

AN INVESTIGATION INTO THE FACTORS INFLUENCING THE PRODUCTIVITY OF NIGHT TIME ROAD CONSTRUCTION

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Declaration

I hereby declare that this research report is my own work. It is submitted for the partial fulfilment of the Degree of Master of Science in Building at the University of the Witwatersrand, Johannesburg. It has not been previously submitted for this purpose, or for any other degree or examination at any other university.

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_____ Day of _____ (year) _____

Abstract

Night time construction has adopted as a preferred method of scheduling to alleviate the problems caused by road works during the day. Over the past few years, night-time construction has been increased; it will inevitably continue to grow. Continued increase in the volume of roadwork done at night has resulted from a combination of road deterioration and traffic congestion. Although night-time road construction is seen as the solution to alleviate the problems associated with day-time repairs and congestion, it has its own challenges and problems. Cost, productivity, quality, noise and human factors are some of the few factors that night-time road construction brings. This study is aimed at understanding the factors that influence the productivity of night-time construction and proposing strategies to improve productivity in the South African context. It is commonly known that quality and productivity differs from one roadwork site to another during night-time road construction. Some roadwork sites can perform well while others are worse off. However, through literature, the factors categorised as human, management and external may influence the productivity regardless of the operation. The current study investigates the influence of these factors on the productivity of work done at night through structured questionnaire. The results of the study show that there is minimal if no effect on the productivity of work done at night. Human factors that influence the performance of the labour have no impact on productivity, whereas management and external factors have minimal impact on the productivity of night-time road construction projects.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Gauteng is the economic hub of South Africa and generates nearly 38% of the total economic activity; there has been a significant growth in developmental housing, offices, and retail and industrial properties in the past decade (SANRAL, 2009).

This has resulted in a road and freeway system that is overloaded because of above average traffic growth. In other words the provision of roads infrastructure is unable to keep up with the increased traffic growth (SANRAL, 2009). The situation is not unique to South Africa; studies from other countries show that highways are reaching their maximum capacity because of the increase in traffic volumes. Most facilities are reaching their design capacity for this reason, especially in urban areas (Arditi *et al.*, 2003). Despite all the advances made on traffic planning and information systems, incomparable increases in urban congestion has been and is still being experienced (Holguin-Veras *et al.*, 2003). Bryden and Mace (2002) added the fact that more roads operating near capacity is not the only difficulty; also, the percentage of roadways that are in need of significant repair is ever increasing.

Roads are an essential medium for all citizens in the country and serve as the backbone of the economy. Roads agencies face the problem of existing dilapidated roads that need to be maintained or replaced coupled with congestion because design capacity is being reached. The South African Roads Agency Ltd (SANRAL) has proposed improvement to the existing Gauteng freeway system as well as the provision of additional infrastructure to improve the current traffic flow and provide a road system that will stimulate the development potential of the province (SANRAL, 2009). There has been an increase in the number of freeway construction projects around South Africa due to increased infrastructure expenditure and funding for road construction projects (Arrive Alive, 2013).

Hinze and Carlisle (1990) claim that work zones on existing highways cause traffic disruptions resulting from “*traffic rerouting, diverting, slowdowns, delays,*

uncertainty, accidents and frustrations” on public roads. Arditi *et al.*, (2003) claim that heavy traffic and congestion last all day; any repair, maintenance, renovation or rehabilitation work conducted during the day on these roads disrupts traffic and adds to congestion and delays. A severe problem is created by closing traffic lanes during the day to make way for work zones on highways that are near capacity. Furthermore, lane closures add to the congestion, which impacts negatively on the service level of popular recreational areas (Park *et al.*, 2001). Even though construction and maintenance of road ways results in unpleasant delays and social impacts, work zones are still inevitable to conserve existing road infrastructure (Bryden and Mace, 2002). Work zones that are setup during the day create a severe economic and social risk. The situation of disturbance to traffic flow is also exacerbated by increasing overcrowding on highways and daytime work zones (Holguin-Veras *et al.*, 2003).

In the recent past, provision was made by the Gauteng freeway improvement project to construct new freeways around Gauteng. The problem that the South African Road Agency faced during the implementation of the project was to set up the work zone in traffic. This was not achievable, because the Gauteng freeway receives a considerable volume of traffic each day; hence, most of the work was done at night (*Engineering News*, 2013). Repairing of roads during the day has become problematic for both contractors and the travelling public. Jackson (2005) claims that to alleviate problems of working in traffic, highway work of all kinds is increasingly scheduled during off-peak periods.

