

**AKENTEN APPIAH - MENKA**  
**UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL**  
**DEVELOPMENT**

**INVESTIGATING THE EFFECTS OF WORKERS FATIGUE ON QUALITY**  
**OF WORKMANSHIP AND PRODUCTIVITY:**  
**A STUDY OF SELECTED PROJECT SITES IN THE OTI REGION**

**PHANUEL KWAKU DRAH**

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Graduate Studies, in Partial Fulfilment of the Requirements for the Award of Master  
of Philosophy (Construction Management) Degree

**NOVEMBER, 2024**

# DECLARATION

## STUDENT'S DECLARATION

I, **PHANUEL KWAKU DRAH**, declare that this thesis, with the exception of quotations and references contained in published works, which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature. ....

Date.....

## SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of dissertation as laid down by the Akenten Appiah – Menka University of Skills Training and Entrepreneurial Development.

**Name of Supervisor:** Dr. Nongiba Alkanam Kheni

Signature. ....

Date.....

## **DEDICATION**

I dedicate this piece of work to the Almighty God for His loving mercies and protection throughout the years of studies. Again, to my wife and Children.

## **ACKNOWLEDGEMENT**

I thank God the Almighty for His protection, guidance, blessings and His mercies throughout my studies. Also, I am grateful to my supervisor Dr. Nongiba A. Kheni for his ongoing mentorship and never ending of facilitation of my work. I am forever acknowledging his unconditional love and support throughout the entire dissertation process.

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## ABSTRACT

The carrying out of most construction site operations involves the exertion of physical effort by construction site workers. The exertion of considerable physical effort coupled with long hours of work often lead to fatigue. Fatigue has deleterious effects on construction site workers' physical and mental health. The aim of the study was to develop strategies for minimizing the effects of workers fatigue on the performance of construction site workers in Ghana. The specific objectives of the study include; to determine the main effects of workers' fatigue on site workers working on building construction projects sites, to determine the extent of the effect of workers fatigue on the quality of workmanship, to assess the influence of workers fatigue on the work output on building construction project sites, and to develop strategies for minimizing the effects of workers fatigue on site workers on building construction project sites. The study adopted a cross sectional survey design and employed a quantitative strategy. The target population was construction site workers working on building construction project sites in the Oti Region. The study adopted purposive sampling technique. The findings of this study revealed that, poor social well-being, slowed reaction time, illnesses, distractions, and exhaustion are the main effects of fatigue. Also, the findings suggest that fatigue negatively affect time and quality performance as well as confidence level of site workers. The study found that fatigue exacerbated by poor environmental design has influence on the work output of site workers. The site workers in the study considered inadequate break for workers and physical and mental exertion as key factors influencing fatigue on building project sites. The study has outline measures for mitigating the effects of fatigue. The research work concluded that the effects workers fatigue consequently have negative effect on quality of workmanship and worker output in the construction sites.as weal site.

**Keywords:** Fatigue, Construction Workers, Effect, Oti Region, Workmanship, Quality.

# CHAPTER ONE

## GENERAL INTRODUCTION

### 1.1 Background of the Study

Workers output on construction sites have been worsening due to general labour discontent, which is leading to an undesirable effect on the quality and cost of construction activities (Construction Industry Development Board, 2022). For this reason, the study aim was to develop strategies for minimizing the effects of fatigue on the performance of construction site workers in the Oti Region. However, the moral of workers on site and employment of labour in the construction industry is vital, it accounts to employment of 15% in the formal and 19 % in the informal sectors and about 94% of the semi-skilled and unskilled labourers (Construction Industry Development Board, 2022). The construction industry of both the developed and developing countries occupies a very delicate position as it is supposed to play an important role for continuous growth (Ofori, 2010) as cited by Ajagbe (2016). All over the world, the construction industry is one of the most vital activities performed in any economy, Ashworth (2010) as cited by Ansah (2018) and usually the construction activities are represented up to about 12% of gross domestic product and employs around 10% of the working population (Sasu,2022).

According to Baines (2010), productivity movement has been around for over 50 years. In this, a few techniques, procedures, and productivity approaches have been advanced. However, the pursuit of improved productivity of unskilled labour still seems an imperfect science and even the term itself seems to be interpreted differently by different countries. Researchers have quoted that Construction is a vital area of the

economy (Thomas and Sudhakumar, 2014) and Hillebrandt, (2000) as cited by Ofori, (2012) and the activities involved are important due to the efficiency and outcomes. Several researchers have defined productivity in many ways.

Thiyagu & Dheenadhayalan, (2015) in their report stated that, construction usually, productivity is said to be labour efficiency, and that is, “unit of work placed or produced per man-hour”. All jobs that "require no special training, judgment, or manual dexterity, but supply mainly muscular strength for the performance of course, heavy work" were classified as "unskilled."(Amanda et al., 2021). as cited by Fagbenle, (2011) they need no, or small training to accomplish what has been assigned to them on construction sites. Productivity improvement in the construction site is by performing the activities involved in making it part of the procedures (Cossio et al., 2012). Labour productivity in the construction site is the exclusive prerogative to those who are practicing because project cost and overrun of time of projects is always affected (Kadir et al., 2005). Unskilled labour output on the construction site is highly needed and improving their output is a vital performance measure which needed to enhance the efficiency and effectiveness of the construction industry (Chan and Kaka, 2007). According to Ansah (2014) in Ghana, the construction activities overflow in every corner especially Accra being the capital city. The aim of the study is to develop strategies for minimizing the effects of fatigue on the performance of construction site workers in Oti region for that matter Ghana and to make recommendations for enhancing the quality of workmanship of construction site workers.

Subsequently, Construction work is considered to represent a high risk for worker’s safety because of its nature, since its activities require greater physical effort and

concentration, thus increasing the risk of accidents. This reality imposes work rhythms that tend to increase the levels of worker's fatigue (Zhang et al., 2015; Powell and Copping, 2016). In this context, the role of ergonomics becomes essential to implement improvements in working conditions that may result in safety, comfort, and health for the worker (Krüger and Coelho, 2006). However, the productivity of the company depends on the performance of the worker, who in turn is influenced by the work environment, work post conditions, physical and mental load, intensity of the activity, and aspects related to worker physiology, such as fatigue. Slower reflexes, a diminished capacity for information processing, memory loss, forgetfulness, diminished awareness, inattention, underestimating risk, impaired coordination, etc. are all consequences of fatigue. Fatigue can result in mistakes and mishaps, health problems and injuries, and decreased output. reduced productivity (Health and Safety Executive-UK, 2021) In the international literature, few studies (Fang et al., 2015; Zhang et al., 2015) present specific methods to evaluate this subject, while in the Brazilian literature the researcher has not come across any recent studies that address the topic. The study aimed to develop strategies to mitigate the effect of construction worker fatigue.

## **1.2 Problem Statement**

Worker's fatigue is a very vital subject that affects the overall performance of a firm. It is 'working faster', rather than 'working harder', by the use of innovation, technology, new and doable professional models by combining inputs (Ulises (2020). According to Organization for Economic Co-operation and Development (OECD), 2015). The subject of workers' fatigue has received imperative attention because of its correlation with economic growth. Sezer, 2016, there are several factors that directly or indirectly affect labour workmanship and quality. Labour management is a significant issue in

construction operations due to the numerous activities involved in the project (Khaled & Mostafa, 2019). Many firms have developed their own means of measuring performance and quality depending on their definition. The importance of labour fatigue on construction site workers in construction project delivery cannot be underestimated. According to Jha (2021) human resources constituted greatest resources in every project.

McTague and Jergeas, (2021) stated that labour cost took from 30 % to 60 % of the total cost of projects in many countries. A researcher by name Sezer (2016) underscored those available statistics on workers fatigue in the construction industry in most countries was low. The Ghanaian construction industry faces challenges such as workers fatigue and low labour performance due to incompetent site supervision, insufficient knowledge about quality performance factors, lack of employee commitment, lack of motivation from management, fatigue, and unrealistic scheduling. The study aims to develop strategies mitigates worker's fatigue's impact on quality of workmanship and provide mitigation measures for improvement. The construction industry in Ghana is considered one of the most dangerous globally, with about 5.7% of occupational injury indicators related to it such as fatigue. The industry's accident frequency rate is 151% higher than the national index of 45, indicating a significant concern for worker safety (Berglund et al. 2019, and GSS 2017).

Furthermore, GSS (2016) provides data on construction-related occupational injury indicators for 2015 where fatigue is regarded as one of the causes. In Ghana, about 96 people died in 2015, according to statistics. However, in the same year of 2015, the construction registered 86 injuries. The Ghanaian construction industry (GCI) found a

137% increase over the national average, which indicates an extremely high accident risk in the sector. 418 occupational injuries were classified as severe nationwide in 2015, which is an increase from the 346 cases reported by GCI at the time as result of workers fatigue especially poor sleep and unrest of workers. According to Kim's study (2021), which aim to investigate the causes of poor sleep among construction workers. The goal of the study was to find out if poor sleep quality is linked to a variety of medical and mental disorders, including weariness and depression.

According to the researcher, due to the nature of the profession, it is normal for construction employees to work long hours at a high intensity in an unpleasant environment. Additionally, the study by Jehan et al. (2017) found a strong correlation between sleep issues and poor mental health. It is well established that sleep problems are connected to depressive and anxious psychological symptoms. Ulises (2017) also conducted research on how to measure and manage the fatigue of construction workers and came to the conclusion that the negative effects of fatigue have a significant impact on our society, causing productivity losses of more than \$100 billion annually and injuries costing more than \$50 billion annually.

The multitude of causes and effects of exhaustion are discussed in literature from domains as diverse as medicine, psychology, engineering, and sociology. Unfortunately, it is difficult to assess fatigue objectively. Gerrard, (2019) noted that, construction site Worker fatigue is a “serious issue” for construction, with over a third of those in the sector working in excess of 50 hours a week, and more than half saying it affects productivity. That is according to a new survey by the Considerate Constructors Scheme, which found that 75% of respondents see fatigue as a major issue

in the industry. It also revealed that 37% of more than 1,000 respondents are working more than 50 hours a week, prompting the launch of the Scheme's "Spotlight on worker fatigue" campaign to highlight the rules and regulations about fatigue in the workplace. The survey also found that: 86% of respondents work over the national average of 37.3 hours per week. 65% do not think the industry is doing enough to prevent worker fatigue. 58% say feeling tired affects their productivity at work. 50% have little understanding of the regulations surrounding worker fatigue. The Considerate Constructors Scheme warned of the serious health and safety risk fatigue can pose in construction, with the potential to significantly impair physical and cognitive capacities, as well as having a damaging effect on the mental health of the industry's workforce (Gerrard, 2019).

In spite of these stated concerns, there is hardly any comprehensive research on the effects of fatigue on construction site workers, particularly, in developing countries especially Ghana. Considering this gap in the literature, the researcher therefore, deem it necessary to investigate the effects of workers fatigue on construction sites workers, to develop strategies of mitigating the effects.

### **1.3 Research Questions**

To help in the examination of the problems associated with the effects of fatigue on the performance of construction site workers in Ghana and to make recommendations for enhancing the performance of construction site workers, the following research questions have been formulated:

- i. What are the main effects of fatigue on construction site workers on building construction projects sites?

- ii. What is the extent of the effect of workers fatigue of quality workmanship of building construction projects sites?
- iii. What is the influence of fatigue on the work output of construction site workers on building construction project sites?
- iv. What are the strategies for minimizing the effects of fatigue on building construction site workers?

#### **1.4 Aim and Objectives of the Study**

The aim of the study is to develop strategies for minimizing the effects of fatigue on the performance of construction site workers. The specific objectives of the study are as follows:

- i. the main effect of workers fatigue on construction site workers.
- ii. the extent effects of workers fatigue on quality of workmanship.
- iii. Assess the influence of workers fatigue on work output.
- iv. strategies for mitigating the effects of fatigue so as to enhance performance of workers.

#### **1.5 Research Methodology**

This study aimed to understand the impact of workers' fatigue on the quality of workmanship and productivity in Ghana. The research methodology involved a thorough analysis of relevant literature and a critical synthesis of the study's axiological, ontological, and epistemological positions. The positivist paradigm was chosen as the primary philosophical perspective, focusing on the effects of fatigue on work output and quality of workmanship. Data was collected through surveys, interviews, case studies, and closed-ended questionnaires. The findings were used to develop strategies

for minimizing the effects of worker fatigue and provide valuable insights for academics and practitioners. The research methodology provided guidance on the methods and techniques needed to carry out the research agenda.

### **1.6 Limitations**

The focus of the study conducted in this research was on the problems associated with the effects of fatigue on the performance of construction site workers in Ghana within Oti region and to make recommendations for enhancing the performance of construction site workers.

Like some other studies, this study will not be without constraints and these are:

- i. The researcher used close-ended questionnaire for information series, and this has a weak point of proscribing the quantity of information collected. There is a probable hood that applicable information might not had been captured due to use of close-ended questionnaire?
- ii. Limited term and assets along with price range are proscribing elements to the studies. Despite those constraints, the effects of this studies were concept upsetting and may be seemed like a foundation for extra precise and analytical paintings on the subject in future.

However, the emphasis in the study was put on the perspective of Oti regions contractors, artisan etc. Thus, the use of in-depth interviews and questionnaires with solely construction site workers. Therefore, the study was limited to gaining an in-depth perspective from developers in the construction industry. In addition, the research was limited to the Oti region within Ghanaian construction sector.

### **1.7 Significance of the Study**

The relevance of this study was to develop strategies for minimizing the effects of fatigue on the performance of construction site workers in Oti and to make recommendations for enhancing the performance of construction site workers. The study would contribute to literature on the extent of the effect of fatigue on the quality of workmanship of construction site workers in selected project sites in the Oti Region. The study will also contribute to literature on the influence of fatigue. Finally, to develop strategies for minimizing the effects of fatigue on construction workers to enhance the performance of workers through the effective management of fatigue on construction project which will again serve as a basis for all stakeholders in the construction industry, including the Ministry of Water Resources, Works and Housing, Association of Building and Civil Engineering Contractors in Ghana, Directors of construction companies, project managers and site supervisors to help contribute their best towards performing certain activities in a manner that will motivate workers in the industry so as to create in the workers a certain amount of satisfaction.

### **1.8 Scope of Study**

The geographic scope for the study is to develop strategies for minimizing the effects of workers fatigue on quality of workmanship of construction site workers in Ghana and to make recommendations for enhancing the performance of construction site workers. Oti region was chosen because of the various construction projects ongoing within this region. Contextually, the study explores strategies for minimizing the effects of fatigue on the performance of construction project. In addition, the study also focuses on the extent of the effect of fatigue on the quality of workmanship and to assess the influence of fatigue on the work output of construction workers for enhancing the

performance of site workers through the effective management of fatigue on construction project sites. Most importantly, the study focused on construction workers such as, masons, carpenters, electricians, (artisans) etc., because they have on-site responsibilities for construction projects. Therefore, the choice of the regions was appropriate, as it would allow the researcher to gather the required data needed for the research from the construction workers.

### **1.9 Organization of the Study**

The research was cauterized amongst six (6) autonomous however interrelated sections. They were discussed as

*Chapter One:* This section dealt with the introduction to the research topic. It captured the general background of the study, the statement of problem, aims, objectives, and scope of the study. The section also captured significance of the study and limitation and delimitation of the study.

*Chapter Two:* This segment dealt with the relevant information on the literature of this study. Discussed and reviewed the existing literature that subsequently forms the foundation for analyzing and interpreting the research data.

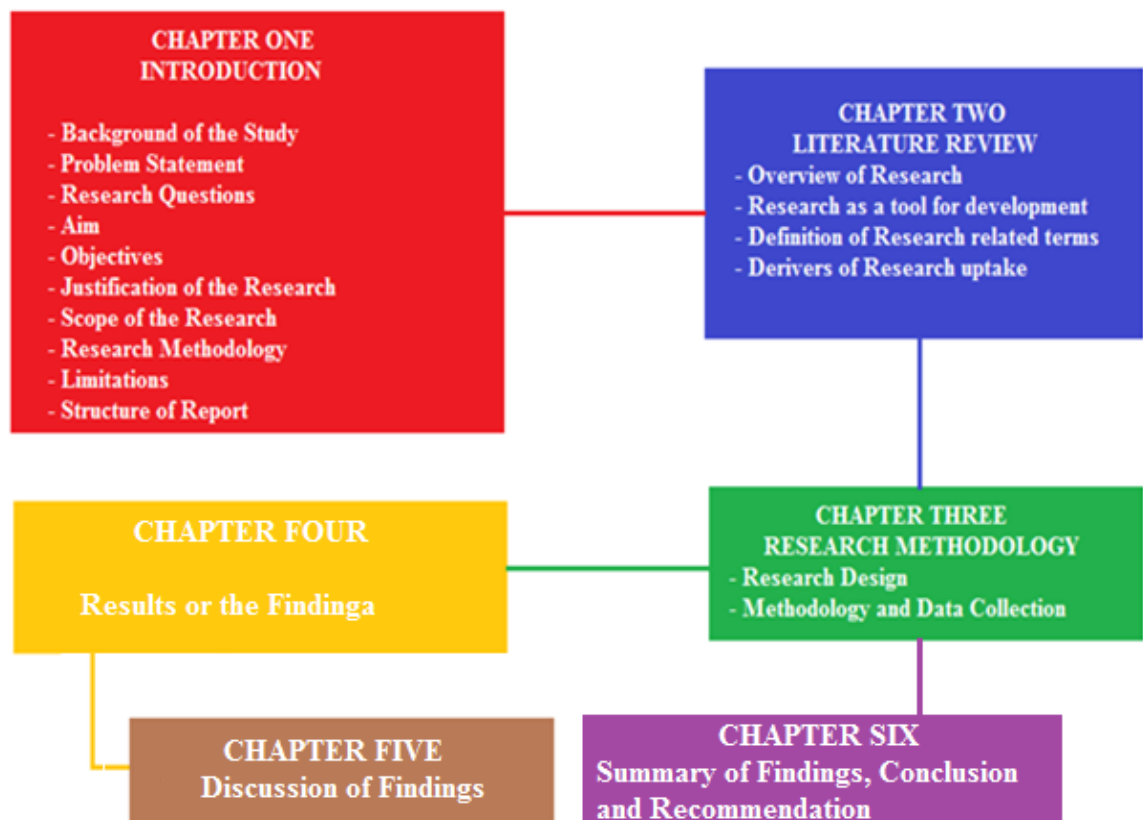
*Chapter Three:* Chapter three-state the methods employed in the research study. It gives detailed information on the study tools and techniques used in collecting the data for the study. The philosophical concerns were the foundation for the research study, the researcher's path in performing this research must be charted (Bryman, 2004). The research method or technique is developed by adopting an approach to answer the study objectives. Quantitative research, according to Almalki (2016), is centered on collecting and analyzing numerical data, whereas qualitative research is relying on data obtained by the researcher from first-hand observation, interviews, questionnaires, and case

studies. The quantitative research, according to Almalki (2016), is based on the measurement of quantity or amount. Numbers are part of the quantitative approach. According to Creswell et al. (2007), quantitative research is one of the first research approaches utilized by many scholars around the world.

*Chapter Four:* Detailed analysis and discussion of the outcome from the respondent by descriptive statistical techniques and relative importance index were used in this chapter.

*Chapter Five:* This chapter dealt with detailed discussion on the study per the findings.

*Chapter Six:* This chapter dealt with the summary of findings, possible conclusion and recommendations of the study. The structure illustrated graphically below in figure 1.1 is the organization of the study.



