation to the findings and highlights the extent to which they have been achieved.

5.2.1 Objective 1: To identify challenges of managing utility relocations in road projects

This objective was addressed by assessing the challenges in managing utility relocations during road construction by using a questionnaire instrument. 16 challenges were identified from literature and respondents ranked them on a five-point likert scale. The study identified the following as the ten (10) topmost utility challenges on road projects in Ghana:

- 1. Lack of training of stakeholders on utility issues;*
- 2. Lack of use of technological tools and software for visualization, identification and management of utility issues;*
- 3. Delays in starting utility identification and relocation work;*
- 4. Late involvement of utility companies;*
- 5. Slow response from utility companies to requests to locate and mark underground utilities;*
- 6. Delays in obtaining rights-of-way for utility;*
- 7. Low prioritization of utility relocations by utility companies;*
- 8. Rework required/change orders;*
- 9. Lack of resources (finance and personnel); and*
- 10. Short time frame for road agencies to plan and design projects*

5.2.2 Objective 2: To examine the impact level of utility relocation issues on road projects

The second objective was attained through a five-point likert question on the impact level of utility issues on road construction (1 being least negative and 5 being most negative). 24 utility related issues on road projects were identified and respondents rated their impact level on a scale of 1 to 5. From the results, the following were identified as

the top 10 (in descending order) utility issues with the most negative impact on road projects:

1. *Failure to identify and characterize utility conflicts;*
2. *Changes in utility relocation plans due to late project design changes;*
3. *Inadequate identification of utility cost reimbursement eligibility;*
4. *Not updating utility relocation estimates at regular intervals during the project development process;*
5. *Difficulty identifying and resolving utility issues for design-bid-build projects;*
6. *Difficulty identifying and resolving utility issues for lump sum projects;*
7. *Difficulty conducting utility coordination activities with State-owned utilities;*
8. *Difficulty conducting utility coordination activities with franchised utilities;*
9. *Difficulty identifying and resolving utility issues in design-build projects; and*
10. *Not identifying utility conflicts during bidding and construction.*

5.2.3 Objective 3: To examine the relationship of time slippage, change orders and cost overruns of road projects with utility relocations

The third objective was achieved through desk study of purposively selected projects. A total of seven projects were thoroughly reviewed to examine utility issues on these projects and their effects on the cost and time performance of these projects. The findings indicate that average cost increment on utility budget due to utility relocation was 117%, while time slippage level averaged 17.14%. Out of the 7 projects reviewed, 3 had client approved change orders directly as a result of utility relocation.