Over the past few years, night-time construction has increased and it will unavoidably continue to grow. Continued increase in the volume of roadwork done at night has resulted from a combination of road deterioration and congestion (Bryden and Mace, 2002). Although night-time road construction is seen as the solution to alleviate the problems associated with day time repairs and congestion, it has its own challenges, such as “*cost, productivity, quality, noise and human factors*” (Park *et al.*, 2001).

The issue of productivity on night-time road construction work has always been a contentious one. El-Rayes *et al.*, (2003) report the decrease in productivity as one

of the disadvantages of night-time construction, while Ellis and Kummar (1993), who conducted a study on “*plant mixed surfaces and milling of existing pavements*” to determine the difference in production levels on day and night-time construction, found that there is no significant difference in day and night-time production rates for both plant mixed and milling projects. As a result of limited reporting on the topic in the literature, no universal statement can be given comparing daytime and night-time productivity of work zones (Rebholz, Al-Kaisy & Nassar, 2004). The construction industry is different from other productivity driven industries. In industries such as the aircraft manufacturing industry, the work is done indoors under controlled working conditions in a factory, unlike the construction industry where work is done outdoors under uncontrollable working conditions (Bates *et al.*, 1999).

Productivity is known to be inconsistent during night-time construction operations (Hancher and Taylor, 2001). Layfield (1988) in Rebholz *et al.*, (2004) claims that productivity of night-time construction is affected by several factors, including “*difference in temperature, workers’ morale, lighting conditions, and traffic loads*”. Liberda *et al.*, (2009) in Jergeas (2001) give a clearer understanding of the factors that affect productivity by categorising them as “*human factors, external factors and management factors*”. Most of the organisations that opt to work at night do so on the assumption that the productivity will remain constant, but literature in studies such as Hancher and Taylor (2001) has shown that it is not so and productivity can be affected at night by several factors, as claimed by Layfield (1998). Given the importance of productivity on construction projects, the matter as well as the factors that make it volatile needs to be investigated. Further investigation is needed into the effects on productivity by night-time construction to enable contractors and road agencies to make informed decisions about performing work at night and productivity. This research aims to analyse the factors that affect night-time road construction productivity in South Africa.

1.2 PROBLEM STATEMENT

There are many night-time road construction works in the country at present. Even though these projects are carried out at night to avoid delays caused by

traffic disruptions, night-time road construction has been associated with a decrease in productivity, which can increase the capital expenditure of the works, and the threat associated with safety of the workers. Literature shows that productivity of night-time road construction is volatile and influenced by various factors (Hancher and Taylor, 2001). Although the factors have been identified, no consensus has been reached on whether productivity increases, remains constant or decreases at night (Rebholz *et al.*, 2004). The available literature is not sufficient to reach a conclusion on the subject and enable those who are considering the use of this construction method to make an informed decision in their planning processes. This study investigates the factors that affect night-time construction productivity and proposes recommendations that will contribute to the existing knowledge on night-time construction in Gauteng South Africa.

1.3 RESEARCH AIMS AND OBJECTIVES

The study is aimed at understanding the factors that influence the productivity of night-time construction and proposing strategies to improve the productivity.

The objectives of the study are to:

- understand the current practices of night-time road construction in South Africa;
- identify the factors influencing productivity during night-time road construction;
- suggest recommendations for the improvement of night-time road construction productivity.

1.4 RESEARCH QUESTION

The study answers the following question(s):

- What are the current practices in the South African night-time road construction industry?
- What are the factors that affect the productivity of night-time road construction?

- Does night-time road construction in South Africa have an impact on productivity?
- What are the recommendations that can be proposed to improve night-time road construction?

1.5 ASSUMPTIONS

The assumptions made by the study were that there would be ample respondents on night-time construction projects in the Gauteng region to enable the study to render accurate statistical results. The other assumption made by the study was that Gauteng is a true representation of the night-time road construction industry in South Africa; it is the economic hub of the country with the most construction activities and a mixture of the country's work force, both from inside the country and in terms of foreign labour.

1.6 RESEARCH STATEMENT

Night-time construction has an impact on productivity of road construction.

1.7 SCOPE OF THE STUDY

The study focused on the three major aspects that affect night-time road construction projects only, namely management, human and external factors. This study was conducted within South Africa in the Gauteng region. The exact values of productivity on each of the projects are not calculated with any quantitative techniques.

1.8 DELIMITATION

The study focused only on human factors, external factors and management factors as the factors that influence productivity of night-time road construction.

Secondly, the study was limited to Gauteng region in South Africa because most of the night-time highway refurbishment projects are currently being conducted in this region and it is one of the biggest economic hubs in the country. However, there are only a limited number of construction companies who are involved in night-time road construction in the Gauteng region. The productivity of the

projects was not calculated with any quantitative technique. Lastly, the population of the study was limited to night-time construction workers, contractors and project managers on projects in Gauteng.