**Figure 1. 1: Structure of the Report**

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

In this chapter, relevant literature was reviewed to serve as a framework for the study. The literature further used to support or refute findings made in the research at the analysis stage of the write-up. The aspects to be reviewed here include:

- i. Overview of the Ghanaian Construction Industry
- ii. Concepts of fatigue, quality, and performance. (Conceptual review, empirical review, theoretical review should be look at)
- iii. The effect of fatigue on the quality of workmanship of construction site.
- iv. The influence of fatigue on quality performance of projects and relevant theories underpinning the study.
- v. The strategies for minimizing the effects of workers' fatigue.

#### **2.2 Overview of the Ghanaian Construction Industry**

It is a generally accepted phenomenon that the construction industry plays a key role in the development of socio-economic growth of a country. This extends to the development goals of making necessary infrastructure available, providing employment opportunities and shelter for society. Among these socio-economic development goals are urban infrastructure, highways, schools, hospitals, houses, townships roads, railways, airports, seaports, power systems, agriculture systems, telecommunications, and others (Chileshe & Berko, 2010; Osei 2013).

The construction industry deals with creation, repair, renovation, or extension land improvements, buildings of engineering nature referred to as the fixed assets of the

country. About half of the gross fixed capital formation of an economy is also constituted by the construction industry, which shows how relevant the construction industry is to the country's economy (Ofori-Kuragu et al., 2016). With the government being responsible for majority of the investment in the construction industry, the level of spending can be regulated to make some expected changes in the economy as the industry is seen as a potential economic regulator. Although the construction industry has complex linkages to several other sectors in the country, these linkages can be used as stimulants for activities of the sectors.

For example, the demand for cement, a key indicator of construction activity, is expected to increase consistently from 8.8 million metric tons in 2017 to 12.5 million by 2021, (Ghana - Country Commercial Guide, 2020). The \$8 billion Ghanaian construction sector, which accounted for 18.8 percent of the nation's annual GDP in 2018, is a central pillar of Ghana's National Development Plan. Provisional estimates released by Ghana Statistical Service indicate that the construction industry recorded a growth rate of 18.3 percent year-on-year for the third quarter of 2018. The industry provides employment for approximately 420,000 people and an estimated 2,500 active building and construction contractors currently operate in the Ghanaian market. Players range from indigenous micro-enterprises and individual contractors to foreign multinational civil engineering and construction giants, (Ghana - Country Commercial Guide, 2020). Although, the Construction Industry substantially support the economy of both developing and developed countries, it has suffered a great decline productivity performance (Choy, 2004). The decline in construction productivity according to Jergeas (2009) which manifest in the form of construction delays, cost overruns and loss of productivity is attributed to poor management practices.

### **2.3. Concepts of Fatigue, Quality, and Performance. (Conceptual review, empirical review, theoretical review should be look at)**

#### **2. 3.1 Concept of Fatigue**

Fatigue can be defined as an effect caused by continued work, weariness or exhaustion of physical and mental strength, which may lead to a temporary reduction in the ability to work (Iida, 2005; Halowell, 2010). Tiredness, in turn, discourages overloading, paralyzing activities to restore normal body processes (Kroemer and Grandjean, 2005; Iida, 2005). Fatigue is caused by a set of factors that range from worker physiology to psychological, environmental and social factors. These factors can cause a reduction in cognitive functions, thus affecting the execution of tasks (Powell and Copping, 2016). In physiology, fatigue is more easily identified, since it directly affects the muscles (Powell and Copping, 2016). Fang et al. (2015) emphasize that activities such as lifting and transporting heavy materials are causes of muscle fatigue and that the degree of fatigue is directly related to human error rates. From the above definitions, fatigue is the ongoing exhaustion that can be both physical and mental, creating limitation in cognitive social, emotional and physiological functioning – tiredness, restless. Drowsy and exhaustion are often used to described fatigue. It usually a result of lack of sleep or stress.

#### **2.3.2 Empirical Review on Fatigue and Project Performance**

Several studies on the effects of fatigue on labour performance on construction sites has been conducted, with different outcomes being reported. The first researcher by the name Ulises D. Techera (2017) on Measuring and Managing Construction Worker Fatigue. The aim of the research study was Meta-analyze the causes and consequences of occupational fatigue and address the way in which fatigue can be identified,

predicted and managed for electrical transmission and distribution (TD) workers. The researcher concluded that, the effort of researchers, industry leaders, and policy makers to make construction a safer environment to produced good fruits. A 67% reduction in recordable incident rates has been observed during the past 2 decades (U.S. Bureau of Labor Statistics, 2015). However, the construction industry is still among the topmost dangerous industries with a fatality rate nearly 3 times greater than the overall industry average. Furthermore, fatalities have plateaued for the last decade, and they have even increased in the past 3 years (U.S. Bureau of Labor Statistics, 2015).

Therefore, there is still much to do regarding safety in construction. With respect to the causes of fatigue, it reveals some knowledge gaps that may be useful for framing new research. For example, there is a wide range of research about the way that fatigue arising from sleep deprivation influences workers, and about the way that irregular and extended shifts influence workers. However, there is a clear need for additional research about the way that workload impacts muscular exertion and the recovery process. Both have a logical foundation that could be supported through rigorous research. These are simply a sample of obvious gaps in the knowledge system. The reader may find additional connections upon which to build a future study. Another research made by Occupational Medicine (Oxford, England 2015) on Influence of fatigue on construction workers' physical and cognitive function.

The aim of the study was to assess the association between construction workers' reported fatigue and their perceived difficulties with physical and cognitive functions. At the end of the research, it was concluded that, of 606 construction workers surveyed, 49% reported being 'tired some days' in the past 3 months and 10% reported 'tired most

days or every day'. Compared with those feeling 'never tired', workers who felt 'tired some days' were significantly more likely to report difficulty with physical function (adjusted odds ratio [AOR] = 2.03; 95% confidence interval [CI] 1.17–3.51) and cognitive function (AOR = 2.27; 95% CI 1.06–4.88) after controlling for potential confounders.

In this study, they also found that workers who felt tired or exhausted were more likely to report difficulty with physical and cognitive function than workers who did not feel tired. This suggests that a worker's physical and mental abilities are related to their level of fatigue. Social desirability bias might play a role in some self-report characteristics, with under-reporting of physical and cognitive difficulties, as workers need to be healthy and injury-free to work. Nick Fox (2019) research on Identifying and Reducing Worker Fatigue in Construction and it was released that, Lack of sleep is closely tied to fatigue. It is well documented that many people do not get enough sleep, with the CDC estimating that one in three Americans do not regularly get the recommended seven hours of sleep each night. The body repairs damaged tissues and muscles and restores energy levels during sleep, making it an especially critical part of preventing fatigue. Therefore, while lack of sleep and fatigue are closely related, it is not as simple as saying lack of sleep is the only cause of fatigue. In the NSC survey, 75 percent of workers said the demands of the job affected their level of fatigue. Another series of worker survey found that workers often felt fatigued "to the point that they had safety concerns" after working 10 hours a day for three to four days in a row.

Results also showed that working long weeks, having fewer than 12 hours between shifts or engaging in shift work all made it more likely that workers did not get at least

seven hours of sleep. There are only so many hours in the day, especially when workers also have other responsibilities after they get home, like spending time with family. The NSC survey also revealed a significant gap between how workers and management feel about fatigue. Almost all construction employers (98 percent) said fatigue was a safety issue, but only 75 percent of workers said the same. It is hard to say for sure why this safety climate gap exists. One possibility is that some workers believe being fatigued is just part of the job they know construction is hard work and do not shy away from that.

#### **2.4 Effect of Workers Fatigue on Quality Workmanship of Construction Site.**

A career in construction can be very rewarding, offering both physical and mental challenges, work that is always changing and excellent pay and benefits. However, we know the nature of the work also brings risks to workers' safety and health. Physically demanding work creates risk for injury, while tight work schedules and varying job locations can lead to extended shifts, irregular work hours and long commutes. These factors and others are what make construction workers among the most at-risk employees in any industry for experiencing fatigue on the job, (Nick, 2019). Fatigue is often an indicator of an unhealthy lifestyle. With the largest number of workers employed, the construction business was among the riskiest places to work (Berhanu et al., 2019).

##### **2.4.1 Effects of Fatigue on Project Quality Performance**

To build a comprehensive systems model of fatigue, implied fundamental factors identified, based on previous research, and the relationships among them that modeled in an organized fashion. To increase the internal validity of the resulting systems model,

our review is limited to research-based studies that provide empirical evidence for conclusions and we focus our attention on causal factors and relationships that have been validated by multiple studies. Additionally, to reduce complexity and avoid repetition, factors that share similar root causes were codified into single, fundamental factors that were aptly labeled. It should be noted that this initial systems model includes all empirical evidence even if the data reported in the study did not have sufficient detail to be included in the subsequent meta-analysis. This was done to illustrate the focal areas of past fatigue research.

#### **2.4.2 Effects of Fatigue on Project Quality**

The outcome of every quality project highly depends on the factors that come into play; construction productivity is affected by materials timeliness, human-related factors, and management practices (Dozzi & AbouRisk, 2002). Moreover, Hewage and Ruwanpura (2006) classified factors affecting productivity into nine, these includes design and changes, worker motivation, inadequate communication, worker skills, non-availability of information, lack of planning, congested work areas, inadequate supervision, and adverse weather conditions. Siebers et al., (2008) asserted that factors affecting quality is management practices. Jergeas (2009) also lined out of poor management practices, which affects quality in the negative sense such include scope changes, error in project designs, improper planning, and scheduling of activities within a project period, improper management of plant and equipment, improper management of materials and improper allocation of workforce on projects. Fugar and Agyarkwah (2010) indicated that low quality products of the Ghanaian Construction Industry are categorized as materials, labour force, scheduling and controlling, environmental changes, contractual relationships, financial and government action.

However, Amoah et al., (2010) in their discussion highlighted that, low quality product in the GCI is classified into two broad topics thus governments' fiscal policies and management related issues. Management related issues include health and safety, site organization, communication, interpersonal skills, availability of training proprietors and technicians. Earlier research conducted by Ncwadi and Dangalazana (2016) indicated that the Construction Industry in South Africa is with the various challenges, lack of experience in construction business, lack of equipment, racial discrimination, and lack of managerial skills. In addition, Wasi and Martin (undated) itemized that, Cash flow, Contract documentation, Management skills, working relationships, Office facilities and equipment, Level of communication, Cultural impact and financial management skills are challenges faced by indigenous contractors in Papua New Guinea. The construction industry is labor-intensive. It can be argued that manpower is the dominant productive resource, which makes the construction production mainly dependent on human effort and performance (Jarkas, 2010). Poor labour output is because of improper supervision, personal shortages, missing materials, poor operating systems, incomplete design documents, poor communications are all managerial related challenges (Ritz, 2001). They may be discrepancies in the factors affecting quality due to different researchers or different criteria for cataloguing the factors that were attributed to the topics treated by the various researchers. From an analytical point of view, the factors can be classified under one big umbrella whether it is worker motivation, communication, information, supervision comes back to management practices. Many construction projects result in cost overrun, delays because management at times compromise some of the project's performance such as time, cost, and quality.

## **2.5. The Influence of Workers Fatigue on the Quality Performance of Projects and Relevant Theories Underpinning the Study.**

The influence of workers fatigue on quality performance of project is considered as one of the most important and influential variables governing economic production activities (Pekuri et al., 2011; Tangen, 2005; Singh et al., 2000). It is also one of the most frequently used performance indicators to assess the success of a construction project as it is the most crucial and flexible resource used in such areas. (Construction Industry Institute, 2006). Considering the size of the construction industry, output trends in this industry have notable effects on national output and on the economy (Allmon *et al.*, 2000). The increased global competition has forced companies and authorities to put even greater emphasis on output improvements (Pekuri *et al.*, 2011). According to Mawdesley & Qambar, (2000) productivity is defined as “the ratio of output to input per man’s working hours”, which can be describe as efficiency of man’s working hours (Harris et al., 2006). From the two definitions, it can be inferred that, the resources invested in an activity should produce at least the same resources invested or better still better outcome. Productivity can also be defined as the numerical relation between a product (output) and its input resource. Productivity in construction can be said to be the way, the rate, the quality, and the cost at which project is executed.

Productivity can be classified as high or low, high productivity means executing a task within the shortest available time by optimizing cost not at the expense of quality and with minimize wastage of resources production and operations management and low productivity is executing the same quantity of task within a longer time frame with maximum waste of resources. The United States construction industry experienced decline growth in productivity (Ritz, 2001).

Levy (2007) asserted that the construction industry in the United States had seen decline and still wallowing in retarded growth.

### **2.5.1 Measuring Tools for Project Performance**

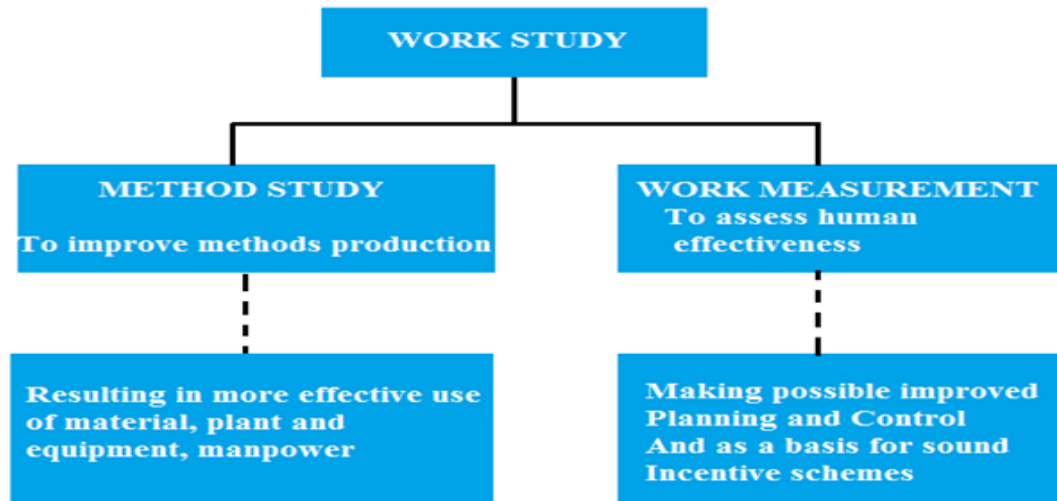
Sarhan and Fox (2013) indicated that construction practitioners in the UK have developed common techniques for measuring project performance. Lee et al., (2005) indicated earlier that most developed countries have introduced their own project techniques measurement tools. Additionally, the benefits of continuous observations are detracted by the unstoppable restrictions of scope, which eventually makes it difficult for large companies to pursue this approach. Where the use of equipment for audio-visual methods are concerned, Winch and Carr (2001) were extremely careful that the workers might feel that the surveillance was unnecessarily intrusive. As such, they avoided the use of such methods to observe the workers and opted instead for direct observation where the researchers got to know the individual workers on a personal level (Chan and Kaka, 2007). Thus, while the workers' uneasiness was achieved completely overcome the inability to observe the whole construction process became evident. Radosavljevic and Horner (2002) revisited formwork and masonry performance data sets across eleven sites in the USA and the UK, only to confirm their suspicion that project performance is not normally distributed, thereby implying that some basic statistical diagnostics may give misleading results and are not applicable'. Amazingly, Radosavljevic and Horner (2002) made a short comparison of the data with volatility studies in econometrics to reveal surprising similarity with Pareto distributions, which are typical of chaotic systems. Productivity can be measured by observing the process of which an activity is executed. Such observation is done in a well thought manner because it will demoralize workers upon realizing that they are

been observed (Brumby et al, 2019). Brumby et al, (2019), again suggested that productivity could be improved by measuring it.

It can be measured by comparing the work done on the project site as against the estimated standards produced during the tendering stage of the project. The work been done on the project site can visualized as provided in Figure 1.1. The construction industry has adapted productivity measurement tools as a way of critiquing project performance by systematically examining the invested resources, end products of resources as well as the project outcome. Such tool is adapted to ascertain the effectiveness and efficiency of a project; however, it is indicated that many frameworks introduced in construction to access project success is more theoretically than practically proven (Takim, et al, & Kelly, 2003). Before undertaking such activities, indicators of success should be determined (Nelson & Economy, 2005) because there are crucial circumstances, which directly and indirectly impact on construction productivity (Mawdesley & Qambar, 2000).

### **2.5.2 Project Work Study**

Project work-study is a systematic approach of observing, recording, analyzing, and examining how an activity is carried out by employees (Work Studies, 2009). Production and Operation Management (undated) added that Work Study is done to improve productivity efficiency by eliminating waste and unnecessary operations.



**Figure 1. 2 Work Study (Work Studies, 2009)**

### **2.5.3 Method Study (MS)**

BS 3138 defines Method Study as “the systematic recording and critical examination of ways of doing things in order to make improvements.” From the BS definition, Method Study can be said to be an analytical approach by which an activity is executed on the construction site. In Production and Operations Management (undated), Method Study (MS) was defined as “the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs. Method study is mostly implemented on construction projects to curb the challenge of cost overruns, time overruns, excessive wastage of resources, quality related issues, workers’ incompetence, MS is a result-oriented activity. The application of work-study subjects each activity of operations into a systematic examination. The Production and Operation Management (undated) stated that Selecting, Recording, Examining, Developing, Evaluating, Defining, Installing and Maintaining (SREDIM) are the procedures involved in method (MS).

#### **2.5.4 Effect and Influence of Workers Fatigue on the Work Output on Construction Site**

The National Health Interview Survey (NHIS) is an annual, nationally representative cross-sectional household survey of the US population, which collects information on various topics including health conditions, psychosocial status, and employment. Data were collected by standardized personal, household interviews conducted by trained interviewers employed by the US Bureau of the Census according to procedures specified by the National Center for Health Statistics (NCHS). The research study pooled two (2) years' (2010–2011) NHIS survey data on adults (age 18 and older) employed as construction workers. In this study, employment was defined as having worked during the week prior to survey interview. Construction workers were selected for analyses based on their occupational title using the two-digit NHIS detailed occupational code created by the NCHS using the 2010 Standard Occupational Classification codes. Survey respondents who had their occupational variable (OCCUPN2) coded as 19 (Construction and Extraction Occupations) were included in the study.

The study used the occupational variable instead of the industry variables available in the NHIS in order to exclude occupations employed in the construction industry but not engaging in construction work (e.g. accountants). All the variables considered in this paper were self-reported by the survey respondents. The study assessed respondents' feeling of fatigue with one survey question: 'In the past three (3) months, how often did you feel, very tired or exhausted?' Response options were never, some days, most days or every day, and the study categorized responses into feeling 'never tired' (i.e. respondents who indicated 'never'), 'tired some days' (those stating 'some days') and

‘tired most days to every day’ (those stating either ‘most days or every day’). The study assessed participants’ physical function through questions about their difficulties with nine daily functional activities, namely: ‘By yourself and without using any special equipment, how difficult is it for you to:

- i. Walk a quarter of a mile about three (3) city blocks?
- ii. Walk up 10 steps without resting?
- iii. Stand or be on your feet for about 2 hours?
- iv. Sit for about 2 hours?
- v. Stoop, bend, or kneel?
- vi. Reach up over your head?
- vii. Use your fingers to grasp or handle small objects?
- viii. Lift or carry something as heavy as 10 pounds such as a full bag of groceries?
- ix. Push or pull large objects as heavy as 10 pounds such as a living room chair?

Respondents were given five response options that the study dichotomized into either ‘no difficulty with physical function’ (i.e., respondents stating ‘not at all difficult’) or ‘any difficulty with physical function’ (those who indicated ‘only a little, somewhat, very difficult or cannot do at all’). The study also assessed cognitive function with the question: ‘Do you have difficulty remembering or concentrating? Response options were no difficulty, some difficulty, a lot of difficulty or unable to do this.