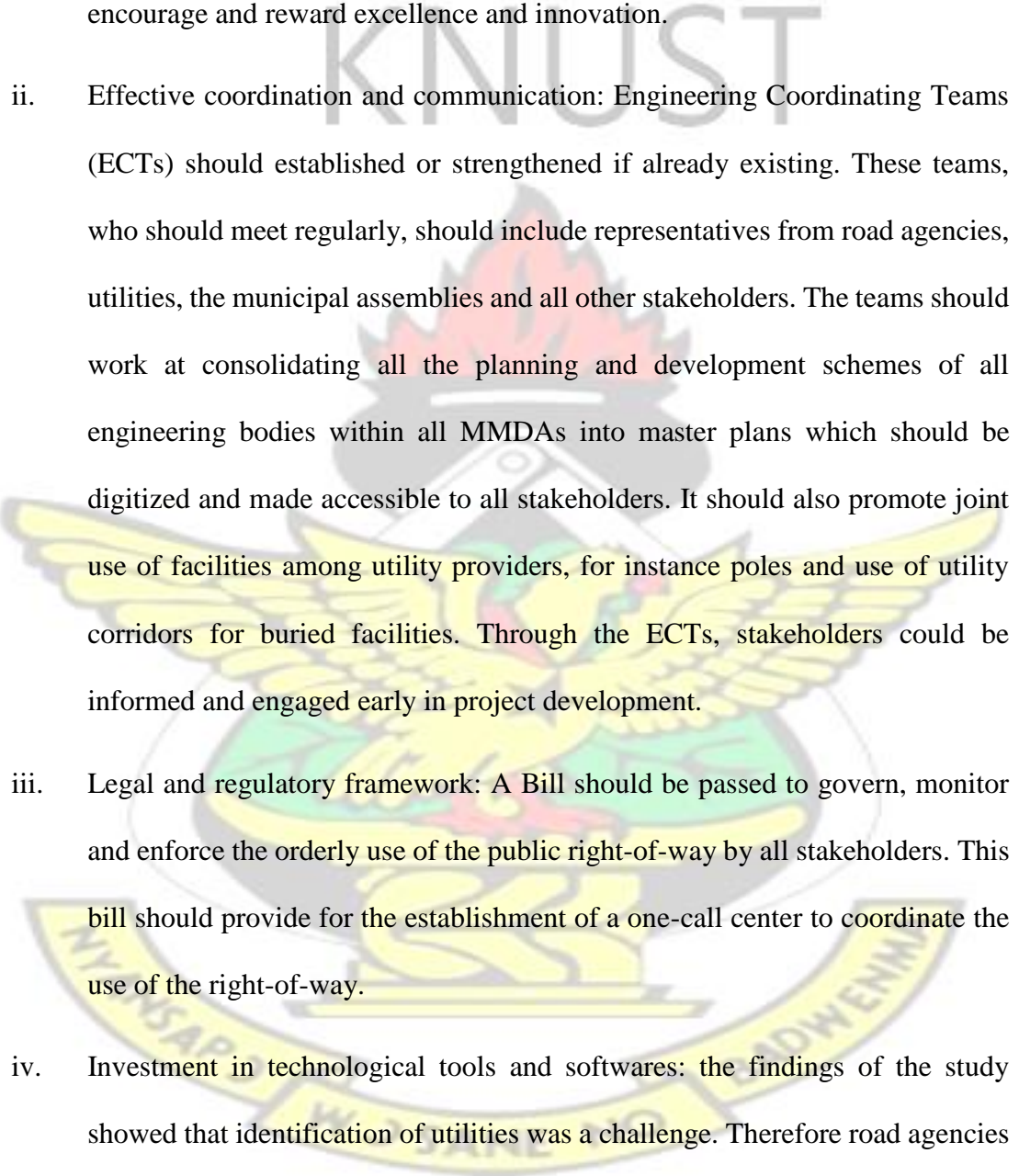
A correlation test conducted on the variables indicated a strong correlation among the variable pairings namely: utility change orders – cost growth – 0.438 and utility change orders – time growth – 0.819.

5.3 CONCLUSION

As indicated throughout this study, utility relocations during road construction have an adverse impact on the time and cost performance of roads. This has been validated by the findings of this study which shows that on average projects delay by about 17.14% and utility budget increased by about 117% due to utility relocations. Delays and cost overruns in projects have economic, social and political ramifications. Road construction involve huge capital outlay, usually tax payers' money (be it donor funded or government funded), which could be used to develop other competing sectors of the economy. Hence steps must be taken to use this capital investment judiciously and all avoidable extra cost eliminated to ensure value for money. Given the disruptive, inconvenient and hazardous nature of road construction, it is imperative that the construction process is expedited to minimize the negative impacts to people and businesses along those routes. No doubt, the study has revealed some challenges in the management process of utility relocations. However, these challenges can be surmounted through the establishment of strong supportive institutions, effective coordination and communication, legal regulation and investment in technological tools as recommended below.

5.4 RECOMMENDATIONS

The research was focused on the impact of utility relocation during road construction. Based on the findings of the study, the following recommendations are suggested to minimize cost overruns and schedule slippage on road projects in Ghana:

- 
- i. Strong and supportive institutions: resilient institutions are needed for success in every discipline. The institutions should be well-resourced (both in resources and in human capital) and develop an institutional culture of teamwork, promote training and development of new skills in utility issues as well as encourage and reward excellence and innovation.
 - ii. Effective coordination and communication: Engineering Coordinating Teams (ECTs) should be established or strengthened if already existing. These teams, who should meet regularly, should include representatives from road agencies, utilities, the municipal assemblies and all other stakeholders. The teams should work at consolidating all the planning and development schemes of all engineering bodies within all MMDAs into master plans which should be digitized and made accessible to all stakeholders. It should also promote joint use of facilities among utility providers, for instance poles and use of utility corridors for buried facilities. Through the ECTs, stakeholders could be informed and engaged early in project development.
 - iii. Legal and regulatory framework: A Bill should be passed to govern, monitor and enforce the orderly use of the public right-of-way by all stakeholders. This bill should provide for the establishment of a one-call center to coordinate the use of the right-of-way.
 - iv. Investment in technological tools and softwares: the findings of the study showed that identification of utilities was a challenge. Therefore road agencies as well as utilities should invest in modern technological tools for locating and characterizing underground utilities. Modern right of way management softwares should also be procured and used to store, recall, share, publish and manage information.

- v. Use of Design – build contracts: the current trends of using design-bid-build contract system for procurement of public works should give way for exploration with the design-build method of procuring works. This will eliminate much of the delays in right-of-way planning and management.

5.5 LIMITATIONS OF STUDY

This study like many surveys is bound to have limitations. It was constrained by the sample size. Due to this, it is possible that some of the variables which were less significant could attain significance with much larger samples. The study also acknowledges the fact that the number of projects used for the desk studies was small and also the fact that some of the projects reviewed were still ongoing and subject to change. However the background of respondents who participated in the survey suggests they have reasonable experience in utility issues. The contract sums of the projects reviewed are typical of most road projects and hence the results can fairly represent the generality of road projects in Ghana.

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APPENDICES

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

KUMASI

COLLEGE OF ARTS AND BUILT ENVIRONMENT

DEPARTMENT OF BUILDING TECHNOLOGY

APPENDIX A: QUESTIONNAIRE SURVEY

Topic: Impact of relocating utility services during road construction: the management of issues when they arrive.

Please kindly respond to the following questions by ticking (✓) the appropriate option in the box provided for each question and write briefly where required. Please note that all information provided will be treated strictly as confidential as this work is purely for academic purposes.

A. General Information

1. Company _____ / _____ Agency: _____
2. Role of respondent in the company/agency: _____
3. Type of activities
 Road agency Utility Provider Utility Contractor General Contractor
 Consultant
4. Area of expertise (Please select all that apply)
 Road works Electricity Water Telecom Gas
 Sanitary sewer lines & Mains TV Cable Others: _____

5. Number of projects executed involving road and utility conflict within the last 10 years?

[] 0 - 5 [] 6 - 10 [] 11 - 20 [] 21 - 50 [] > 50

B. Questions on Utility challenges and impact level on projects

6. The following are some challenges of managing utility relocations during road construction. To what extent do you agree?

Use the scale: 1 = strongly disagree 2 = disagree 3 = not sure 4 = agree 5 = strongly agree

No	Challenges	1	2	3	4	5
1	Lack of resources (finance and personnel)					
2	Short time frame for road agencies to plan and design project					
3	Low prioritization of utility relocations by utility companies					
4	Increased workload on utility relocation crews					
5	Delays in starting utility identification and relocation work					
6	Phasing of construction and utility relocation work out of sequence					
7	Lack of „as – built“ drawings					
8	Delays in obtaining rights of way for utility					
9	Shortages of labor and equipment for contractor					
10	Project design changes required changes to utility relocation					
11	Late involvement of utility companies					
12	Slow response from utility companies to requests to locate and mark underground utilities					
13	Rework required/change orders					
14	Inadequate coordination or sequencing among utilities using common poles/ducts					
15	Lack of training of stakeholders on utility issues					
16	Lack of use of technological tools and software for visualization, identification and management of utility issues					

7. Please indicate the overall impact level of the following utility related issues on project performance on a scale of 1 to 5