1.9 RESEARCH METHODOLOGY

The study utilized the “*research onion*” proposed by Saunders et al., (2006) to select an appropriate methodology. The “*research onion*” has a number of layers that describe different techniques in selecting an appropriate methodology. The study subscribed to positivism as the research philosophy to gather and analyse information needed for the research. The research approach adopted by the study was deductive reasoning, as this gave the best structure to deal with the research problem. Furthermore, the study utilized surveys as a strategy to investigate the research question and objectives. The study firstly collected secondary data through a literature review of related journals. Findings from that data were used to formulate questions for the survey to collect primary data from three respondent groups. The sampling method used was deliberate sampling, as this would solicit accurate information from select target groups. Workers that work on night-time construction projects were targeted to respond to a low-level survey that concentrated mainly on human and external factors. Project managers in the employ of the South African roads agency were also targeted to respond to a medium-level survey that focused on management and external factors. The last survey, dealing with all three – human, external and management – was distributed to construction companies and classified as a high-level survey. The results of the survey were analysed through simple descriptive statistics that used graphs and tables to show the distribution of the results.

1.9.1 Ethical considerations

This study adhered to the framework and policies of the School of Construction Economics and Management of the University of the Witwatersrand Research Ethics Committee.

Information given by the participants (construction workers) may not be favourable to anyone. Names of participants who participated in the survey were

not disclosed. Furthermore, the responses were kept confidential and remain the property of the University.

One of the questionnaires targeted low-level workers who might not be proficient in English and this would have discriminated against them when answering the questions. The questionnaire was therefore translated to the language of their proficiency for those who were not proficient in English.

Responses from the contractors might taint their relationship with the Road Agencies who employed them; hence, contractors' names and names of those employees who answered the questionnaire on their behalf were not published as part of this study.

Furthermore, no data was obtained under duress and all participants were informed of their right to discontinue participation in this research at any time without reason.

Persons below the age of 16 were not allowed to participate in the questionnaire that was used for the purpose of this study and confirmation of this was obtained from the participants before answering any questions.

1.9.2 Structure of the report

The report consists of five chapters. Chapter one introduces the research area being investigated and comprises the problem statement, research question, hypothesis, objectives of the study, research assumptions, delimitation, research methodology, ethical considerations and the structure of the study.

The second chapter presents the literature review that was used to identify the existing knowledge in the area of research and to further examine the factors surrounding night-time road construction productivity.

Chapter three outlines the methodology and provides a justification of the selected method to conduct the investigation. The chapter comprises the research strategy, design and data collection, population and means of data analysis.

The data analysis and presentation of results are provided in the fourth chapter, which presents an analysis of the data obtained, the findings of the study, the construction workers' survey results, contractors' survey results, project managers' survey results and a summary of all survey results.

The fifth chapter, Conclusions and Recommendations, concludes the findings of the research after statistical analysis of the results and proposes recommendations on the topic.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The literature review starts with a general definition of productivity for all productivity driven industries. The definition is further narrowed down to productivity in the construction industry and other related industries. In addition, the review describes night-time road construction according to different authors. A discussion on the decision to carry out night-time road construction activities, the benefits and challenges of night-time construction activities is also included as part of the literature review.

The literature review defines night-time road construction in the context of this study. Furthermore, the review evaluates existing literature to establish the current knowledge of the factors surrounding night-time road construction productivity. Literature consulted comprised mostly reviewed journal articles in the same field of study. The review further describes different definitions of productivity from different authors and outlines the definition used in this study. The literature review also defines night-time road construction, road construction activities, benefits and challenges of night-time road construction, and factors that influence night-time productivity.

2.2 DEFINING PRODUCTIVITY

Productivity does not have a standard definition (Shehata and El-Gohary, 2012). There are different ways of defining productivity; however, although the approach may be different, the underlying principles remain the same. OECD (2008) states that differences do exist with measurement of productivity and the purpose of the measurement and/or availability of data will be what determine the choice between these measurements.