We dichotomized responses into ‘no difficulty with cognitive function’ or ‘any difficulty with cognitive function’ (those who indicated ‘some difficulty, a lot of difficulty or unable to do this’). In addition, the study examined demographic details, health behaviour and health condition characteristics of the sample population to identify any correlations with the main outcome measures of difficulty with physical and cognitive functions.

These variables included age, smoking status, alcohol consumption, sleep hygiene, psychological distress, and arthritis at time of interview. The age of participants was categorized into 18-44 or 45 and older. Responses for smoking status were dichotomized into 'current non-smoker' (i.e., former smoker or never smoker) or 'current smoker' (i.e., 'current every-day smoker' or 'current someday smoker'). Responses for alcohol consumption were categorized into 'current non-drinker' (i.e., responses of 'Lifetime abstainer', 'Former infrequent', 'Former regular' or 'Former, unknown frequency'), 'Infrequent to light drinker' (i.e., 'Current infrequent' or 'Current light') and 'Moderate to heavy drinker' (i.e., 'Current moderate' or 'Current heavier'). Responses for the average hours of sleep in a day were dichotomized into '6 hours or less' and '7 hours or more'. Seven hours of sleep was used as the reference given that in the extant literature it is associated with the lowest levels of illness and mortality (Grandner et al, 2010).

Psychological distress was assessed by the K6 Scale (Kessler et al, 2002). Comprising six questions about how often respondents feel sad, nervous, restless, hopeless, effortful, and worthless. Responses were dichotomized into 'distress' (K6 scores of 6–29) and 'no distress' (score 30). Arthritis status was assessed by the question: 'Have you EVER been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout?' Participants could respond either yes or no. In accordance with the findings, it was noted that, a total of 63280 adults participated in the 2010–11 NHIS of whom 606 (0.96%) were employed as construction workers during the survey study period. The characteristics of these subjects, by physical and cognitive functions, the feeling of tiredness or exhaustion and other variables. Among the sample, 49% reported feeling tired or exhausted some days in the past three (3)

months and 10% reported feeling tired or exhausted most days or every day. Twenty-two percent (135) of workers reported difficulty with physical function and 8% (50) reported difficulty with cognitive function. Chi-squared test results showed significant differences ( $P < 0.05$ ) in reported physical and cognitive functions between workers who reported tiredness or exhaustion and those who did not. Significant differences in physical and cognitive functions were also found between different groups when categorized by age, psychological distress, and arthritis status. The study also found that, workers who felt tired or exhausted were more likely to report difficulty with physical and cognitive function than workers who did not feel tired. This suggests that worker's physical and mental abilities are related to their level of fatigue.

#### **2.5.5. Relevant Theories underpinning the Study**

The use of the theories to underpin studies is mainly in the areas of qualitative interpretive research. This is primarily because of the interplay between technical and non-technical factors, which are involved in the field of fatigue in the construction industry. Underpinning theories are referred to, by Gregor (2002) as theories for understanding social context in IS studies. The theories are intended to explain "how" and "why" things happen in the way that they do. The theory, which underpins a study, is often viewed as a lens. In Orlikowski (2000), the word "lens" is used in the sense of assessment, where certain features are focused upon and emerge, and where the rest of the picture falls into the background. Lenses are used as an analytical tool to aid interpretation and analysis of data in research. The analysis of the data determines and shapes the results of the study. The analysis of data is fundamental to any study. Hence, the tool (theory) used in the analysis is deemed critical. How data is collected and analyzed is within the frame of the theory, which underpin the study.

### **2.5.6. Physical and Cognitive Function Theory**

Physical and cognitive function theory (PCFT) focuses on person's ability to perform physical activities. The theory is concerned with the relationship between physical and cognitive function of a person. Physical function refers to a person's ability to perform normal physical activities of daily living such as walking, reaching and climbing, whereas cognitive function involves a range of intellectual processes, including perceiving, remembering, thinking and decision-making, (Steel et al, 2002). On a construction site, workers generally plan and think (i.e., exercise cognitive functions) about the tasks they will perform and use their physical strength to execute those tasks (i.e., physical function). It is plausible that limitations in physical or cognitive function may impair an individual's work performance and may even increase their risk of workplace injuries, (Anstey et al, 2005). In view of the physical and mental nature of fatigue, it is possible that fatigue will impair physical and cognitive functions and influence health and safety adversely.

### **2.5.7. Fatigue and Work Performance of XYZ Employees Theory**

Fatigue and Work Performance (FWPT) focuses on fatigue and work performance of employees in terms of productivity worker, health, and work performance. The theory is concerned with the relationship between fatigue and work performance of employees. According to Doni Hikmat, (2018), fatigue can adversely affect safety, health, work performance, and worker productivity, and it can occur if there are risk factors in the workplace, such as monotony, workload level, and long hours, which can take a control physically and mentally. XYZ is a government agency that educates and trains personnel in human resources in the field of quality testing of goods. In carrying out its duties, XYZ organizes programming and evaluation of employees through

education/training, as well as the implementation of standard training, promotion, cooperation of education, and administrative and household affairs. Annually, XYZ organizes more than 25 training events, in which the training duration varies. The many activities that XYZ carries out encourage employees to work hard, including long hours, which can elicit fatigue. Doni Hikmat, (2018), indicated a statistically significant relationship between fatigue and work performance ( $r = -0.771$  and  $p = 0.0005$ ) and stated that, a very strong and inversely proportional relationship in which the higher the fatigue experienced by XYZ employees, the more their work-performance quality suffered.

#### **2.5.8. Fatigability Theory**

Fatigability theory (FT) focusses on the rate of change in a performance over a given time of task. The theory of fatigability is the decrement in magnitude or rate of change in a performance criterion relative to a reference value over a given time of task performance. It is important to highlight here that the definition of fatigability excluded the possibility of something being fatigability when there is no performance change or lack of improvement.

For example, in Skau et al. (2019), found that patients suffering from problems with fatigue after a mild traumatic brain injury (TBI) performed on a cognitive task (Digit Symbol Coding) (Wechsler, 2010) equivalently well at two time points that were intermediated with 1.5 h of intense cognitive activity. At the same time, healthy controls improved their performance.

### **2.5.9 Contributory Factors of Fatigue**

Assigned work-related workload, defined as the product of physical demand and time, has been strongly linked to fatigue (Akerstedt et al. 2002). Ribet and Derriennic (2000) found that heavy workloads negatively influence sleep and, thus, interfere with the recovery process accumulating fatigue debt in the individual. In addition, high levels of required workload without the option for lower-effort alternatives cause an effort-to-reward imbalance that can ultimately lead to mental fatigue (Boksem et al. 2008). Hsiao and Simeonov (2001) and Gander et al. (2011) found that time on task alone was inadequate for fatigue prediction as accurate predictions require consideration of time on task, cognitive and physical demands, repetition, and scheduled breaks.

#### **2.5.9.1 Overtime and Long Work Hours (LWH)**

As defined by the Fair Labor Standards Act (1938), overtime in the US is the amount of work time in a week that exceeds 40 hours. Overtime can be accomplished either by working more than eight hours per day in a five-day-per-week schedule or by having fewer days off from work per week. The occurrences of overtime were a common problem of industrialized environments (Kodz et al. 2003). More specifically, in Europe about 20% of the working population experiences at least 5 hours of overtime weekly and 13% of the full-time employees in Europe work at least 10 hours of overtime a week (Pascal and Damien 2001). In the US, the situation is similar where about 26% of the male working population and 11% of the female working population work at least 10 hours of overtime weekly. Additionally, the amount of overtime has been growing over the past 50 years, especially among women due to their increasing presence in the workplace (Caruso 2006; Bureau of Labor Statistics 2015). The fatigue-related consequences of overtime are directly connected to the perceived benefits and

conditions under which overtime takes place. In this regard, there were three different types of overtime situations:

- i. Mandatory, low reward, low autonomy, and highly demanding overtime. In this case the worker is forced to work overtime in an environment that the worker cannot have control or required to perform highly demanding activities or does not feel that the increased payment or future time off were sufficient compensation. This kind of overtime is associated with the most severe mental fatigue, dissatisfaction with the job, job burnout, negative work/home interaction, and slow recovery (Van Der Hulst and Geurts 2001; Beckers et al. 2008).
- ii. Mandatory, high-reward overtime. The second kind of overtime is that which is performed solely because the extra payment is desired.  
  
This kind of overtime encourages people to work up to a point that exceeded their healthy state of functioning to earn more money, causing relatively high levels of fatigue (Gander et al. 2011).
- iii. Voluntary overtime. This overtime is not driven solely by the economic reward, but also by personal fulfillment. When it is limited by the workers themselves, it is performed with a high level of autonomy, overtime does not appear to have significant negative consequences, causing very low levels of both muscular and mental fatigue within natural physiological limitations (Taris et al. 2007). Park et al. (2001) concluded that 20 hours of overtime per week is the point after which fatigue recovery becomes extremely difficult, even when overtime is voluntary.

Extended shifts can also cause fatigue. In contrast to overtime, which involves an accumulated number of workhours in a week, extended shifts, or long working hours

(LWH) refers to single or compound shifts that involve more than eight hours of work in a twenty-four-hour period. It is important to note that LWH do not necessarily implied overtime. Some schedules such as 10-hour shifts for 4 days per week involve LWH but not in overtime. LWH studies showed that memory efficiency decreases during cognitive activities when uninterrupted time on task exceeds 3.5 hours (Kivipelto et al, 2006). Once 3.5 hours of continuous work has been accumulated, mental acuity can only be maintained at the expense of extra mental exertion. The perpetuation of such effort will cause mental fatigue (Kivipelto et al, 2006). LWH also causes fatigue by exposing the individual to other work stressors such as noise, inadequate lighting, extreme temperatures, and other environmental and social factors, when present, for an additional period (Park et al. 2001; Dembe et al. 2005). The fatigue impact of LWH depends on the activity performed. If the activity requires mental effort, it will generate mental fatigue; otherwise, it will generate muscular fatigue or a combination of both.

#### **2.5.9.2 Sleep Deprivation**

Sleep deprivation is mostly discussed and arguably the most significant cause of both muscular and mental fatigue. It affects between 15% to 20% of US adults and is becoming an increasing concern in our modern society due to various schedule irregularities and conflicting priorities that compromise sleep (Dinges et al. 2005). To Belenky et al. (2003) it produced a comprehensive analysis of fatigue-related consequences of different sleep routines. They studied three different sleep restriction conditions: a mild sleep restriction (7 hours of sleep per night), a moderate sleep restriction (5 hours), and a severe sleep restriction (3 hours or less). The results were compared to control group, which obtained 8 hours of sleep during period of the study.

To them sleeping less than 8 hours generated negative outcomes. Particularly, those who experienced only mild or moderate sleep deprivation showed reduction in their mental and physical performance, which stabilized after a few days but still was under the normal level of performance. Moreover, those who experienced severe sleep deprivation showed an ongoing degradation that cannot be stabilized even after few days. Various authors agree that a single night of partial sleep deprivation will generate a reduction in performance that can last several days (Van Dongen and Dinges 2005; Lim and Dinges 2008). Interestingly, Belenky et al. (2003) noted that no significant improvements in fatigue for workers who obtain more than 8 hours of sleep compared to the control group. Typically, sleep is compromised by early morning and night shifts that cannot only disrupt the circadian rhythm of the individual but also affect their social and family life (Folkard and Tucker 2003). Such adverse effects are mostly prevalent to the first night after a period of rest when typical work shifts re-commence (Roach et al. 2004).

In addition to fatigue, sleep disruption causes impaired physical performance, decreased work satisfaction, increased stress, and interrupted future sleep patterns (Harrison and Horne 2000; Philibert 2005). Unless this cycle is broken and workers recover completely from the previous workday, the sleep deprivation process can become chronic, ultimately resulting in serious long-term mental and physical health problems (Medic G et al, 2017). Sleep efficiency and quality are important as the mind and the body of human beings need rest to avoid weariness (Dawson and McCulloch 2005; Zhang and Liu 2008). Sleep deprivation is seen as such a strong precursor of fatigue that Dawson and McCulloch (2005) claim that fatigue can be accurately predicted by simple measuring amount of sleep that a worker experiences in the 24-48

hours prior to a shift. They however argue that sleep patterns prior to work are a better indicator of occupational fatigue than actual observations at work.

### **2.5.9.3 Mental Exertion**

Some causes of fatigue can be purely mental. Mental exertion, defined as sustained cognitive activity that requires extraordinary mental effort, is the principal cause of mental fatigue (Lorist et al. 2005). Mental fatigue can be recognized by individuals themselves as they have difficulty in concentrating, making timely decisions, planning, and responding to stimuli (van der Linden et al. 2003; 2003b; Boksem et al. 2005, 2006; van der Linden and Eling 2006). In addition to subjective indicators of mental fatigue, Lorist et al. (2005) used brain-scanning technology, such as the electroencephalogram, to directly measure mental lassitude and unequivocally correlated mental exertion with mental fatigue.

### **2.5.9.4 Muscular Exertion**

Muscular exertion, a purely physical occurrence, is a primary cause of localized fatigue (Jason et al. 2010). The link between muscular exertion and localized muscular fatigue has been studied in numerous ways. For example, fatigue is caused by the repetitive contraction of a specific muscle through electrical impulses (dynamic exertion), or by keeping a specific muscle contracted (static exertion). Beyond the static and dynamic state of exertion, there is either a metabolic or a central nervous system degradation that explains the onset of muscular fatigue. For example, a fatigued quadriceps muscle consumes much more energy than a relaxed muscle, although metabolic energy production remains unchanged (Wan et al, 2017). This results in exponential cumulative fatigue generation. Although mental and muscular exertion yield obvious

and distinct impacts on mental and muscular fatigue, respectively, other factors affect both mental and muscular capabilities. Some of these factors interact producing a compounding effect on the development of general fatigue.

#### **2.5.9.5 Work Environmental Factors**

Noise, light intensity, vibration, and temperature are all environmental factors linked to fatigue. Noise has been found to cause fatigue through over stimulation for example, Ulises et al, (2016). Showed that airplane mechanics and boat patrol crews experienced mental fatigue as a result of high duration of exposure to low frequency noise. Additionally, extreme temperatures (i.e., below 35F and above 95F) increase the rate of muscular fatigue (Zivin and Neide. 2010). Similarly, Ulises et al, (2016) found a significant positive correlation between poor lighting and fatigue and Jiao et al. (2004) found a positive correlation between vibration and fatigue.

#### **2.5.9.6. Social Environment at the Workplace**

Most of the working population spends one-third to one-half of their working hours at work. Relationships with co-workers, managers, and subordinates play a major role in the development of mental fatigue (Bültmann et al. 2001). Some specific psychosocial experiences can exacerbate mental fatigue. For example, workplace abuse, defined as daily harassment from co-workers or abusive supervision for prolonged periods of time, can cause severe mental fatigue (Tepper 2000; Zapf and Gross 2001). Similarly, Pien et al. (2021) found that conflicts and adversarial situations at work develop high levels of mental fatigue, even if they are essential attributes of the work type (e.g., negotiations). Other social factors that strongly influence the onset of mental fatigue are the perception of low autonomy, high emotional demands, and job insecurity (Taris et al. 2007).

### **2.5.9.7 Emotional Predisposition and Distress**

Fatigue influences everyone differently depending on his or her emotional predisposition and is often exacerbated under distress. Emotional disposition pertains to the propensity of an individual to experience negative emotions such as fear and sadness (Gibson et al. 2003). Bültmann et al. (2001) performed a field study with 11,020 workers from 45 different companies and discovered that those who are more likely to experience negative emotions are more likely to encounter mental fatigue than individuals who are more emotionally resilient. Furthermore, in a study of 16,139 employees from the public sector, Ala-Mursula et al. (2005) showed that the onset of fatigue is accelerated under stressful conditions, especially for individuals who are emotionally vulnerable.

### **2.6 Consequences of Fatigue**

Fatigue research tends to focus on either causal factors or outcomes of fatigue. Causal factors and outcomes are rarely modeled together. Here, implied causes and consequences of fatigue are analyzed exclusively underlying their relationship with fatigue as the main variable of interest. Occasionally, some causes and consequences of fatigue can be connected via mechanisms other than fatigue, particularly with mental disorders and long-term health concerns. However, this review did not include these secondary relationships. Below is a comprehensive review of empirical literature that has linked occupational fatigue with specific mental and physical consequences. Some of these consequences are subtle or acute while others can manifest on delay or can be chronic. Understanding the interrelationships among consequences of fatigue is critical to modeling the true impact that fatigue can have on an individual.

### **2.6.1 Mood Changes**

Mood Changes, related to short-term emotions and feelings, can be assessed by numerous variables such as tension, anger, vigor, sadness, anxiety, and depression. Mood is typically measured subjectively through the Profile of Mood State introduced by Vassend et al. (2018). According to the prevailing literature, fatigue results in strong negative changes to mood states, which can change emotional stability, increase anxiety, and eventually lead to long-term depression (Harrison and Horne 2000; Sagaspe et al. 2006; Scott et al. 2006; Boonstra et al. 2007; Kajtna et al. 2011).

In addition, a negative mood or emotional state has been shown to decrease complex cognitive performance, clouding risk perception (Tixier et al. 2014). Scott et al. (2006) studied the mood-related consequences of fatigue arising from 30 hours of sleep deprivation and concluded that tension and anger were not affected but that feelings of depression and sadness manifested quickly, even after only one missed sleep cycle. Kajtna et al. (2011) studied the timing of mood-related change arising from fatigue and found that fatigued individuals experienced relatively high levels of anxiety between 0400 and 0800 hours and relatively low levels between 1600 and 2000 hours. Interestingly, using a series of complex and controlled experiments, Kajtna et al. (2011) found that the fatigue-induced mood changes compromise an individual's ability to concentrate on a stimulus.

### **2.6.2 Cognitive Degradation**

Cognitive functions, classified as complex or basic, are essential for effective completion of work and for healthy life outside of work. Complex cognitive functions include, but are not limited to, the ability to plan, perceive risk, and make decisions under uncertainty. Basic cognitive functions include attention, vigilance, and response

to stimuli (Jovanovic et al. 2012). When studying the impact of fatigue on cognitive performance, researchers typically manipulate degrees of sleep deprivation and measure performance with standardized cognitive activities (Van Dongen and Dinges 2005; Lim and Dinges 2008; Zhang and Liu 2008) Studies on complex cognitive performance involve sophisticated experimental methods and the use of advanced technologies. Researchers have focused on the impacts of acute fatigue on verbal fluency and communication, decision-making capability, creative thinking, planning, executive control, and novelty performance. Overwhelmingly, data support that all of these complex cognitive functions are significantly deteriorated even with modest fatigue levels (Harrison and Horne 2000). With the help of electroencephalographic (EEG) tools, functional neuroimaging, and psychophysiological assessments, researchers have found that the Prefrontal Cortex (PFC), which governs the executive functions of the brain, is the locus of deterioration when an individual is fatigued (Jones and Harrison 2001; van der Linden et al. 2003). Unlike basic functions that can be rote and automatic, complex tasks require uncompromised PFC functionality (Jones and Harrison 2001).

Thus, the brain is highly susceptible to even modest fatigue levels when executive functions are required to make complex decisions (Nilsson et al. 2005; Boonstra et al. 2007). In an occupational environment, this translates to a differential in potential consequences depending on the tasks performed by different workers with the same levels of fatigue. In addition to complex cognitive functions, other more basic and automatic cognitive functions can be compromised. One of the earliest and most comprehensive investigations of the relationship between fatigue and cognitive performance found that a single night of sleep deprivation decreased cognitive

performance by 30% (Kajtna et al, 2011). Furthermore, their findings showed that cognitive performance was reduced by an additional 30% during the second 24-hour period of sleep deprivation and remained stable at 40% of the original cognitive performance after 48 hours without sleep. This study was empirically validated by Van Dongen and Dinges (2005); Lim and Dinges (2008); and Zhang and Liu (2008) who later replicated the experiment with a more heterogeneous sample of participants and a more diverse set of cognitive tasks and fatigue scenarios.