1 = Least negative impact

5 = Most negative impact

Code No.	Issue	Impact Level				
		5	4	3	2	1
1.0	Staffing problems due to:					
1.1	Difficulty hiring and retaining staff with adequate utility coordination experience					
1.2	Difficulty providing training opportunities in utility issues					
1.3	Utility staff turnover					
2.0	Not identifying utility conflicts during:					
2.1	Planning, feasibility studies, and programming					
2.2	Preliminary/conceptual design					
2.3	Environmental process					
2.4	Design					
2.5	Bidding and construction					
3.0	Difficulty getting utility owners to participate in discussions during:					
3.1	Planning, feasibility studies, and programming					
3.2	Preliminary/conceptual design					
3.3	Environmental process					
3.4	Design					
3.5	Bidding and construction					
4.0	Difficulty conducting utility coordination activities with:					
4.1	State-owned utilities					
4.2	Franchised utilities					
4.3	Other utility operators					
5.0	Inadequate utility relocation cost estimates due to:					
5.1	Failure to identify and characterize utility conflicts					
5.2	Not updating utility relocation estimates at regular intervals during the project development process					
5.3	Inadequate identification of utility cost reimbursement eligibility					
5.4	Changes in utility relocation plans due to late project design changes					
6.0	Difficulty identifying and resolving utility issues for:					
6.1	Design-bid-build projects					

6.2	Design-build projects					
6.3	Lump sum projects					
6.4	Other project delivery methods, please state					

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APPENDIX B: SAMPLE FORM FOR DESK STUDY



PROJECT RECORDS

Sheet No.

No	Project	Scope (Length - km)		Cost (GH¢ 000)		Time (months)		Project Status	No. of utility related change orders	Utility relocation impacts				Utility Contr. to cost / time growth	
		Plan	Accom.	Budget	Actual	Plan dur.	Accom. dur.			Add. Time reqmt by utilities-mth	BOQ utility budget (GH¢ 000)	Utility cost to date (GH¢ 000)	Utility contr. to extra cost (GH¢ 000)	% Cost growth	% Time growth

Accom: accomplished **dur:**

duration

Contr: contribution



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APPENDIX C: HUMAN RESOURCE PROFILE OF THE MINISTRY OF ROADS & HIGHWAYS (AS OF 2010)

Source: Ministry of Roads & Highways, 2009-2010 Review Report

**GHANA HIGHWAY AUTHORITY
STAFF CATEGORY (PROFESSION)**

CATEGORY	AGE GROUPINGS				TOTAL
	19 - 30	31 - 45	46 - 55	56 - 60	
Engineers	28	25	55	17	125
Other Profession Staff	5	8	9	6	28
Technician Engineers	46	33	122	75	276
Administrators/Accountants	52	71	198	162	483
Skill Workers	11	30	189	165	395
Direct Labour Staff	62	56	245	249	612
TOTAL	204	223	818	674	1,919



DEPARTMENT OF FEEDER ROADS

STAFF CATEGORY (PROFESSION)

CATEGORY	AGE GROUPINGS				TOTAL
	19 - 30	31 - 45	46 - 55	56 - 60	
Engineers	8	30	21	3	62
Other Professional Staff	0	10	3		13
Technician Engineers	4	107	42	17	170
Administrators/Accountants	3	27	41	13	84
Technical Officers	0	11	12	36	59
Direct Labour Staff	3	40	102	87	232
TOTAL	18	225	221	156	620

STAFF CATEGORY (GENDER)-DFR

CATEGORY	GENDER		TOTAL
	FEMALE	MALE	
Engineers	2	60	62
Other Professional Staff	1	12	13
Technician Engineers	4	166	170
Administrators/Accountants	45	39	84
Technical Officers	2	57	59
Direct Labour Staff	5	227	232
TOTAL	59	561	620

STAFF CATEGORY (PROFESSION)-DEPARTMENT OF URBAN ROADS

CATEGORY	AGE GROUPINGS				TOTAL
	19 - 30	31 - 45	46 - 55	56 - 60	
Engineers	26	23	9		58
Quantity Surveyors	13	5		1	19
Technician Engineers	14	59	6		79
Administrators	22	56	45	7	130
Accounts Staff		17	13	3	33
Technical Officers	4	7	3	2	16
Direct Labour Staff	13	69	83	11	176
TOTAL	92	236	159	24	511

STAFF CATEGORY (GENDER)-DUR

CATEGORY	GENDER		TOTAL
	MALE	FEMALE	
Engineers	54	4	58
Quantity Surveyors	15	4	19
Technician Engineers	75	4	79
Administrators & Accountants	69	94	163
Technical Officers	16		16
Direct Labour Staff	166	10	176
TOTAL	395	116	511