Productivity can be described as the sum of the output compared to the sum of the input to used to create that output. Some of the resources as described in the study include labour, capital, energy and raw material, which can be grouped together to relate what is known as multiple or total factor productivity, or they can be

singled out for single factor productivity (O’Grady and McCabe, 2009). Slitherers (2009) describe productivity in the manufacturing industry as the measure of the output compared to the input. Productivity in the construction industry can be described in several expressions such as performance factors, productivity rate; unit person-hour (p-h) and others (Dozzi and AbouRizk, 1993). Rebholz *et al.*, (2004) define productivity in the road construction industry as the tons of asphalt laid in an hour or per day. Merrow *et al.*, (2009) also try to define productivity in the construction industry using three approaches, namely the economic approach, construction manager’s approach, and project approach: The economics approach measures labour productivity as the economic output per hour worked. The construction manager’s approach measures productivity at task level by determining the work accomplished per hour at the gang or individual level. The project approach measures productivity with the whole project as the unit of observation. Dozzi and AbouRizk (1993) state that productivity has two significant measures, which are the efficient use of labour, and the relative competency of labour to achieve what is required; the latter being the most important to contractors and organised labour. For purposes of this study, the two definitions given by Dozzi and AbouRizk (1993) were used.

2.3 DEFINING NIGHT-TIME ROAD CONSTRUCTION

The concept of night-time road construction is simply doing construction work that would usually be done during the day at night. Hancher and Taylor (2001) describe night-time construction as the performing of construction and maintenance work at night. The same opinion is held by those authors who have done work on night-time construction practices; the only difference is the start and end time of the construction work at night. In Hinze’s (1990) opinion, road traffic on highways peak from 7 am until 7 pm and night-time construction is the occurrence of construction work during off-peak traffic. Abraham *et al.*, (2007) define night-time construction as the “graveyard” 7 pm to 6 am, which differs from Budhu and Parekh (2007), who state that the contractors in their study were only allowed to perform work between the hours of 9 pm and 5 am. It is also noted that the scheduling time depends on the nature of work to be performed.

Rebolz *et al.*, (2004) mention that night-time construction activities of roads that involve overlay jointing are the most difficult and contractors should plan to start work before 10 pm and end before 7 am. It is clear that the scheduling of the work which can be described as night-time construction is all done at night, which as described by the Oxford Dictionary online (2012) as the phase that occurs between dusk and dawn, and that may be different depending on the area and season of the year.

2.4 DECISION TO CARRY OUT NIGHT-TIME ROAD CONSTRUCTION

Planning stages of the project are whether the decision to carry out night-time construction should be taken or not (Minchin Jr *et al.*, 2011). Congestion during the day has been cited as motivation for conducting construction work at night. To offset the disturbance of daytime traffic congestion, most maintenance and construction activities now occur at night (Douglas and Park, 2003). KamWa *et al.*, (2007) report that highway repairs are done during off-peak hours as this reduces the burden on the road users; however, doing such work on the weekend has proven fruitless as this still causes delays. This has led to work for the Ben Schoeman/N1 contract for example, to be done at night. Disruptions caused by construction work on highways result in major delays, , thus scheduling the work at night is seen as a more favourable option to reduce the burden of work zones on the travelling public (Al-Kaisy and Naisar, 2003).

The impact of lane closure and their associated delays on the public is seen as the major but not the only reason for opting to carry out construction and maintenance activities at night.



Figure 2.1: Daytime road delay

Source: Pillay (2011)

The geographic location of where the construction will be taking place is also a factor in determining whether to setup work zones at night. Both traffic and location consideration will play a key role in the decision making process for night-time construction. Other factors may also play a role in the decision-making, but most authors conclude that the two mentioned above form the basis of most decisions. Anderson and Ullman (2000) argue that residential areas would prefer not to have night-time construction work while the opposite can be said for businesses that would appreciate construction work to be carried out at night to prevent customers from having a negative perception about their business.

2.5 ROAD CONSTRUCTION ACTIVITIES THAT ARE DONE AT NIGHT

Construction activities that are done at night are no different to those that are done during day. The only difference might be the methods due to the differences in day and night-time lighting and temperature. Construction activities done at night are: “(1) *resurfacing, barriers walls* , (2) *traffic separators*, (3) *milling and surface removal*, (4) *marking and stripe painting*, (5) *bridge deck construction*, (6) *concrete pavement construction*, (7) *base course construction*, (8) *ditch and channel excavation*, (9) *embankment filling and compaction*, and (10) *high way signing*” (Jackson, 2005).



Figure 2.2: Concrete paving construction at night

Source: Gallo Images (2012)

Hancher and Taylor (2001) report that in a survey they conducted to ascertain the rating of how night-time construction affected quality and productivity, they found that “*earthworks, bridge deck pour, bridge deck overlay, structural bridge work, concrete pavement, asphalt pavement, blasting, drainage/utilities, rock excavation, striping, sign placement, and traffic control systems*” were the only activities being done at night. In a survey on the type of work that is done at night, Hinze and Carlisle (1990) report that the contractors interviewed stated that “*asphalt paving, bridge decks, Portland and concrete paving, hauling, structures, pccp repair, pile drilling, milling, grading, drainage, excavation and utilities*” were the type of work done at night. There seems to be consensus amongst the authors as to the type of construction activities that are performed at night and those are similar to activities that are done during the day.