### **2.6.3 Illnesses**

Fatigue has also shown to have significant long-term impacts on the human body. For example, researchers have found evidence that night shift workers experience higher levels of fatigue and, consequently, present gastrointestinal disorders, irregular bowel activity such as constipation and diarrhea, bowel pain, and even ulcers at a rate that is nearly double their dayworker counterparts (Knutsson 2003).

Furthermore, Knutsson (2003) found that shift workers present a 40% higher risk of suffering cardiovascular disease or myocardial infarction than daytime workers. Although gastrointestinal and cardiovascular conditions are the most common occupational illnesses related to fatigue, some postulate that fatigue has greater consequences among those who are pregnant or have diabetes (Knutsson 2003).

### **2.6.4 Human Error and Injuries**

As previously discussed, lassitude of cognitive functions decrease recall, reaction time, ability to plan, and ability to respond to stimuli. Additionally, lassitude of the muscular system decreases the ability to physically execute a plan. Thus, it is not surprising that

researchers have found evidence of a direct relationship between the degree of fatigue and rates of human error (Lorist et al. 2000; van der Linden et al. 2003). Human error is said to occur when an individual takes unintentional actions or is unable to execute planned functions and an undesired outcome is realized.

## **2.7. Strategies for Minimizing the Effects of Fatigue.**

With Ghana being a developing country, the challenges facing the Ghanaian construction industry are similar to those reported from other developing countries. Even though developing countries attribute the development of the country's economy to the construction industry, the industry is yet to be given the acknowledgement that it deserves (Ofori, 2012; Osei, 2013).. The industry is not planned holistically which has resulted in its operations being carried out in fragments, using of conflicting components with inefficiency, wastage and inability to make proper plans that will lead to development. With the government being the major client of the Ghanaian construction industry, there is limited financial commitment from them to meet the large demand for several categories of outputs expected from the industry (Ofori, 2012; Osei, 2013). Some of the challenges facing the Ghanaian construction industry are explained below.

### **2.7.1 Eliminating Factors Causing Fatigue**

The best way to control and minimize the effects of fatigue on construction workers is by eliminating the factors causing fatigue at the source. If elimination is not reasonably practicable, the fatigue must be minimized.

What is reasonably practicable to do to manage the fatigue will vary depending on the type of industry, the structure of an organization as well as the person carrying out the

work, (Guide for Managing the Risk of Fatigue at Work, 2013). Minimizing or controlling of fatigue can be done through the following:

- i. *Work schedules*: which limit the time workers can physically and mentally recover from work may cause fatigue, for example early shift start times or late finishes, short breaks between shifts, shifts lengthened by overtime or double shifts and not enough non-sleep rest breaks during a shift, (Guide for Managing the Risk of Fatigue at Work, 2013).

Control measures for fatigue, which can be built into a work schedule, may include:

- a. designing working hours and rosters to allow for good sleep opportunity and enough recovery time between workdays or shifts for travelling, eating, washing and sleeping
- b. developing a working-hours policy on daily work hours, maximum average weekly hours, total hours over a three-month period, on-call work and work-related travel
- c. developing procedures to manage and limit excessive working hours, for example requiring minimum breaks on a regular basis, especially during longer shifts
- d. ensuring workers have and take adequate and regular breaks to rest, eat and rehydrate
- e. scheduling safety critical work outside the low body clock periods between 2am and 6am, and between 2pm and 4pm
- f. managing workload and work-pace change caused by machinery breakdowns or planned and unplanned absences
- g. avoiding work arrangements which provide incentives to work excessive hours
- h. managing overtime, shift swapping and on-call duties

- i. implementing processes to manage accrued leave balances and requests for leave, for example setting maximum limits of leave accrual to encourage workers to use it
  - j. considering future rosters and schedules when approving request for leave or shift swaps, and ensuring leave is reflected in rosters
  - k. having access to on-call workers for unplanned leave, emergencies or where workload increases
  - l. developing plans to deal with workload changes due to absenteeism
  - m. filling vacant positions as soon as reasonably practicable and maintaining a relief pool of staff in high demand areas where fatigue is a risk
  - n. Considering alternative options to face-to-face meetings, for example teleconferencing so workers are not required to spend time travelling to meetings.
- ii. *Shift Work and Rosters*: When planning work schedules and rosters for specific work arrangements, including shift and night work, FIFO, DIDO, seasonal, on-call and emergency services work arrangements; consideration should be given to implementing additional specific control measures, (Guide for Managing the Risk of Fatigue at Work, 2013). Specific control measures may include:
- a. structuring shifts and designing work plans so work demands are highest towards the middle of the shift and decrease towards the end
  - b. avoiding morning shifts starting before 6am where possible
  - c. avoiding split shifts or if there is no alternative to split shifts consider their timing, for instance whether they are likely to disrupt sleep
  - d. setting shift rosters ahead of time and avoiding last-minute changes, to allow workers to plan leisure time

- e. allocating shift and night workers consecutive days off to allow for at least two full nights' sleep including some weekends
  - f. aligning shift times with the availability of public transport or if required, provide alternative transport at the end of a long shift
  - g. overlapping consecutive shifts to allow enough time for communication at shift handovers
  - h. avoiding overtime allocation after afternoon or night shifts
  - i. consider if night work is necessary and rearrange schedules so non-essential work is not carried out at night
- iii. *Job Demands:*** Control measures to prevent or minimize the risk of fatigue can include:
- a. ensuring fit-for-purpose plant, machinery and equipment is used at the workplace (for example, ergonomic furniture, lifting equipment and anti-fatigue matting for repetitive tasks performed while standing)
  - b. encouraging workers to report concerns they may have about work-related fatigue
  - c. redesigning the job to limit periods of excessive mental or physical demands
  - d. introducing job rotation to limit a build-up of mental and physical fatigue
  - e. developing contingency plans for potential situations where workers may have to unexpectedly work longer hours, more shifts or a long sequence of shifts, and
  - f. Planning for expected changes in workflow including anticipated peaks and troughs during the year.
- iv. *Environmental Conditions:***
- a. Avoid working during periods of extreme temperature or minimize exposure time through job rotation.

- b. Provide a cool area where workers can take a rest break and rehydrate in hot work environments.
- c. Install ventilation and mechanical cooling devices in hot, small and enclosed spaces such as truck cabins.
- d. Provide adequate facilities for rest, sleep, meal breaks, onsite accommodation (if appropriate).
- e. Install adjustable, low-vibration seats in machinery and vehicles and provide low vibration handheld equipment.
- f. Provide and maintain a workplace, which is well lit, safe and secure.

A fatigue policy can be included with other work health and safety policies, for example policies on bullying, drugs and alcohol and fitness for work and should be developed in consultation with workers or their health and safety representative.

### **2.7.2 Monitoring and Reviewing**

Once control measures are implemented, they should be monitored and reviewed to ensure they continue to effectively manage fatigue. Consider implementing trial periods for any new work schedules and encouraging workers to provide feedback on their effectiveness. To determine the frequency of monitoring and review consider the level of risk, high-risk hazards need more assessments that are frequent. (Guide for Managing the Risk of Fatigue at Work, 2013).

### **2.7.3 Introduction of Technology**

Incorporation of new technologies into the Ghanaian construction industry is still low as this is evident on construction sites around the country. There are new technologies, which has been put in place to assist in the construction process and improve the

productivity and quality of the products of the construction industry. The implementation of these technologies will no doubt increase development of the construction industry, which will in turn improve the economy of the economy of the country (Assibey-Mensah 2009; Forster and Mensah 2013).

## **2.8. Summary of the Literature Review**

In summary, the construction sector is one of the most hazardous and deadly industry. According to the U.S. Bureau of Labor Statistics (2015) in 2014; there were a total of, 4,679 fatal work injuries, which equates to an all-industry and government jobs fatality rate of 3.3 fatalities for every 100,000 full-time equivalent workers (FEW). That same year, the construction industry showed a fatality rate of 9.4 for every 100,000 FEW; thus, presenting a fatality rate nearly 3 times greater than that of the overall working population. Fatigue occurs when we are low on energy. In more scientific terms, fatigue is physical or mental exhaustion as a result of exertion. Fatigue can be physical or mental and often occurs as some combination of the two. Many additional factors can contribute to fatigue, including lack of sleep, disruption of sleep patterns, diet, times of emotional stress and chronic health conditions such as diabetes. The chapter begun with an overview of the construction industry. From the overview, it was realized that the construction sector contributes significantly to the social-economic development and the gross domestic product (GDP) of every country.

More so, the decline in construction productivity according to which manifest in the form of construction delays, cost overruns and loss of productivity is attributed to poor management practices. Productivity is considered as one of the most important and influential variables governing economic production activities. Productivity can be classified as high or low, high productivity means executing a task within the shortest

available time by optimizing cost not at the expense of quality and with minimize wastage of resources production and operations management and low productivity is executing the same quantity of task within a longer time frame with maximum waste of resources. The review also touches on factors affecting productivity and it was noted that, the outcome of every project highly depends on the factors that come into play; construction productivity is affected by materials timeliness, human-related factors and management practices. In addition, the construction industry has adapted productivity measurement tools as a way of analyzing project performance by systematically examining the invested resources, end products of resources as well as the project outcome. The review explores on the extent of the effect of fatigue on the quality of workmanship of construction site workers and was released that, fatigue is a workplace hazard as it affects the ability to think clearly and respond appropriately and as such has been linked to workplace injury.

Construction workers are prone to fatigue as construction work typically involves heavy workloads, awkward working postures and prolonged working hours. Although a wide consensus is lacking, the concept of fatigue is broadly described as the lassitude or exhaustion of mental and physical strength that results from bodily labour or mental exertion. The review continues with the influence of fatigue on the work output of construction site workers. It was noted that, workload characteristics, overtime and long work hours and sleep deprivation are all influence of fatigue on the work output of construction site operatives.

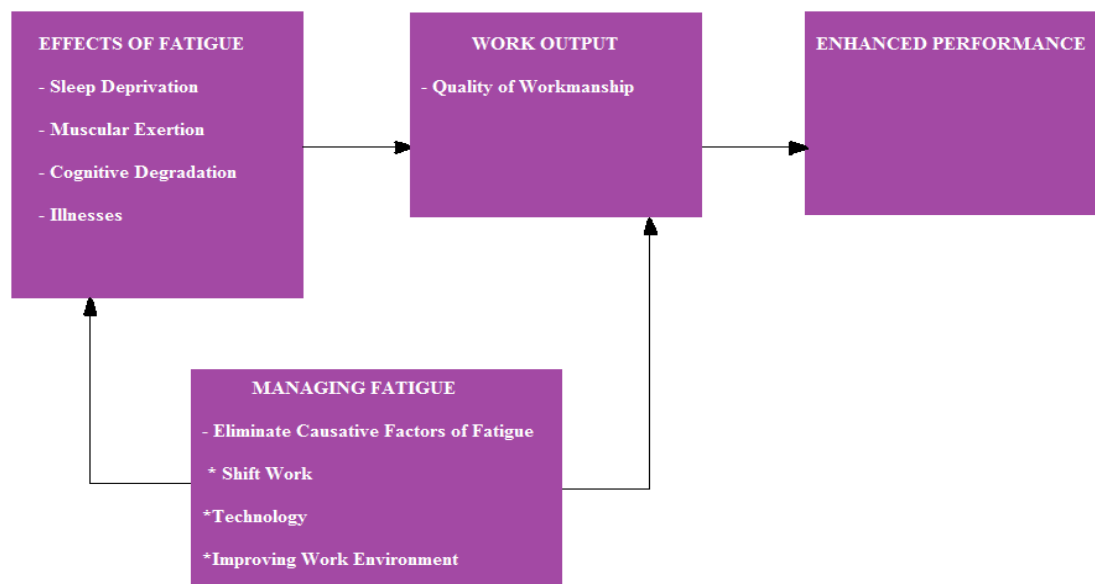
More so, mental exertion, muscular exertion, work environmental factors and social environment at the workplace also influence fatigue on the work output of construction

site workers. It was also noted that, causes and consequences of fatigue are analyzed exclusively underlying their relationship with fatigue as the main variable of interest. Occasionally, some causes and consequences of fatigue can be connected via mechanisms other than fatigue, particularly with mental disorders and long-term health concerns. Another review was on the strategies for minimizing the effects of fatigue on construction site workers. It was released that, the best way to control and minimize the effects of fatigue on construction site workers is by eliminating the factors causing fatigue at the source. If elimination not reasonably practicable, the fatigue must be minimized. What is reasonably practicable to do to manage the fatigue will vary depending on the type of industry, the structure of an organization as well as the person carrying out the work. In addition, there are new technologies, which has been put in place to assist in the construction process and improve the productivity and quality of the products of the construction industry. The final empirical review was made on the following:

- i. Ulises D. Techera (2017) on Measuring and Managing Construction Worker Fatigue.
- ii. Occupational medicine (Oxford, England 2015) on influence of fatigue on construction Workers' physical and cognitive function.
- iii. Nick Fox (2019) research on Identifying and Reducing Worker Fatigue in Construction
- iv. A National Safety Council (NSC) study on fatigue concluded that 100 percent of construction workers.

With respect to the literature review, even though there is an abundant body of literature addressing the relationship between general fatigue and mood changes, there is no

significant research that investigates the effects of workers fatigue on quality of workmanship and productivity in Ghana specifically project site in the Oti region. The figure 2.1 shows proposed conceptual framework on effects of worker fatigue on quality of workmanship and productivity. The framework first looks at the effects of fatigue such as sleep deprivation, muscular exertion, cognitive degradation, and illnesses. The effect of fatigue affects the work output in terms of quality of workmanship. To enhance the performance of construction workers, effective management of fatigue is needed through eliminating causative factors of fatigue such as shift work, technology and improving work environment.



**Figure 2.1: Summary of Chapter 2 (Source: Author, 2022)**

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3.1 Introduction**

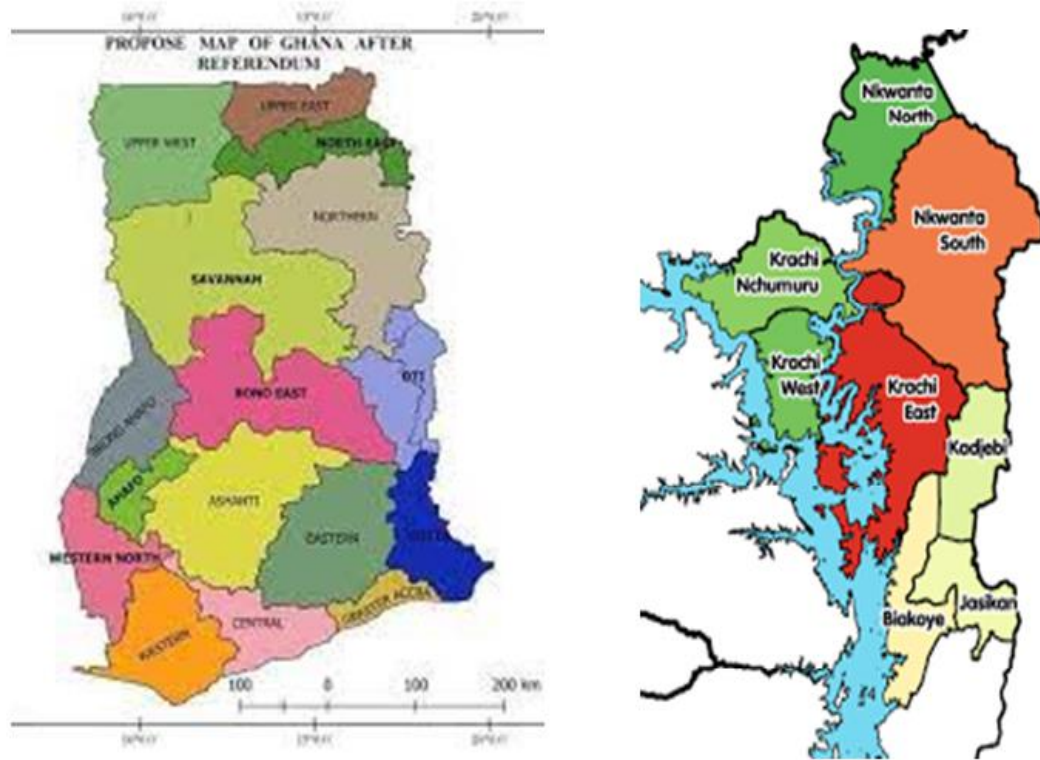
The research approach used to attain the study's goal and objectives was detailed in this chapter. The study approach or philosophical assumptions, research design, types and sources of data, sample methods, data collection procedures, and data management and analysis were all covered in detail in this chapter. It also includes thorough descriptions of the methodologies utilized and how they were appropriate for the research.

#### **3.2 Choice of the Study Area**

The selected region of the research location was Oti Region. The Oti Region is one of the six created regions of Ghana in December 2018. The region was carved out of the northern part of the Volta Region where the fulfillment of a campaign promise made by New Patriotic Party. Prior to the 2016 Ghanaian general election, the then candidate Nana Akufo-Addo declared that when elected, he would explore the possibility of creating new regions out of some of the existing regions in Ghana in order to bring government closer to citizens. The execution of plans for the creation of the regions was seeded to the newly created Ministry of Regional Reorganization and Development, which is under the leadership of Hon. Dan Botwe. Government of Ghana ministry charged with the responsibility of supervising the creation of new regions in Ghana. In March 2017, the ministry sent the blueprint for the creation of the region along with others to the Council of State. The final stage for the creation of the region was decided through a referendum by the people within the catchment area of the new region. A referendum on 27 December 2018 approved the creation of Oti Region. On

Election Day, 323,708 out of 366,481 (88.33% voter turnout) registered voters cast their votes.

A total of 319,296 (98.64 per cent) voted Yes and 2,878 voted No (0.89 per cent) while the number of rejected ballots was 951 (0.24 per cent). The political administration of the region is through the local government system. Under this administration system, the region is divided into eight MMDA's (made up of 0 Metropolitan, 2 Municipal and 6 Ordinary Assemblies). Each District, Municipal or Metropolitan Assembly, is administered by a Chief Executive, representing the central government but deriving authority from an Assembly headed by a presiding member elected from among the members themselves. The Oti Region is bordered on the north by the Northern region, to the south by the Volta Region, and to the west by the Volta Lake. It has nine districts. The Oti Region is much drier than the rest of the southern areas of Ghana, due to its proximity to the north. The vegetation consists of mostly of grassland, especially savanna with clusters of drought-resistant trees such as baobabs or acacias. Between December and April is the dry season. The wet season is between about May and November with an average annual rainfall of 750 to 1050 mm (30 to 40 inches). The highest temperatures are reached at the end of the dry season, the lowest in December and January. However, the hot Harmattan wind from the Sahara blows frequently between December and the beginning of February. The temperatures can vary between 14 °C (59 °F) at night and 40 °C (104 °F) during the day.



**Figure 3. 1: The Map of Oti Region**

### **3.3 Philosophical Assumptions of the Study (Research Paradigm)**

In conducting research study, it is prudent to consider the philosophical assumptions or paradigm that underpins the research study. A paradigm may be considered as a “set of beliefs, values and techniques which is shared by members of a scientific community, and which acts as a guide or map, dictating the kinds of problems scientists should address and the types of explanations that are acceptable to them” (Keong et al, 2023). In the world of research, there are a number of paradigms and even new paradigms have continued to evolve over time. The study adopted purely positivist paradigm and cross-sectional survey. Which was conducted through the reviewed of relevant literature and analyzed the research papers received. This was aid in the development of a structured questionnaire, which were answered by masons, carpenters, electricians, plumbers (artisans) etc., in the construction sector of Oti region.

Their responses were coded in SPSS and subsequently analyzed using mean score ranking technique. In addition, the research design is explanatory as the study seeks to assess the problems associated with the effects of fatigue on the performance of construction site workers in Ghana within Oti region and to make recommendations for enhancing the performance of construction site workers. Furthermore, the research used only primary data as a source of information for the study.

Primary data can be described as data that are gathered by the researcher because at the time of study, data was not available. According to Baiden (2006), the three main research approaches are quantitative, qualitative, and triangulation. The study was conducted using a deductive approach. Deductive approach can be explained by the means of hypotheses, which can be derived from the propositions of the theory. In other words, deductive approach is concerned with deducting conclusions from premises or propositions. There were review of existing literature on adoption of framework contracts.

The thought of various literature aimed at increasing the understanding of the problems associated with the effects of fatigue on the performance of construction site workers in Ghana within Oti region and to make recommendations for enhancing the performance of construction site workers. A survey was conducted utilizing a questionnaire based on the literature study findings to collect primary data for analysis. Data collected were processed before descriptive statistical tools were used for the analysis. From the analysis, the findings of the study were established, after which recommendations were made.

### **3.4 Research Strategy**

Research design, according to Ghauri and Gronhaug (2010), is the overall framework for connecting a theoretical exploration study topic to relevant and realistic empirical exploration. At that time, this segment provides a structure for the study population, sampling procedure, and investigation unit. The subject of this deductive research study is to investigate the effects of workers fatigue on quality of workmanship and work output of projects in Ghana. The study's major goals were to determine the extent of the effect of workers fatigue on the quality workmanship of construction site in selected project sites in the Oti Region. In addition, to assess the influence of workers fatigue on the work output of construction site in selected project sites in the Oti region and finally, to develop strategies for minimizing the effects of workers fatigue on construction site in the Oti Region. The study allows the researcher to gather, summarize, present, and interpret data in order to gain clarity. Data was mostly gathered from primary sources in order to get first-hand information in order to answer the research study's stated goal.

The deductive research strategy was used for the study because of the study's goal. According to Kothari (2005), this design indicates study population ideologies. In addition, the strategy displays structured instances, problems, occurrences, or data relevant to living situations for a community or to express an attitude. According to Teddlie and Tashakkori (2006), cross – sectional survey design can help researchers provide data that shows the makeup and features of related groups.

### **3.5 Research Design**

According to Bryman (2009), there are six basic research design in research initiatives. These approaches include action research, case studies, surveys, experiments, ethnography, and archive analysis. Action research is research in which the researcher engages with practitioners, according to Bradburt-Huang (2010). Because of the nature of this type of research, it is frequently done as part of a project to improve a company's practices. Ethnographic research is conducted primarily with a specific group in their natural context, using data-gathering techniques such as observations and face-to-face interviews. People in their natural habitat are also studied as part of the case study research. Case studies, on the other hand, differ significantly from ethnographic research in that they are more explanatory.

The number of existing concepts, as well as the context in which they exist, are described via survey research (Bryman (2009), Bryman (2009), survey research has three distinct characteristics. To begin, survey research identifies specific characteristics of a population. Second, the study's data is gathered from people, which makes the study subjective. Finally, survey research employs a sample population from which the results can be extended to the general public. According to Bryman (2009), an experiment is a research approach that involves altering one variable to another to discover casual correlations between variables. It is ideal for projects where the variables or hypotheses are used to test a theory (Cresswell, 2009). It is perfect for addressing queries like "how" and "why." For this study, the survey research technique was the most appropriate. It was necessary to describe concepts as part of the research.

### **3.6 Research Method**

The philosophical concerns are the foundation for this research study, the researcher's path in performing this research must be charted (Bryman, 2004). The research method or technique is developed by adopting an approach to answer the study objectives. Quantitative research, according to Almalki (2016), is centered on collecting and analyzing numerical data, whereas qualitative research is relying on data obtained by the researcher from first-hand observation, interviews, questionnaires, and case studies. The quantitative research, according to Almalki (2016), is based on the measurement of quantity or amount. Numbers are part of the quantitative approach. According to Creswell et al. (2007), quantitative research is one of the first research approaches utilized by many scholars around the world.

The quantitative research method is defined as "a method for examining the relationship between variables in order to test objective ideas, which can then be monitored using devices, resulting in numerical data that can be analyzed using statistical methods" (Creswell and Garrett, 2008: p330). To tackle the research problem, quantitative research takes numerical data and analyzes it using mathematically based tools. A good example of such software is the Statistical Package for the Social Sciences (SPSS). This study used a quantitative method due to the researcher's time and resource restrictions. In order to acquire more data in the limited time and resources available, the researcher utilized a quantitative approach, employing a questionnaire. The qualitative approach, according to Ormord and Leedy (2005), describes, interprets, verifies, and assesses occurrences. Qualitative research, according to Rajesakar et al. (2006), implies quality. Qualitative data collection approaches include interviews, focus groups, and observations (Creswell, 2014). The goal of the qualitative method is to learn and

understand how people perceive the world (Fellows and Liu, 2015). A mixed methods study is one in which researchers gather and analyze both quantitative and qualitative data. Mixed research technique approaches include sequential explanatory, sequential exploratory, sequential transformational, concurrent triangulation, concurrent nested, and concurrent transformative (Creswell, 2013).

### **3.7 Population of Study**

According to Jacobs (2012), a population is the larger group from which participants are selected to engage in a study endeavor. "Population" refers to a variety of subjects that you will need to consider (Yount, 2006). The target population of the study comprised construction site workers on building construction project sites. Construction site workers include; mason, carpenters, steel benders, painters, electricians, and labours employed by D1K1, D2K2, D3K3, and D4K4 building construction industries. The target population of the study was construction tradesmen in the Oti Region. The tradesmen included; masons, carpenters, electricians, plumbers, painters, and Steel benders in the construction sector within the Oti Region.

#### **3.7.1 Sampling Techniques**

The phrase "sampling techniques" refers to the process that was used to choose the sample (Bryman, 2004). A research scientist must constantly assess the best way to sample a community. The probability sampling technique and the non-probability sampling approach are the two basic sampling techniques. Due to the lack of a sample frame, the non-probability sampling technique was chosen as the most suitable. Non-probability sampling is a method of selecting a sample when determining the likelihood of selecting a sample member is impossible. The study adopted purposive sampling

technique. Site workers who had attained a minimum experience of two years and could read, understand and respond to questionnaires were selected. However, the purposive sampling techniques was selected based on the expertise, experience, knowledge relevant to research topic hence workers fatigue. Furthermore, the purposive sampling techniques allows the researcher to target and recruit participants (construction workers) who have the most relevant knowledge and experience related to fatigue, this can include workers who have experienced fatigue in their work. By targeting these individuals, the researcher can gather rich and detailed data that can provide valuable insights into the effects and prevention of fatigue among building construction workers.

### **3.8 Data Collection**

The primary data gathering strategy for this study was the questionnaire. A questionnaire, according to Kothari (2004), is a series of questions or explanations designed to collect data from respondents in order to achieve research goals. According to Naoum (2001), the questionnaire is likely the most commonly used data collection tool for directing overviews to find realities, conclusions, and perspectives. A questionnaire was used for this analysis since it boosts perceptions' dependability and replication due to the inherent normalized estimate and examining procedures.

#### **3.8.1 Primary Data**

The first form of data is primary data, which is collected by the researcher for the study. As a result, the primary data is the information gathered to help solve the research problem. Furthermore, primary data is not available when the research begins; however, the researcher collected it for the specified purpose.

### **3.8.2 Secondary Information**

The second type of data is secondary data. This type of data exists at the time of the study, and the research may use the secondary data for reanalysis. For this study, only primary data was used.

### **3.8.3 Ethical Considerations**

The following ethical considerations were made for this study:

- i. The participants of the study must not be subjected to harm.
- ii. In addition, information discovered through research should not be used to harm people. There must be a high degree of respect for the dignity of research participants.
- iii. Furthermore, full consent from research participants should be secured prior to the start of the study. According to Fisher (2007), informed consent is a significant issue in research ethics. He emphasized that everybody who is used as a source of information for study must accept and understand what they are doing and why they are doing it. There must also be complete secrecy of the study data and complete protection of the privacy of the research participants.
- iv. Anonymity of individuals and organizations involved in the research. Furthermore, communication concerning the study should be done with honesty and transparency.

### **3.8.4 Questionnaire Design**

The data collected was done with the aid of a structured questionnaire. A sample of the questionnaire is shown in the appendix of the study. The questionnaire was separated into four (4) sections.

#### **3.8.4.1 Section A: Respondent Profile**

The first component of the survey asked respondents to describe their background, including their level of experience and greatest level of education. It should be easy to determine the respondent's working profile with this information.

#### **3.8.4.2 Section B: the main effect of workers fatigue on construction site workers.**

The first objective of the study was carried out by asking respondents questions to indicate and rank the extent of the effect of workers fatigue on the quality of workmanship of construction sites workers. The following effect were considered: (a) Human Error and Injuries, (b) Worker's productivity decreases greatly (c) Ability to think clearly and respond appropriately, (d) Sleep deprivation and (e) Illnesses. In addition, (f) Mood Changes, (g) Worker has slowed reaction quality, (h) Worker has slowed reaction time, (i) Mental Exertion and (j) Muscular Exertion and decreases in strength. Finally, (k) Distraction during complex tasks, (l) Worker's commitment to safety, (m) Physical and cognitive- tiredness or exhaustion, (n) Psychological distress and (p) Poor health conditions. The rankings were to be done using a five-point scale that was interpreted as 1. Very small 2. Small 3. Moderate 4. Severe 5. Very Severe. The mean score and standard deviation were used in the analysis of responses received from respondents to determine the overall level and the main effect of workers fatigue on construction sites workers.

#### **3.8.4.3. Section C: the effects of workers fatigue on quality of workmanship.**

The second objective of the study was carried out by questioning respondents to rank and indicate the effects of workers fatigue on quality of workmanship. The following factors were considered: (a) work or activities carried out do not meet the required

standard of specification, (b) there is no requirement for rework for work or activities completed, (c) work or activities are completed within the required duration, (d) work or activities that are completed are free defects, (e) workers have the requisite skills required to carry out work or activities assigned them, (f) there is no confidence in the work or activities carried out by sites workers, (g) consultant is not satisfied with work or activities carried out. The rankings were to done using five-point likers - scale that was interpreted as 1. Strongly disagree 2. disagree 3. Neither agree nor disagree 4. agree 5. Strongly agree. The mean score and standard deviation were used in the analysis of responses received from respondents to determine the overall level and the effect of workers fatigue on quality of workmanship of construction sites workers.

#### **3.8.4.4 Section D: To Assess the Influence of Workers Fatigue on the Work**

##### **Output.**

The third objective of the study was carried out by asking respondents questions to indicate and rank the factors, which influence worker fatigue on the work output of construction sites. The following factors were considered: (a) Extended shifts or long working hours, (b) Mandatory, low reward overtime, (c) Short or adequate sleep deprivation, (d) Inadequate break for workers, (e) Physical and Mental Exertion. In addition, (f) Work Environmental Factors- high vibration, and temperature, (g) Social Environment at Workplace- Relationships with co-workers, (h) Emotional Predisposition and Distress, (i) General health condition of workers and (j) Lack of motivation of workers. Finally, (k) Poor environmental design, (l) Knowledge and skills of employee-training, (m) The age of the employee, (n) Social lifestyle-smoking and alcohol status of employee and (p) Employee taking certain medication. The rankings were to be done using a five-point scale that was interpreted as 1. Strongly Disagree 2.

Disagree 3. Neutral 4. Agree 5. Strongly agree. The mean score and standard deviation were used in the analysis of responses received from respondents to determine the overall level and the influence workers fatigue on the work output of construction site.

#### **3.8.4.5 Section F: Strategies for Minimizing the Effects of Workers Fatigue on construction sites.**

The fourth objective of the study was carried out by asking respondents questions to indicate and rank the strategies for minimizing the effects of workers fatigue on construction sites. The following strategies, which were considered: (a) Build fatigue management into the planning stages of the project, (b) Maintain regular and adequate break for employee-one hour, (c) Limit the number of consecutive shifts of night work, (d) Training workers about the safety risk of fatigue and how to identify them, (e) Require a minimum number of hours prior to reporting for the next shift after working eight or nine hours or more. In addition, (f) Implement procedure to monitor and manage fatigue risk, (g) Include fatigue in root cause investigation following on-the-job incident, (h) Provide a way for employees to anonymously report problematic work schedules, (i) Provide adequate reward and motivation for employee and (j) Working with health and safety officer, supervisor, and managers to determine the impact of work schedules and workload. Finally, (k) Reviewing workers records, as well as work systems and practices, (l) Provide adequate and ventilated environmental conditions, and (m) Consideration of age when during employment. The rankings were to be done using five-point likers - scale that was interpreted as 1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree. The mean score and standard deviation were used in the analysis of responses received from respondents to determine the overall level and strategies for minimizing the effects of workers fatigue of construction site.

### 3.9 Data Analysis and Statistical Techniques

Data analysis is a valuable stage to transfer the questionnaire into reliable information and determine the collected data to achieve the research objective (Umair et al., 2015). Data analysis focuses on the relationships between the variables. The data were coded with the help of the statistical package for the social sciences (SPSS) computer software. Of analysis were descriptive statistics and mean score ranking. The positioning files were created utilizing a Relative Importance Index (RII) produced for all Likert-type questions. This was received in light of the fact that Adnan et al. (2006) affirmed that to dissect information on an ordinal scale (for example, Likert scale 1–5), the use of the Importance Index is likewise appropriate. The RII was determined by increasing the individual frequencies by comparing estimations of reactions under each appraisal of 1–5 and partitioning the whole by the result of the all-out number of respondents and 5, which is the most noteworthy figure on the five-point Likert scale.

$$RII = \frac{1y_1 + 2y_2 + 3y_3 + 4y_4 + 5y_5}{5n}$$

Where  $y_1$ ,  $y_2$ ,  $y_3$ ,  $y_4$ , and  $y_5$  are the corresponding number of respondents who choose factors under each rating of 1-5 and  $n$ = the total number of respondents

The mean scores were

Calculated based on the formula  $M = \frac{\sum s}{n}$  (Cheung and Chan, 2011).

Where "M" = mean score,

"s" = the respondents' score based on a five-point Likert scale, and

"n" = the total number of respondents.

The discussion of the results was done with the aid of tables and text. The variable with the highest mean was deemed the most significant. However, in some cases where the means were equal, the standard deviations separated them. Thus, the lowest standard deviation variable was deemed the most significant, as it possesses the lowest variability.

## **CHAPTER FOUR**

### **DATA PRESENTATION AND ANALYSIS**

#### **4.1 Introduction**

This chapter consists of the data collected as part of the research and the analysis of the data by the researcher. This section also served to present, analyzed, and thoroughly discuss the results of the quantitative data collected in order to answer the survey questions and achieve the objectives of the survey. Descriptive statistics, inferential statistics, and hypothesis testing results were displayed based on the data collected by the survey. The chapter started with an analysis of background information and ended with the determination of labour productivity measures for key activities in the masonry, concrete, painting, carpentry, and roofing trades.

#### **4.2 Response Rate**

Assessing the demographics of respondents in data collection surveys is important to ensure the validity and reliability of results to draw valid conclusions and generalize (Cresswell, 2009). It also helped establish the credibility and reliability of the data collected (Hair et al., 2010; Dainty, 2008; Bryman, 2009). Out of a total of 280 questionnaires distributed to construction site workers, 170 were completed and returned. The study therefore achieved a response rate of 61%. Therefore, it can be said that the recorded response rate is high and sufficient for statistical analysis. The high response rate was the result of continuous follow-up by telephone, and in-person visits to the respondents.

#### **4.3 Analysis of the Biographic Data**

To gain a thorough understanding of the nature of the data, descriptive statistics in the form of frequency distribution and percentages were used to analyze the demographic

data. This was to help provide an understanding of the profile of the respondents for the study and that their level of expertise and experience was suitable according to credence to their responses and the overall research findings. This was very useful in enhancing the reliability and credibility of the responses and results in a survey (Bryman, 2009). The part of the questionnaire assessing the background information had five questions that related to workers in the construction industry, educational background and qualification, the composition of the project team and the management system. In addition, the years of experience of the construction project management, particularly years of worker's experience and related education in construction were increasingly suggested as important indications defining the expertise and experience. The summary of the results of the background data is presented in Table 4.1.

**Table 4. 1: Respondents' Professional Background, Qualification and Experience and Ministry of Water Resources, Works & Housing classification.**

<b>Area of Specialization</b>	<b>Frequency (n = 170)</b>
Mason	65
Carpenter	37
Steel bender	35
Electrician	33
<b>Experience in the construction industry</b>	
2- 5 years	46
6 – 10 years	56
11 – 15 years'	38
Above 16 years	30
<b>Highest Academic Qualification</b>	
BECE	43
NVITI	64
Intermediate	34
Advance	29
<b>Ministry of Water Resources, Works</b>	
D1K1	49
D2K2	59
D3K3	35
D4K4	27

*Source: Field survey, 2022*

#### **4.3.1 Respondents' Area of Specialization**

From the total of 170 responses realized at the close of the survey, artisans who were on construction project were Masons 65. From Table 4.1 above, Carpenters 33, steel benders 35. Similarly, 33 of the respondents were electricians. The result on the area of specialization of the respondents said to give a fair reflection and representation of workers who understands the effects of workers fatigue on, quality performance of projects in Oti and most especially workers in Ghana. Hence, this was an indication that the perceptions given by the workers on the variables in the study were more likely to be balanced across the various areas of specialization.

#### **4.3.2 Respondents Experience in the construction industry**

Besides, from Table 4.1, the experience of the workers partaking in the survey showed (46 persons) had Less than 5 years of experience in the construction industry. A total of 56 persons have had between 5 – 10 years of experience. Workers having between 11-15 years of experience were 38, (30) had between Above 16 years of experience. A critical examination of the banded breakdown of the background experience of the respondents (majority) have at least six years of experience in construction project delivery around Oti region. In mainstream human resource management practice as well as drawing on the practical perspective of management practice and employment in Ghana, a minimum of six year of experience is considered adequate for senior worker's position whilst having ten years and above is suitable for executing work. Drawing on this, a plausible conclusion is that the respondents are well vested in the activities of construction project delivery and are more likely to offer Valid and reliable responses in the survey.

### **4.3.3 Respondents' Highest Academic Qualification**

The educational qualification of the workers who responded to the survey as reported in Table 4.1 ranged from Basic Education Certificate Examination (BECE) to Advance Level. A total of 43, had BECE and (64 persons) out of the total respondents hold Intermediate/NVTI. In addition, workers acting as project team leaders with Advance level qualification were 34. Drawing on the practical perspective of the training and the courses of the various workers in the construction industry in Ghana, it was deduced from the results that, almost all workers have had BECE education with a greater proportion (127) having a minimum of Advance. The likely antecedent of this is that the educational background of the worker were considered adequate and more likely to understand and give accurate interpretations to the variables and thus offer correct and consistent responses.

### **4.3.4 Distribution of Classification of Respondents' Companies**

The financial classification of the organization according to the Ministry of Works and Housing's contractor registration was the last study of the respondent's profile. In accordance with the Table 4.1 59 of the workers work with an organization with the classification of D2K2, while 49 workers fall under D1K1.

Finally, 35 of the respondents fall under D3K3, and 27 workers respectively falls under D4K4. The likely antecedent of this was that the financial classification D2K2 of the respondents of the project team were considered adequate and more likely to understand and give accurate interpretations to the variables and thus offer correct and consistent responses. The results from the descriptive statistics indicate and demonstrate that, the respondents indeed have sufficient level of expertise and experience which is suitable in according to credence to their responses on the variables and hence the overall

research findings. Consequently, the respondents who also constitute the category of participants needed for the study, were very active in construction project delivery and were more likely to offer credible responses in the data gathered.

#### **4.4. Effects of Workers' Fatigue on Construction sites workers**

This section assessed the effects of building construction workers fatigue on workers. Table 4.2 presents the observed effects of workers' fatigue on construction project sites. Fifteen observed variables were considered as the main indicators of workers' fatigue. Fatigue can adversely have effect on the productivity of labour on construction project sites. Literature suggested that fatigue reduces alertness, which may lead to errors and an increase in incidents and injuries. The analysis was to evaluate the effects of fatigue on workers, using a Likert scale of 1 to 5 where; 1 represents very small effect, 2 represents small effect, 3 represents moderate effect, 4 represents severe effect, and 5 very severe effect. Since a mean score of 2 may be construed as moderate effect and 3 severe effects, arguably a mean score of 3 or greater may be appropriately construed as having an effect. Accordingly, the researcher considered cut off mean of 3 of any of the observed effects of fatigue as being significant. The component of the survey asked respondents to indicate their level of severity on effects of fatigue on the construction project using a five-point Likert scale.

The data was analyzed using the mean, standard deviation statistics, regression analysis and variance. The researcher determined that a score of 3.00 is acceptable according to the study if the mean value is greater than or equal to 3.00 shows the severity of the that factor. A low standard deviation means the data points were close to the mean, while a high standard deviation means the data points were spread out over a wide range of

values. The results were presented in the Table 4.2 descriptive statistics on effect of workers' fatigue.

The Table 4.2 shows the results of the descriptive analysis as well as the results of another relevant statistical test. The mean scores and the standard deviation values of all the respondents' responses on effect of workers' fatigue on the building construction sites, ranges from 2.50 to 3.21 and .234 to .743 respectively. Nevertheless, the mean scores and the standard deviation values of all the effect of workers' fatigue on the construction project were much higher than 3.00 and .234 respectively. However, all the identified factors can be regarded as effects on workers' fatigue of construction project considering their mean and standard deviation values. From the mean and standard deviation results, the first five effect of worker's fatigue (mean  $\geq 3.00$ ) which are 'mood Changes', 'worker has slowed reaction time', 'Illnesses', 'poor health conditions' and 'psychological distress'. The results indicate that, these effects of worker fatigue were considered the most severe effect of workers fatigue at building construction sites in Ghana and therefore should draw the policy makers', stakeholders, and advocated attention.

The results indicated that, mood changes were rank first according to table 4.2 with the mean value of (3.21), implies that, it has severed influence on the building construction sites workers which led to the poor-quality performance of the construction project around the said project location. The respondents regard mood changes as significant effect of workers fatigues. However, mood change may occur because of 'illness' and thus led to 'workers having slowed reaction time'. Illnesses shows significant long-term impacts on the human body and causes mental exertion.

Mental exertion is the sustained cognitive activity that requires extraordinary mental effort, which causes mental fatigue, and reduce activeness of the construction workers and end up affecting performance of the project. Nevertheless, workers have slowed reaction to time was rank second and illness was also rank third with the mean score (3.19) and (3.18) respectively which indicate it severity on the construction workers. The result further revealed that, 'poor health conditions' which was rank fourth with the mean score of (3.14). The rank and the mean score show the severity of this effect of workers fatigue on performance of the site workers.

Poor health conditions which lead to inability to perform physically, mentally or socially of what is required from a person. However, poor health conditions which is cause by illness and led to 'psychological distress' rank fifth with mean score of 3.12. Psychological distress had high mean value, which shows severity on the construction workers on project site. Psychological distress refers to nonspecific symptoms such as stress, anxiety, and depression. High levels of psychological distress indicate a mental health disorder and may reflect common mental disorders such as depression and anxiety disorders, therefore construction professional, stakeholders, and contractors to be attentive to the first fives effect of workers fatigues in order to have good performance from workers.

In addition, 'mental exertion' (mean=2.94) which was rank sixth has been regarded as one of the effect of workers fatigue which affect performance of the construction workers. Mental exertion is the sustained cognitive activity that requires extraordinary mental effort, which causes mental fatigue, and reduce activeness of the construction workers and end up affecting performance of the project. 'Distraction during complex

tasks' (mean=2.90) was rank seventh, which implies that, the effect of worker's fatigue can cause distraction during complex tasks which can affect the time performance of the project. Nevertheless, physical and cognitive- tiredness or exhaustion' (mean=2.86) which was rank eighth thus, causes delays in construction project delivery within the enclaves of Oti region.

More so, 'muscular exertion and decreases in strength' (mean=2.82) and worker's commitment to safety, (mean=2.78) they were rank ninth and tenth which means that, construction workers are often subjected to undue physical tension from repeated lifting and handling of materials as they perform their work. As a result, many construction workers experience significant muscle fatigue, which can negatively affect project performance. Therefore, assessing the level of muscle fatigue before work and implementing appropriate interventions to reduce physical stress can prevent worker fatigue from adversely affecting construction work.

The final five effect of workers fatigue which affect performance of any construction workers were position eleventh to fifteenth but all the five - effects had significant mean value which cannot be overlook. The mean values were (2.74, 2.70, 2.60, 2.55 and 2.50) respectively. Sleep deprivation has been shown to cause muscle protein breakdown, which is thought to be the underlying mechanism of weaken and impaired regeneration of the catalyzed rat tibia is frontal muscle.

However, sleep deprivation lead to 'worker slowed reaction quality' which result in ability to think clearly and respond appropriately' and 'worker's productivity decreases greatly as well as human error and injuries. Human error due to worker's fatigue reduces the productivity of the construction workers, which result in injuries and affect

time performance of the project. Therefore, all the above effect of worker's fatigue led to reduce workmanship of the construction workers. However, attention given to above effect and proper ways to address those effects will result of workers. The table below shows effect of workers fatigue of building construction sites.

**Table 4.2: Descriptive statistics effects of workers fatigue on construction sites**

**workers.**

<b>Effect of Workers' Fatigue</b>	<b>Mean</b>	<b>Std. Dev</b>	<b>Variance</b>	<b>Ranking</b>
Mood Changes	3.21	.234	1.832	1 <sup>st</sup>
Worker has slowed reaction time	3.19	.245	1.779	2 <sup>nd</sup>
Illnesses	3.18	.246	1.778	3 <sup>rd</sup>
Poor health conditions	3.14	.255	1.763	4 <sup>th</sup>
Psychological distress	3.12	.283	1.754	5 <sup>th</sup>
Mental Exertion	2.94	.333	1.716	6 <sup>th</sup>
Distraction during complex tasks	2.90	.373	1.666	7 <sup>th</sup>
Physical and cognitive- tiredness or exhaustion	2.86	.433	1.663	8 <sup>th</sup>
Muscular Exertion and decreases in strength	2.82	.303	1.629	9 <sup>th</sup>
Worker's commitment to safety	2.78	.493	1.499	10 <sup>th</sup>
Sleep deprivation	2.74	.543	1.496	11 <sup>th</sup>
Worker has slowed reaction quality	2.70	.593	1.392	12 <sup>th</sup>
Ability to think clearly and respond appropriately	2.60	.643	1.277	13 <sup>th</sup>
Worker's productivity decreases greatly	2.55	.693	1.074	14 <sup>th</sup>
Human Error and Injuries	2.50	.743	1.015	15 <sup>th</sup>

**Source: Field survey, 2022**

#### **4.5. Effect of Fatigue on Quality of Workmanship**

Descriptive statistical analysis was first run to ascertain or assessed the level of quality of workmanship on the construction project sites studied. The respondents were asked to rate observed variables that indicate the quality of workmanship on a scale of 1 to 5 where strongly disagree represents 1, disagree represents 2, neither agree nor disagree

represents 3, agree represents 4, and strongly agree represents 5. A cut off mean score of 3.0 was used for agreement on each of the variables. An aggregate score was also obtained as indicator of the overall level of quality of workmanship thought by the respondent of the project considered. This overall score represented the value of the dependent variable (quality of workmanship) for subsequent regression analysis. Table 4.6 presents the results of the descriptive statistical analysis to assess the level of quality of workmanship.

From the Table 4.6, it shows that, 'Consultants were satisfied with work or activities carried out', and 'workers have the requisite skills required to carry out work assigned them (mean=3.88) can have great impact on the quality of workmanship of the project. The commitment from the consultants and workers with requisite skills to carry out work can really influence the quality of the workmanship, for that reason, the respondents ranked consultant and workers' first with the highest mean value of (=3.88). The mean value shows the level of severity impact on the project quality.

'Work that were completed were free of defects' also ranked third with the mean value of (3.74) and 'There was no requirement for rework for work or activities completed' was ranked fourth with mean value (=3.72). According to the respondents, work completed are free from defects and were seen as very severe effect on the quality of the project and makes it free from rework. The respondents indicated that, the quality of workmanship by the workers on any project raises the confidence level of the site workers.

Thus rank 'There were confidence in the work carried out by site workers' ranked fifth with the mean value of (3.60) and 'Work or activities are completed within the required

duration' was also ranked sixth with the mean value of (3.58). The two factors had both high mean value and greater than the expectation, which shows the extent of its severances to the quality of workmanship by the site workers. Finally, 'activities carried out meet the required standard of specification' was ranked seventh but very severe due to the mean value (3.40) according to the result from the figure.

The regression data presented in Table 4.7 below indicated that, adequate working condition, adequate break for workers promote quality of good workmanship on construction project site such that, activities carried out meet the required standard of specification and workers have the requisite skills required to carry out activities assigned them. Furthermore, there is no requirement for rework for activities completed. Hence, activities were completed within the required duration and work or activities that are completed were free of defects. Nevertheless, the results also indicated that, effect of fatigue influence the quality of workmanship on the construction project site. The activities carried out on site do not meet the required standard of specification and operatives' requisite skills required to carry out activities assigned them was also affected by the fatigue which end up affecting the quality of work. Finally, there was confidence in the activities carried out by site workers were also indicated significant predictors for the dependent variable known as consultant, was satisfied with activities carried out in the analysis. Nevertheless, the dependency was significant and influential correlations between the independent variables. The severer correlation occurred between consultants was being satisfied with activities carried out in the construction project (1.000) and activities carried out meet the required standard of specification (0.741).

**Table 4.3: Effects of Fatigue on Quality of Workmanship**

<b>Effect of Fatigue on Quality of Workmanship</b>	<b>Mean</b>	<b>Std. Dev</b>	<b>Variance</b>	<b>Ranking</b>
Consultant is satisfied with work or activities carried out	3.88	1.415	1.294	1 <sup>st</sup>
Workers have the requisite skills required to carry out work or activities assigned them.	3.88	1.414	1.292	1 <sup>st</sup>
Work or activities that are completed are free of defects	3.74	1.375	1.176	3 <sup>rd</sup>
There is no requirement for rework for work or activities completed.	3.72	1.368	1.156	4 <sup>th</sup>
There is confidence in the work or activities carried out by site operatives.	3.60	1.365	1.147	5 <sup>th</sup>
Work or activities are completed within the required duration.	3.58	1.248	.817	6 <sup>th</sup>
Work or activities carried out meet the required standard of specification.	3.40	1.209	.713	7 <sup>th</sup>

**Source: Field survey, 2022**

**Table 4.4: Effects of Fatigue on Quality of Workmanship**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	1.149	.163		6.201	.000	.803	.594
Workers have the requisite skills required to carry out work or activities assigned them.	.390	.085	.457	4.171	.000	.201	.579
Work or activities that are completed are free of defects	.127	.172	.194	1.043	.118	-.127	.490
There is no requirement for rework for work or activities completed.	-1.771E-014	.202	.000	.000	1.000	-.322	.322
There is confidence in the work or activities carried out by site operatives.	.256	.163	.412	1.058	.033	.011	.600
Work or activities are completed within the required duration.	.100	.159	.133	.498	.452	-.136	.338
Work or activities carried out meet the required standard of specification.	-.321	.149	-.505	-1.656	.010	-.637	-.103

**Table 4. 5: Model Summary**

Model	R	R Square	Adjusted Square	RStd. Error of the Estimate	Change Statistics					Durbin Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.833 <sup>a</sup>	.770	.760	.267	.770	75.694	5	76	.000	.450

#### **4.6 To Determine the Effect of Workers Fatigue on workers Output.**

The main purpose of this analysis was to know the severity of effect of workers fatigue on the output of construction site workers. Table 4.3 below presents the regression analysis of the independent variables (effects of fatigue) on the dependent variable (workers' output).

From the regression description analysis presented above, Worker has slowed reaction time, psychological distress and Illnesses as significant effect on the workers' output. However, Human Error and Injuries, Mental Exertion, Worker has slowed reaction on quality whiles Worker's productivity decreases greatly, all were effects of fatigue on the construction site workers.

Furthermore, Muscular Exertion and decreases in strength, Poor health conditions, Physical and cognitive- tiredness or exhaustion, Distraction during complex tasks and Worker's commitment to safety were also effects of fatigue on construction workers in Oti region. Finally, Ability to think clearly and respond appropriately, Sleep deprivation were significant predictors for the dependent variables (mood changes), namely the mood changes in the analysis. However, the dependency was significant and powerful correlations between the independent variables. The most influential correlation occurred between mood changes (1.000) and psychological distress (0.801).

**Table 4.6: Effects of Fatigue on Workers' Output**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	.255	.135		8.148	.000	.881	.528
Worker has slowed reaction time	.265	.074	.320	3.770	.000	.112	.417
Illnesses	.327	.142	.461	1.963	.004	.130	.615
Poor health conditions	1.257E-014	.161	.000	.000	1.000	-.225	.225
Psychological distress	.209	.135	.352	1.262	.027	.035	.482
Mental Exertion	-.155	.151	-.265	-1.659	.101	-.461	.049
Distraction during complex tasks	1.112E-013	.208	.000	.000	1.000	-.319	.319
1 Physical and cognitive- tiredness or exhaustion	-.073	.210	-.120	-.291	.597	-.406	.240
Muscular Exertion and decreases in strength	2.532E-014	.180	.000	.000	1.000	-.263	.263
Worker's commitment to safety	.125	.212	.190	.497	.453	-.199	.453
Sleep deprivation	3.348E-014	.242	.000	.000	1.000	-.387	.387
Worker has slowed reaction quality	-1.110E-013	.264	.000	.000	1.000	-.430	.430
Ability to think clearly and respond appropriately	.055	.213	.097	.201	.664	-.264	.393
Worker's productivity decreases greatly	-.166	.131	-.276	-1.320	.180	-.341	.079
Human Error and Injuries	-.049	.105	-.091	-.454	.482	-.171	.144

**Table 4.7: Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.864 <sup>a</sup>	.829	.815	.182	.829	54.839	13	68	.000

**Source: Field survey, 2022**

#### **4.7 Strategies for Minimizing the Effects of Fatigue**

This section of the analysis was to analyze strategies for minimizing the effects of fatigue on construction site. After the analysis, the result was presented on a Table 4.9 Minimizing the effects of workers' fatigue. From the Table 4.9, it was realized from the respondents that, to minimize the effect of fatigue on construction site was by 'Working with health and safety officer, supervisor and managers to determine the impact of work schedules and workloads' and 'Provide adequate and ventilated environmental conditions. These two strategies were rank first with the highest mean value (3.89). This means the respondents has high expectation and agreed that, working with good safety officer and supervisor to determine work schedules and workloads would minimize the effect of fatigue on the construction site. Not only on working with safety or supervisor but providing adequate and ventilated environmental condition would help to minimize the effects of fatigue on building construction sites. However, the respondents also agreed that on-the-job incident investigation should include fatigue, which is the root cause of any incident on site. This was ranked third with the high mean value (3.56), which indicated the severity or the impact on site. Another strategy which minimize the effect of workers fatigue was by 'Providing adequate reward and motivation for employee' and by 'Providing a way for employees to anonymously report problematic work schedules' according to the respondents. High motivation can serve to ameliorate the effects of fatigue. Aside that, the workers should be giving an opportunity for anonymously report problematic work schedules in order to minimize the effect of workers fatigue on site. The analysis also indicated that 'Implementing procedure to monitor and manage fatigue risk' could also minimize the effect on workers fatigue on site. Irrespective of the position of this strategy rank sixth with the mean value (3.00)

was high which show the seriousness of the strategy, how it can minimize the effect of workers' fatigue. The respondents agreed that every worker require a minimum number of hours prior to reporting for the next shift after working eight or nine hours or more', to enable the worker to prepare for the next shift. This was rank seventh with the mean value (2.99). Further, the analysis result indicated that, 'Reviewing workers records, as well as work systems and practices', Training workers about the safety risk of fatigue and Consideration of age during employment minimized the effect of workers fatigue on construction site. The eighth, ninth and tenth with the mean value (2.98), (2.96) and (2.95) respectively.

Finally, the respondents agreed that, limiting the number of consecutive shifts for night work, maintaining regular and adequate break for employee one hour and building fatigue management into the planning stages of the project tends to minimize the effect of workers fatigue on construction site. Looking at the mean value for each of them, (2.80), (2.73) and (2.54) show the severity of these strategies on project site. Ensuring and practicing of these, strategies go a long way to minimize the effect of workers fatigue on construction worker on site.

**Table 4.8: Strategies for Minimizing the Effects of Workers Fatigue**

<b>Strategies for Minimizing Effects of Workers Fatigue</b>	<b>Mean</b>	<b>Std. Dev</b>	<b>Variance</b>	<b>Ranking</b>
Working with health and safety officer, supervisor, and managers to determine the impact of work schedules and workloads	3.89	1.493	1.539	1 <sup>st</sup>
Provide adequate and ventilated environmental conditions	3.89	1.489	1.525	1 <sup>st</sup>
Include fatigue in root cause investigation following on-the-job incident	3.56	1.468	1.457	3rd
Provide adequate reward and motivation for employee	3.02	1.46	1.434	4th
Provide a way for employees to anonymously report problematic work schedules	3.02	1.452	1.409	4th
Implement procedure to monitor and manage fatigue risk	3.00	1.448	1.397	6th
Require a minimum number of hours prior to reporting for the next shift after working eight or nine hours or more	2.99	1.444	1.383	7th
Reviewing workers records, as well as work systems and practices	2.98	1.443	1.38	8th
Training workers about the safety risk of fatigue and how to identify them	2.96	1.424	1.324	9th
Consideration of age when during employment	2.95	1.387	1.212	10th
Limit the number of consecutive shifts of night work	2.80	1.372	1.168	11th
Maintain regular and adequate break for employee-one hour	2.73	1.367	1.153	12th
Build fatigue management into the planning stages of the project	2.54	1.36	1.131	13th

**Source: Field survey, 2022**

#### **4.8 Measurement of Labour Productivity of Key Activities on Construction Site**

Over the past decade, construction productivity has steadily declined due to the lack of a standardized productivity database system. The purpose of this section was to

examine the work techniques used to determine the workload of masonry, concreting, roofing, carpentry, and painting work on construction sites. This section of the study assessed to measure the labour productivity of key activities on the construction site. The measurement was based on the following, masonry, concreting, painting, carpentry, and roofing with respect to gang size and output per the area worked on. The measurement of labour productivity used percentage and frequency with respect to its area of work and the output per man-day.

The measurement of labour productivity analysis was basically based on work measurement of the labour force according to the respondents. The assessment was based on number of gangs, area work on and output, which was group under skilled and non-skilled with respect to the following work activity (Masonry, Concreting, Painting, Carpentry and Roofing). Table 4.5 revealed that, 2 Masons to 2 Labourers for masonry work constituting 23% within 45 m<sup>2</sup> wall, 3 Masons to 2 Labourers had 29.4% within 45 m<sup>2</sup> wall, and 4 Masons to 2 Labourers had 17.6%, for masonry work within area of 45 m<sup>2</sup> wall. Finally, 5 Masons to 3 Labourers constituting 13.5% within area of 45-m<sup>2</sup> wall and 6 Masons to 3 Labourers had 16.5% within area of 45 m<sup>2</sup> wall with more resources used but completed before time. However, most of the respondents agreed that, to get a good output of work needs 3 Masons to 2 Labourers to complete the project on time for masonry work.

The respondents agreed that, for concreting work activity needs a Mason to 12 Labourers to complete the project before or on time and this made of (55 respondents) constituting 32.4% with concrete volume of 45m<sup>3</sup>. Other respondents were of the view that a Mason to 10 Labourers can be used for concreting which constitute 15.3% of

45m<sup>3</sup>, 42 respondents indicated that concreting work can be completed on time with 2 Masons to 10 Labourers with a concrete volume of 45m<sup>3</sup>. Twenty-five (25) also indicated that, concreting work can be completed before time with 2 Masons to 12 Labourers which made up of 14.7% and 22 respondents agreed that 2 Masons to 14 Labourers was the best option for concreting work irrespective of the scope of the design constitute 12.9% with concrete volume of 45m<sup>3</sup> but with more resources used but before time.

The table 4.5 revealed that, 27 respondents constituting 15.9% with two coats paint wall-30,6 m<sup>2</sup>/day, agreed that, 2 Painters to 1 Labourers was good for painting works, while 47 respondents which made up of 27.6% opt for 3 Painters to 1 Labourers for painting two coats paint wall-30,6 m<sup>2</sup>/day, and 31.2% respondents agreed on 4 Painters to 2 Labourers to paint wall-30,6 m<sup>2</sup>/day. Finally, 13.5% agreed on 5 Painters to 2 Labourers and 11.8% of the respondents opt for 6 Painters to 2 Labourers for painting work of two coats paint wall-30,6 m<sup>2</sup>/day. However, majority of the respondents were of the view that, to meet the deadline and good output for any painting project needs 4 Painters to 2 Labourers.

According to the table 4.5, majority of 58 respondents opt for 3 Carpenters to 1 Labourers which constitute 34.1% for any good output for carpentry rough formwork 22,5m<sup>2</sup>/day and 21.8% of the respondents agreed on 4 Carpenters to 2 Labourers, while 17.1% of the respondents agreed on 2 Carpenters to 1 Labourers for carpentry work. In addition to these, 14.7% respondents agreed on 5 Carpenters to 2 Labourers and finally 12.3% agreed on 6 Carpenters to 2 Labourers for any carpentry rough formwork 22,5m<sup>2</sup>/day project, however, one needs more resources, but the project can be completed before time.

The analysis also indicated that, to complete roof covering with purlins 67,5m<sup>2</sup>/day project before time needs 5 Carpenters to 2 Labourers according to 58 respondents made up of 34.1%, while 37 respondents agreed on 4 Carpenters to 2 Labourers for roofing work made of 21.8% to complete the project on time. More so, 17.6% of the respondents opt for 6 Carpenters to 3 Labourers for roofing work of roof covering with purlins 67,5m<sup>2</sup>/day. Aside these percentages, 25 respondents constitute 14.7% and 11.8% of the respondent agreed on 3 Carpenters to 2 Labourers and 7 Carpenters to 3 Labourers roof covering with purlins 67,5m<sup>2</sup>/day for roofing project. Thus, the general finding that firm labour productivity was directly related to the influence of number of gang's variables in predicting total labour productivity in the construction industry of developing countries is supported by masonry, concreting, painting, roofing, and carpentry work as a case study.

**Table 4.9: Measurement of Labour Performances**

<b>Masonry Work Activity</b>	<b>Frequency (n= 170)</b>	<b>Percentage</b>	<b>Area of Work</b>	<b>Output</b>
2 Masons to 2 Labourers	39	23%	Wall-45 m <sup>2</sup>	More days used
3 Masons to 2 Labourers	50	29.4%	Wall-45 m <sup>2</sup>	Completed on time
4 Masons to 2 Labourers	30	17.6%	Wall-45 m <sup>2</sup>	Completed before time
5 Masons to 3 Labourers	23	13.5%	Wall-45 m <sup>2</sup>	Completed before time
6 Masons to 3 Labourers	28	16.5%	Wall-45 m <sup>2</sup>	More resources used but before time
<b>Concreting Work</b>				
Mason to 10 Labourers	26	15.3%	45m <sup>3</sup>	More days used
Mason to 12 Labourers	55	32.4%	45m <sup>3</sup>	Completed before time
2 Masons to 10 Labourers	42	24.7%	45m <sup>3</sup>	Completed on time
2 Masons to 12 Labourers	25	14.7%	45m <sup>3</sup>	Completed before time
2 Masons to 14 Labourers	22	12.9%	45m <sup>3</sup>	More resources used but before time
<b>Painting Work Activity</b>				
2 Painters to 1 Labourers	27	15.9%	Two coats paint wall-30,6 m <sup>2</sup> /day	Target was not achieved
3 Painters to 1 Labourers	47	27.6%	Two coats paint wall-30,6 m <sup>2</sup> /day	Completed on time
4 Painters to 2 Labourers	53	31.2%	Two coats paint wall-30,6 m <sup>2</sup> /day	Completed before time
5 Painters to 2 Labourers	23	13.5%	Two coats paint wall-30,6 m <sup>2</sup> /day	More resources used but before time
6 Painters to 2 Labourers	20	11.8%	Two coats paint wall-30,6 m <sup>2</sup> /day	More resources used but before time

<b>Carpentry Work Activity</b>				
2 Carpenters to 1 Labourers	29	17.1%	Rough formwork 22,5m <sup>2</sup> /day	Target was not achieved
3 Carpenters to 1 Labourers	58	34.1%	Rough formwork 22,5m <sup>2</sup> /day	Completed on time
4 Carpenters to 2 Labourers	37	21.8%	Rough formwork 22,5m <sup>2</sup> /day	Completed on time
5 Carpenters to 2 Labourers	25	14.7%	Rough formwork 22,5m <sup>2</sup> /day	Completed before time
6 Carpenters to 2 Labourers	21	12.3%	Rough formwork 22,5m <sup>2</sup> /day	More resources used but before time
<b>Roofing Work Activity</b>				
3 Carpenters to 2 Labourers	25	14.7%	Roof covering with purlins 67,5m <sup>2</sup> /day	Target was not achieved
4 Carpenters to 2 Labourers	37	21.8%	Roof covering with purlins 67,5m <sup>2</sup> /day	Completed on time
5 Carpenters to 2 Labourers	58	34.1%	Roof covering with purlins 67,5m <sup>2</sup> /day	Completed before time
6 Carpenters to 3 Labourers	30	17.6%	Roof covering with purlins 67,5m <sup>2</sup> /day	More resources used but before time
7 Carpenters to 3 Labourers	20	11.8%	Roof covering with purlins 67,5m <sup>2</sup> /day	More resources used but before time

**Source: Field survey, 202**

## **CHAPTER FIVE**

### **DISCUSSION OF RESULTS**

#### **5.1 Introduction**

This chapter discussed, analyzed, and interpreted the findings according to the respondents. It also explained the significance of the results and tie everything back to the research questions. The chapter is organized into four main sections namely; effects of fatigue on building construction projects sites, extent of the effect of workers fatigue on the quality of workmanship, influence of workers fatigue on the work output, and strategies for minimizing the effects of fatigue.

#### **5.2 Main effects of workers' fatigue on selected construction projects sites in the Oti Region**

The findings show that these effects of worker fatigue were thought to be the most severe effects of worker fatigue at the construction project site in Ghana's Oti area, and as a result, they should be brought to the attention of policy makers, stakeholders, and advocates. The results indicated that, mood changes were rank first according to table 4.2 with the highest mean score, which implies that, it has severed influence on the workmanship on the project which affect quality performance of the construction workers around the said project location.

Literature suggests that exhaustion causes severe mood shifts that might alter emotional stability, heighten anxiety, and ultimately result in long-term depression (Harrison and Horne 2000; Sagaspe et al. 2006; Scott et al. 2006; Boonstra et al. 2007. Kajtna et al. 2011). Additionally, it has been demonstrated that bad mood or emotional state impairs

sophisticated cognitive function and distorts risk perception (Tixier et al. 2014). The respondents regard mood changes as significant effect of fatigue of quality workmanship and project performance were concern. However, mood change may occur because of 'illness' and thus led to 'workers having slowed reaction to time'. Illnesses shows significant long-term impacts on the human body and causes mental exertion. Mental exertion is sustained cognitive activity that requires extraordinary mental effort, which causes mental fatigue, and reduces activeness in the construction worker and end up affecting the time performance of the project. Nevertheless, workers slowed reaction to time was rank second and illness was rank third, which indicated severity on the construction workers. The result further revealed that, 'poor health conditions' which was rank fourth to shows the severity of the effect of workers fatigue on quality performance of the site workers. Poor health conditions lead to inability to perform physically, mentally, or socially of what required from a person. Purely mental factors might also contribute to weariness. The primary cause of mental fatigue was mental exertion, which was defined as continuous cognitive work that demands tremendous mental effort (Lorist et al. 2005).

When people have trouble concentrating, making quick judgments, planning, and responding to stimuli, they are showing signs of mental exertion (Van der Linden et al. 2003; 2003b; Boksem et al. 2005, 2006; van der Linden and Eling 2006). Along with objective measures of mental tiredness, Lorist et al. (2005) used brain-imaging technology, such as the electro encephalogram, to evaluate mental lassitude directly and unmistakably linked mental exertion with fatigue. However, poor health conditions which is cause by illness and led to 'psychological distress' rank fifth. Psychological distress had high mean value, which shows severity on the construction workers on

project site. Psychological distress refers to nonspecific symptoms such as stress, anxiety, and depression. High levels of psychological distress indicate a mental health disorder and may reflect common mental disorders such as depression and anxiety disorders, therefore construction workers, stakeholders, and contractors to be attentive to the first five effects of workers' fatigue to have quality workmanship from the project workers. Distraction during complex tasks was ranked seventh, which implies that, the effect of worker's fatigue causes distraction during complex tasks, which affect the time performance of the project. Nevertheless, physical and cognitive- tiredness or exhaustion' which was ranked eighth thus, causes delays in construction project delivery within the enclaves of Oti region.

More so, 'muscular exertion and decreases in strength and worker's commitment to safety, they were ranked ninth and tenth which means that, construction workers are often subjected to undue physical strain from repeated lifting and handling of materials as they perform their work. As a result, many construction workers experience significant muscle fatigue, which can negatively affect project performance. Localized fatigue is mostly brought on by muscular activity, a purely physical event (Jason et al. 2010). Numerous methods have been used to study the relationship between localized muscle exhaustion and muscular effort. For instance, repetitive electrical muscular contractions (dynamic effort) or maintaining a particular muscle engaged could result in tiredness (static exertion). Therefore, assessing the level of muscle fatigue before work and implementing appropriate interventions to reduce physical stress can prevent worker fatigue from adversely affecting construction work.

The final five effects of workers' fatigue which affect quality of workmanship of any construction workers were position eleventh to fifteenth but all the five-effects had significant mean values which cannot be overlooked. Sleep deprivation, Worker has slowed reaction quality. Ability to think clearly and respond appropriately, Worker's productivity decreases greatly, Human Error, and Injuries were all effects of fatigue on construction workers. Sleep deprivation has been shown to cause muscle protein breakdown, which is thought to be the underlying mechanism of atrophy and impairs regeneration of the catalyzed rat tibialis anterior muscle. Belenky et al (2003)'s thorough analysis of the effects of various sleep schedules on fatigue was published. They investigated the effects of three different levels of sleep restriction: mild (7 hours per night), moderate (5 hours), and severe (11 hours) (3 hours or less). The outcomes were contrasted with those of the control group, which slept for 8 hours every night throughout the study.

They found that getting less than eight hours of sleep had harmful effects. Particularly, individuals who only suffered mild or moderate sleep loss displayed a decline in their mental and physical performance, which stabilized after a few days but remained below the range of performance that is considered normal. Additionally, individuals who were severely sleep deprived displayed a continual decline that did not settle even after a few days. According to various writers (Van Dongen and Dinges 2005; Lim and Dinges 2008), a single night of partial sleep deprivation results in a decline in performance that can persist several days. Belenky et al. (2003) found it interesting that there were no appreciable reductions in weariness for workers who slept for longer than 8 hours compared to the control group. However, sleep deprivation leads to 'worker has slowed reaction quality' which results in inability to think clearly and respond appropriately' and

'worker's productivity decreases greatly as well as human error and injuries. Human error due to worker's fatigue reduces the productivity of the construction workers, which result in injuries and affect time performance of the project. Therefore, all the above effect of worker's fatigue led to reduce the quality of workmanship of the construction workers within the Oti region. However, attention given to above effect and proper ways to address those effects resulted in quality workmanship of the workers.

### **5.3 Extent of the Effect of Workers Fatigue**

The analysis revealed that, the commitment from the workers with requisite skills to carry out work can really influence the quality of the work. According to Donald Sull (2003) a senior lecturer at the MIT who argued that any current activity that ties an organization to a future course of action is referred to as a commitment. Management depends on commitments. They serve as a company's way of obtaining the resources required for its survival. Investors, clients, and staff would probably shun any company whose management refused to publicly commit to a plan and back its intentions with investments. However, commitments go beyond merely being necessary. They can be effective tools when used appropriately to help a business outperform its rivals. The extent of the effect of fatigue on time and quality performance in selected project site depends on the commitment from the consultant and workers. Lack of commitment from the consultant and workers influence the extent of the effect of fatigue on time and quality performance of the construction project. Donald Sull (2003) emphasizes that, the same way that commitments define companies, they also define people. They both empower and restrain. They offer consistency over time. They contribute to who we are. In the end, what enables competent managers to develop into outstanding

leaders understands the connection between personal ethos and professional devotion. Hence, the rate at which consultant commit in managing the effects of fatigue will determine the rate of commitment from the construction workers.

Free defects fall under the concepts of zero defect, which was coined by Philip Crosby. Simplilearn (2022) stated that, the term "Zero Defects," which was introduced by Philip Crosby in his book "Absolutes of Quality Management," has become well known and esteemed in the field of quality management. Others have made a concerted effort to disprove the doubters, pointing out that "zero faults" in quality management does not refer to perfection but rather to a situation in which waste is removed, defects are decreased, and you are upholding the highest standards of quality in projects. Nevertheless, proper management of fatigue will lead to reduce the extent of effect of fatigue on time and quality of construction project and promote activities that were completed free of defects', hence there is no requirement for rework for activities completed' by the workers or the site workers. According to the result, work or activities completed are free from defects which were seen as very severe effect on the quality of the project and makes it free from rework.

Finally, the result indicated that, quality of workmanship by the workers on any project raises the confidence level of the site workers. Thus, activities are completed within the required duration shows the extent of its severances to the quality of workmanship by the site workers. (Chemers, et al., 2000 and Clark et al., 2008) stated that, self-confidence has been described in a variety of ways. These meanings typically incorporate confidence in one's own performance ability. Although one thinks they are valuable, the value judgment is self-directed, whereas the personal judgment is

frequently externally motivated (Park and Crocker, 2005). The confidence in the activities carried out by site workers due to health condition and adequate working condition on the construction project led to activities completed within the required duration. Hence, help to carried out activities to meet the required standard of specification of the construction project goals.

#### **5.4 Influence of Workers' Fatigue on Work Output**

The results from the analysis revealed that, poor environmental design has influence on the work output of the project. Jiao et al. (2004) stated that, factors affecting the workplace environment, such as noise levels, illumination, vibration, and temperature, could affect the kind and severity of workers' fatigue.

Furthermore, Knowledge and skills of employee training has high influence on workers fatigue on the work output of construction Site. According to Jennifer Herrity (2020), employees have a great opportunity to expand their knowledge base and develop their professional abilities through training, which helps them be more productive at work. Despite the expense of employee training, if it is constant, the return on investment is enormous. Employee training programmes help improve the knowledge and skills of employees to match the various changes in the industry. Knowledge and skills of employee training assist them gain the knowledge and skills they need to keep up with the many changes occurring in the sector. These enhancements will have a favorable impact on employee productivity, which can boost an organization's profitability and effectiveness. Employees may receive training in a variety of topics, including safety, human relations, and work ethics.

The result indicated, 'Social lifestyle-smoking and alcohol status of employee' has a sever influence on workers work output of any construction project according to the results. Apart from the social lifestyle of workers, 'Employee taking certain medication' also influence worker work output of the project and therefore, workers taking certain medication was one of the key factors which influences workers fatigue on work output on construction project. There are primarily two explanations for the connection between job stress and smoking and alcohol usage. To establish internal stability (homeostasis), first self-medicate the physiological effects of stress, such as increased cortisol, decreased serotonin, and catecholamine production (Ayyagari P, Sindelar JL (2010). To lessen the effects of work stress, alcohol and cigarettes can also be used as anti-anxiety or anti-depressant medications. Second, job stress can impair self-control, making it challenging for smokers and drinkers to quit or limit their consumption. It can also lead former smokers and drinkers to relapse and start smoking or drinking again (Ayyagari P, Sindelar JL (2010).

Given that, most people start smoking and drinking before they enter the workforce, several studies revealed that influence of job stress on the intensity of smoking and drinking is more significant than the impact on smoking and drinking status. The analysis also revealed that 'Work Environmental Factors- high vibration, and temperature' was rated very severe by the respondents according to the analysis and the respondents perceived high vibration and temperature within the working environment affect the work output of the project. Jiao et al. (2004) stated that, factors affecting the workplace environment, such as noise levels, illumination, vibration, and temperature, could affect the kind and severity of workers' fatigue. Furthermore, 'Lack of motivation of workers' and Emotional Predisposition and Distress was both noted as one of the

key factors which influence workers fatigue on work output on construction project. When assessing fatigue, it is necessary to take individual variances into account. The causes of these variations are found in everyone's somatic or psychological traits, which may be temporary or permanent. For instance, a somatic cause of fatigue can be sleep apnea, which prevents enough rest and causes a fatigue debt that builds up over time (Chervin 2000). However, the development of mental tiredness is also influenced by an individual's emotional state, whether it be positive or negative (Bültmann et al. 2000). In general, scores between surveys that assess personal traits (independent variables) and subjective fatigue measures have been compared to examine the influence of personal predisposition on fatigue (dependent variable). The 'Social Environment at Workplace- Relationships with co-workers and the age of the employee was noted as one of the key factors which can also influence the workers fatigue on work output on project site and it play an important role as far as work output is concern. It was also revealed that, 'Inadequate break for workers' and 'Physical and Mental Exertion' were considered by the respondents as severe key factor which influence workers fatigue on work output at project site finally, 'Short or adequate sleep deprivation, 'Extended shifts or long working hours' and 'Mandatory, low reward overtime' had high mean value which are key factors which influence workers fatigue on work output of the construction project.

### **5.5 Strategies for Minimizing the Effects of Workers Fatigue**

It was realized from the analysis that, to minimize the effect of fatigue on construction site was by 'Working with health and safety officer, supervisor and managers to determine the impact of work schedules and workloads 'and 'Provide adequate and ventilated environmental conditions for the workers on project site. Hence, good safety

officer and supervisor to determine work schedules and workloads will minimize the effect of fatigue on the construction site.

Absolute Health Services (AHS) (2022) stated that most businesses would benefit from adding a safety officer, who also serves a cost-saving purpose while benefiting management, the staff, and the company's reputation. Not only on working with safety or supervisor but also on providing adequate and ventilated environmental condition will help to minimize the effects of fatigue on construction project site. According to University of Massachusetts, Amherst (2022) stated that through ductwork, the combined air is subsequently transported throughout the inside, with some of the interior air being expelled outside. When one or more of these processes are insufficient, the quality of the indoor air may degrade. For instance, if enough outdoor air is not transported into and disseminated throughout the building, carbon dioxide (a gas created when people breathe) may build up in building areas. The best engineering control for preventing problems with indoor air quality is ensuring an appropriate supply of fresh outdoor air. It was also revealed that, on-the-job incident investigation should include fatigue, which is the root cause of any incident on site. The Occupational Safety and Health Administration (OSHA) claims that incident investigations that concentrate on identifying and resolving root causes rather than assigning blame will also boost workplace morale and productivity.

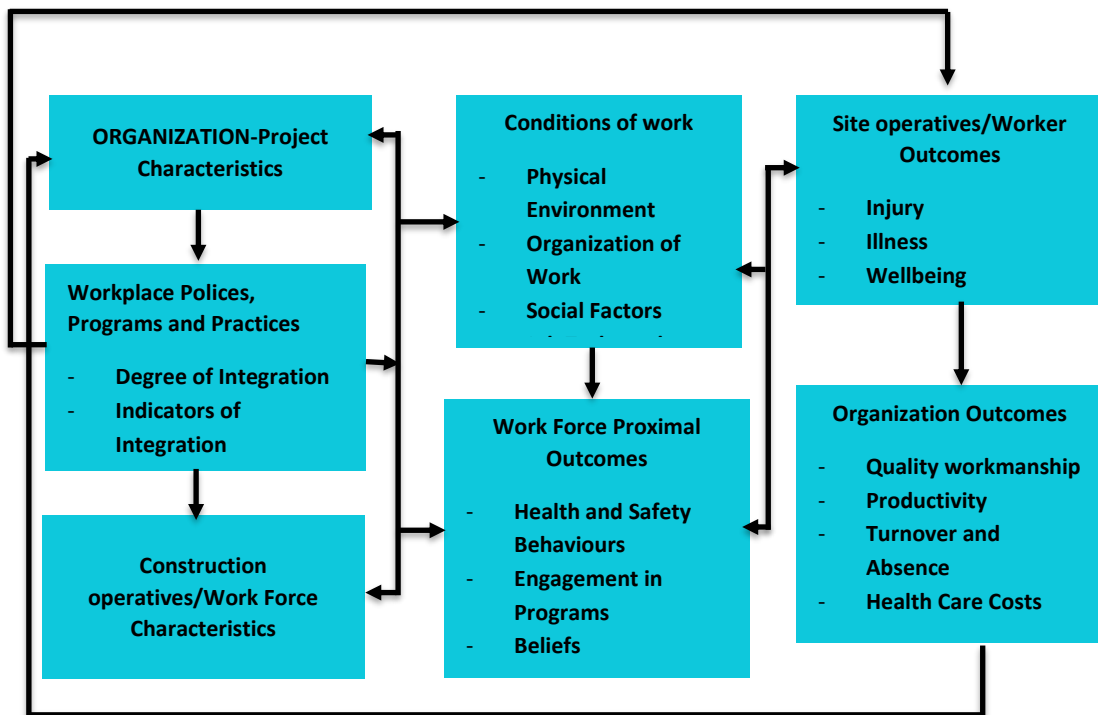
Kathleen Clair (2023) said the investigation on any incident dive into fatigue investigation and the root causes in order to minimize effect of fatigue on construction site.

More so, 'Providing adequate reward and motivation for employee' and by 'Providing a way for employees to anonymously report problematic work schedules' according to the could help minimize the effect of workers' fatigue. According to Mullins (2005), a significant international study by proud foot, Consulting found that low worker morale was the main cause of productivity loss. Therefore, providing adequate reward and motivation for employee promote and minimize the effects of fatigue on construction site.

In addition, 'Implementing procedure to monitor and manage fatigue risk' can also minimize the effect on workers fatigue on site and the respondents agreed that every worker require a minimum number of hours prior to reporting for the next shift after working eight or nine hours or more', to enable the worker prepare for the next shift. Finally, analysis result indicated that, 'Reviewing workers records, as well as work systems and practices', Training workers about the safety risk of fatigue and Consideration of age during employment will minimize the effect of workers fatigue on construction site. The result also shows that, limiting the number of consecutive shifts for night work, maintaining regular and adequate break for employee one hour and building fatigue management into the planning stages of the project tends to minimize the effect of workers fatigue on construction site.

In order to investigate the effects of workers fatigues, safety, health, and welfare, a summary on enhancing the performance of site through the effective management will help in defining research hypotheses and priorities. The conditions of work, as determined by construction organizational policies, plans, and practices within the context of the company as well as worker characteristics, were at the center of our prior

summary of the working environment (Fig. 5.1). (Sorensen et al., 2016). According to Schulte et al. (2019), workplace physical, organizational, and psychosocial environments have a direct effect on workers safety, health, and happiness. They also have an impact on construction project delivery outcomes like quality of workmanship, turnover, absenteeism, productivity, time and healthcare expenses. The model also highlights the significance of organizational interventions that enhance working conditions by illuminating the causal pathways by which workplace policies, programs, and practices may affect worker and company outcomes.



**Figure 5.1: Summary on enhancing quality of workmanship and work output with promotion of workers health and safety**

## **CHAPTER SIX**

### **SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION**

#### **6.1 Introduction**

The findings of the research based on the previous chapters were summarized in this chapter. The research conclusion was also included in this chapter, as were some recommendations based on the findings. The limitations of the study were discussed, and recommendations for future research were given. This chapter is organized as follows, a review of the research objectives, and a description of the findings, recommendations, future research directions and research constraints.

#### **6.2 Effects of Workers' Fatigue**

The findings of the study revealed that, poor social well-being, slowed reaction time, illnesses, distractions, and exhaustion are the main effects of fatigue. These effects lead to significant long-term impacts on the human body which lead to poor health conditions. In turn, poor health conditions lead to inability to perform physically and mentally.

#### **6.3 Effect of Workers Fatigue on Quality of Workmanship**

The second objective was to determine the effect of fatigue on quality of workmanship in selected construction project sites within Oti region. The findings revealed that fatigue negatively affect time and quality performance. The adverse effects of fatigue on quality of workmanship can affect the confidence level of the site workers.

#### **6.4 Effects of Workers Fatigue on Work Output**

The third objective was to determine influence workers fatigue on the work output of construction site. The findings suggest that fatigue exacerbated by poor environmental design has influence on the work output of site operatives. The site operatives in the study considered inadequate break for workers and physical and mental exertion as key factors influencing fatigue on building project sites. In addition, short or adequate sleep deprivation, extended shifts or long working hours' and mandatory, low reward overtime had influence site operatives' fatigue.

#### **6.5 Strategies for Minimizing the Effects of Workers' Fatigue**

The final objective was to determine the strategies for minimizing the effects of workers fatigue on construction site. However, thirteen (13) identified strategies for minimizing the effects of workers fatigue on the Oti construction project. The study suggest that it is essential to work with health and safety officers, supervisor, and site managers to determine the impact of work schedules and workloads and provide adequate and ventilated environmental conditions for the workers on project site. It was also revealed that, on-the-job incident investigation should include fatigue, which was the root cause of any incident on site. The Occupational Safety and Health Administration (OSHA) claims that incident investigations that concentrate on identifying and resolving root causes of fatigue will also boost workplace morale and productivity. More so, providing adequate reward and motivation for employee and by providing a way for employees to anonymously report problematic work schedules' according to the could help minimize the effect of workers' fatigue. The study further revealed that, implementing procedure to monitor and manage fatigue risk can also minimize the effects of fatigue on building construction sites. Every worker requires a minimum number of hours prior

to reporting for the next shift after working eight or nine hours or more', to enable the worker to prepare for the next shift.

## **6.6 Conclusion**

The study concludes that the main effects of workers' fatigue include; mood changes, slowed reaction time, distractions, and illnesses. These effects consequently have negative effect on the time and quality of performance as well site operatives' level of confidence.

The study concludes working with safety officers, site managers and well-trained staff can help address the effects of fatigue on building construction sites. Also, investigating the root causes of fatigue with a view to finding solutions to the incidence of fatigue on building construction sites is essential. Additionally, it is essential to assess impact of work schedules and workloads with a view to designing the work environment that could result in minimal or absence of fatigue.

## **6.7 Recommendations**

The following recommendations are made based on the findings of the study to address the incidence of fatigue and manage its effects on building construction project sites in the study setting.

- i. Work schedules should be planned in a manner to reduce the effects of workers' fatigue. So, attention should be given to effects outlined in the research work and proper ways to address those effects will result in enhanced quality of workmanship and increased output.

- ii. The study further recommends concerted efforts should be made at ensuring supervisory personnel (safety officer, site manager, and site supervisors) should be well trained to enable them handle the incidence of fatigue and other related issues. Proper management and commitment of fatigue will lead to reduce the extent of effect of fatigue on time and quality of construction project and promote activities that are completed free of defects.
- iii. The study further recommends that, providing adequate reward and motivation for site operatives as well adequate welfare schemes to ameliorate the effects of fatigue.
- iv. The study finally recommends that, employee training programmes must be part of the organization plans to help improve the knowledge and skills regarding work shifts, workload and aspects of tasks that could leading to fatigue.

### **6.8 Recommendation to Future Research**

Further work needs to be done to expand the scope of the study by developing a framework for mitigating effects of workers fatigue in construction sites in Ghana. The study also recommends that; further investigating should be conducted “assessing the perception of construction project Managers and contractors on the effect of workers fatigue in the construction industry.

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## **APPENDIX A**

**AKENTEN APPIAH - MENKA UNIVERSITY OF SKILLS TRAINING AND  
ENTREPRENEURIAL DEVELOPMENT**

**FACULTY OF TECHNICAL EDUCATION**

**DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY**

**MASTER OF PHILOSOPHY (MPHIL). CONSTRUCTION MANAGEMENT**

**QUESTIONNAIRE SURVEY**

**TOPIC: INVESTIGATING THE EFFECTS OF WORKERS FATIGUE ON  
QUALITY OF WORKMANSHIP AND PRODUCTIVITY IN GHANA:  
A STUDY OF SELECTED PROJECT SITES IN THE OTI REGION**

Dear Sir/Madam

This questionnaire is design to collect data for the research titled above. This research is conducted as part of an academic requirement for the award of a Master of Philosophy Degree in Construction Management from the Akenten Appiah - Menka University of Skills Training and Entrepreneurial Development. You are assured that the information obtained from this survey shall be kept anonymous and completely confidential and used for research purposes only. Your participation in this survey is voluntary and I will be grateful if you could answer these questions. I would like to thank you for your cooperation in completing these questions.

Yours Sincerely,

**Phanuel Kwaku Drah**

MPhil. Student

## SECTION A

### GENERAL INFORMATION FROM RESPONDENT - PROFILE

(Please Choose Your Option by Ticking Its Corresponding Box)

#### 1. Please indicate your Profession/designation/gender/age?

- A. Mason  Gender: Male  Female
- B. Carpenter  Age: 18yrs – 30yrs  31yrs – 45yrs
- C. Steel bender
- D. Electrician

#### 2. Please indicate the years of Experience in the construction industry.

- A. Less than 5 years  B. 5 – 10 years
- C. 11 – 15 year's  D. Above 16 years

#### 3. What is your highest academic Qualification?

- A. BECE  C. Intermediate
- B. NVTI  D. Advance

#### 4. What is the financial classification of your firm according to the Ministry of Water Resources, Works & Housing (MWRWH)?

- A. D1/K1  B. D2/K2
- C. D3/K3  D. D4/K4

## SECTION B: EFFECT OF FATIGUE ON QUALITY PERFORMANCE

This section seeks your expert opinion on the extent of the effect of workers fatigue on time and quality of workmanship of construction projects.

**6. What is the level of severity of the following effects of fatigue on construction site?** Please rank the factors on a scale of 1 to 5 where; 1 represents very small effect,

2 represents small effect, 3 represents moderate effect, 4 represents severe effect, and 5 very severe effect.

	<b>Effect of Workers Fatigue</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>a</b>	Human Error and Injuries					
<b>b</b>	Worker's productivity decreases greatly					
<b>c</b>	Ability to think clearly and respond appropriately					
<b>d</b>	Sleep deprivation					
<b>e</b>	Illnesses					
<b>f</b>	Mood Changes					
<b>g</b>	Worker has slowed reaction quality					
<b>h</b>	Worker has slowed reaction time					
<b>i</b>	Mental Exertion					
<b>j</b>	Muscular Exertion and decreases in strength					
<b>k</b>	Distraction during complex tasks					
<b>l</b>	Worker's commitment to safety					
<b>m</b>	Physical and cognitive- tiredness or exhaustion					
<b>n</b>	Psychological distress					
<b>p</b>	Poor health conditions					

**7. To what extent do you agree on the following statements on the quality of workmanship of operatives on your construction project site?** Please rate using a scale of 1 to 5: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5). *(Please tick the box which best reflect your view).*

<b>A</b>	<b>Quality of Workmanship of workmanship</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>a</b>	Work or activities carried out meet the required standard of specification.					
<b>b</b>	There is no requirement for rework for work or activities completed.					
<b>c</b>	Work or activities are completed within the required duration.					
<b>d</b>	Work or activities that are completed are free of defects					
<b>e</b>	Operatives have the requisite skills required to carry out work or activities assigned them.					
<b>f</b>	There is confidence in the work or activities carried out by site operatives.					
<b>g</b>	Consultant is satisfied with work or activities carried out.					

**SECTION C: EFFECTS WORKERS' FATIGUE ON WORK OUTPUT OF CONSTRUCTION SITES WORKERS**

**8. To what extent do you agree on the following effect of workers' fatigue on work output on project sites?** Please rate using a scale of 1 to 5: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5). *(Please tick the box which best reflect your view).*

<b>A</b>	<b>Key effects of Workers Fatigue on Work Output</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>a</b>	Extended shifts or long working hours					
<b>b</b>	Mandatory, low reward overtime					
<b>c</b>	Short or adequate sleep deprivation					
<b>d</b>	Inadequate break for workers					
<b>e</b>	Physical and Mental Exertion					
<b>f</b>	Work Environmental Factors- high vibration, and temperature					
<b>g</b>	Social Environment at Workplace- Relationships with co-workers					
<b>h</b>	Emotional Predisposition and Distress					
<b>i</b>	General health condition of workers					
<b>j</b>	Lack of motivation of workers					
<b>k</b>	Poor environmental design					
<b>l</b>	Knowledge and skills of employee-training					
<b>m</b>	The age of the employee					
<b>n</b>	Social life style-smoking and alcohol status of employee					
<b>p</b>	Employee taking certain medication					

**SECTION D: STRATEGIES FOR MINIMIZING THE EFFECTS OF FATIGUE ON CONSTRUCTION SITES**

This section was to determine strategies for minimizing the effect of workers fatigue on construction site. Please indicate the level of influence on the following under the main key influence of workers fatigue on the work output of construction project in their order of severity.

**9. To what extent do you agree on the following strategies for minimizing the effects of workers’ fatigue on their performance?** Please rate using a scale of 1 to 5: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5). *(Please tick the box which best reflect your view).*

<b>A</b>	<b>Strategies for Minimizing the Effects of Workers Fatigue</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>a</b>	Build fatigue management into the planning stages of the project					
<b>b</b>	Maintain regular and adequate break for employee-one hour					
<b>c</b>	Limit the number of consecutive shifts of night work					
<b>d</b>	Training workers about the safety risk of fatigue and how to identify them					
<b>e</b>	Require a minimum number of hours prior to reporting for the next shift after working eight or nine hours or more					
<b>f</b>	Implement procedure to monitor and manage fatigue risk					
<b>g</b>	Include fatigue in root cause investigation following on-the-job incident					

<b>h</b>	Provide a way for employees to anonymously report problematic work schedules					
<b>i</b>	Provide adequate reward and motivation for employee					
<b>j</b>	Working with health and safety officer, supervisor and managers to determine the impact of work schedules and workloads					
<b>k</b>	Reviewing workers records, as well as work systems and practices					
<b>l</b>	Provide adequate and ventilated environmental conditions					
<b>m</b>	Consideration of age when during employment					

**SECTION D: MEASUREMENT OF LABOUR PRODUCTIVITY OF KEY ACTIVITIES**

**10. Estimates of labour productivity for construction sites**

<b>A</b>	<b>ACTIVITY</b>	<b>Gang Size</b>	<b>Area of Work</b>	<b>Output</b>
<b>a</b>	Masonry		Wall-45 m <sup>2</sup>	
<b>b</b>	Concreting		45m <sup>3</sup>	
<b>c</b>	Painting		Two coats paint wall-30,6 m <sup>2</sup> /day	
<b>d</b>	Carpentry		Rough formwork 22,5m <sup>2</sup> /day	
<b>e</b>	Roofing		Roof covering with purlins 67,5m <sup>2</sup> /day	

## **APPENDIX B**

### **BRIEF PROFILE OF THE STUDY AREA**

The selected region of the research location was Oti Region. The Oti Region is one of the six created regions of Ghana in December 2018. The region was carved out of the northern part of the Volta Region and will be in fulfillment of a campaign promise made by New Patriotic Party. Prior to the 2016 Ghanaian general election, the then candidate Nana Akufo-Addo declared that when elected, he would explore the possibility of creating new regions out of some of the existing regions in Ghana in order to bring government closer to citizens. The execution of plans for the creation of the regions was seeded to the newly created Ministry of Regional Reorganization and Development, which is under the leadership of Hon. Dan Botwe. Government of Ghana ministry charged with the responsibility of supervising the creation of new regions in Ghana. In March 2017, the ministry sent the blue print for the creation of the region along with others to the Council of State. The final stage for the creation of the region was decided through a referendum by the people within the catchment of the new region. A referendum on 27 December 2018 approved the creation of Oti Region. On Election Day, 323,708 out of 366,481 (88.33% voter turnout) registered voters cast their votes.

A total of 319,296 (98.64 per cent) voted Yes and 2,878 voted No (0.89 per cent) while the number of rejected ballots was 951 (0.24 per cent). The political administration of the region is through the local government system. Under this administration system, the region is divided into eight MMDA's (made up of 0 Metropolitan, 2 Municipal and 6 Ordinary Assemblies). Each District, Municipal or Metropolitan Assembly, is administered by a Chief Executive, representing the central government but deriving

authority from an Assembly headed by a presiding member elected from among the members themselves. The Oti Region is bordered on the north by the Northern region, to the south by the Volta Region, and to the west by the Volta Lake. It has nine districts. The Oti Region is much drier than the rest of the southern areas of Ghana, due to its proximity to the north. The vegetation consists of mostly of grassland, especially savanna with clusters of drought-resistant trees such as baobabs or acacias. Between December and April is the dry season. The wet season is between about May and November with an average annual rainfall of 750 to 1050 mm (30 to 40 inches). The highest temperatures are reached at the end of the dry season, the lowest in December and January. However, the hot Harmattan wind from the Sahara blows frequently between December and the beginning of February. The temperatures can vary between 14 °C (59 °F) at night and 40 °C (104 °F) during the day. The figure 3.1 below shows the map of Oti Region.