2.6 BENEFITS OF NIGHT-TIME ROAD CONSTRUCTION

There are benefits to night-time construction and that might be one of the reasons for the recurrent use of this method of scheduling and why it has become so popular. Some of the reported benefits of conducting night-time construction are discussed below.

2.6.1 Congestion

The impact of roadwork on traffic and motorists delays are significantly reduced or avoided altogether (Elrahman, 2008), which will result in reported traffic

congestion reduction (El-Rayes *et al.*, 2003), due to the fact that traffic is least at night and lane closure will therefore have minimal impact (Rebholz *et al.*, 2004). This has also been cited as the main reason for Departments of Transport to migrate from daytime construction to night-time construction (Holguin-Veras *et al.*, 2003).

2.6.2 Longer working periods

Rebholz *et al.*, (2004) and Arditi *et al.*, 2003 claim that night-time construction provides longer lane closure periods, which will lead to a shortened construction period. Jackson (2005) also reported extended working hours as one of the advantages of nighttime construction. Work zones that operate at night may also experience higher levels of productivity as there is minimal disruption from traffic and extended work shifts (Elrahman, 2008).

2.6.3 Minimized economic impact

Businesses may be able to operate efficiently during the day and not close due to the disturbance from the construction activities. Delivery and shipping will not be interrupted by the traffic congestion on the roads (Rebholz *et al.*, 2004); this also includes materials that are delivered to the construction site (Holguin-Veras *et al.*, 2003).

2.6.4 Environmental impact: improved air quality

With reduced traffic congestion, pollution from automotive exhaust emissions decreases (Elrahman, 2008). This is also claimed by Rebholz *et al.*, (2004), who cite reduced exhaust emission, which leads to better air quality as one of the benefits of night-time construction.

2.6.5 Enhanced working conditions

An opportunity to enlarge work zones is created by the smaller volume of traffic at night; this then allows the concurrent performance of multiple tasks (El-Rayes *et al.*, 2003). Lower temperatures experienced at night will lead to enhanced work conditions during the hot construction seasons (Shepard and Cottell, 1984).

2.7 CHALLENGES OF NIGHT-TIME ROAD CONSTRUCTION

Despite the benefits of night-time construction, the literature also points out some of the disadvantages experienced during night-time construction.

2.7.1 Decreased levels of safety

It has been reported that low visibility and reduced alertness of workers and drivers may lead to an increase in the risk of accidents. Visibility has also been cited in other literature as a challenge and deterrent of safety. Arditi *et al.*, (2003) cite visibility as a potential cause of hazards for both the workers and the drivers.

2.7.2 Noise pollution

Construction equipment causes noise that may be a nuisance to residents and businesses near the work zone. Elrahman (2008) cites noise, vibration, light and other disturbances as challenges of night-time construction.

2.7.3 Negative impact on workers' health

Workers' sleep deprivation, fatigue, the effects on the human biological clock and social and domestic adjustment difficulties have been cited as some of the negative impacts on workers' health caused by night-time construction operations (Jackson, 2005). The lack of sleep may also cause physiological and mental stresses and employee satisfaction may be affected negatively (Elrahman, 2008).

2.7.4 Extensive traffic control

Al-Kaisy and Naisar (2003) report that, given the lack of visibility at night the challenge with night time construction is to develop a traffic control plan that is suited for the safety of the construction workers and the road users. Project cost and duration may increase due to the enhanced traffic control that are required and which is complex to set up and remove (Elrahman, 2008). There is also an inherent safety risk with assembling traffic control devices at night and in the early hours of the morning (El-Rayes *et al.*, (2003).

2.7.5 Lighting problems

El-Rayes *et al.*, (2003) report that the main challenges of night-time construction are unsatisfactory lighting and reduced visibility. Hinze and Carlisle (1990) report that one of the responded in their survey on the “*quality of night asphalt paving*” stated that the lighting used on night time construction project is certainly not as good as natural sunlight during the day time. Others authors argue that working on the road at night is safer while others also argue that the lack of lighting also makes a work zone more dangerous at night even though there is less traffic (Minchin Jr *et al.*, 2008)

2.7.6 Difficulty with staff scheduling

Hinze and Carlisle (1990) report that the labour problem with night time construction was to get top and lower ranking personnel to work for eight hours at night. If presented with a choice night-time, construction personnel who married with kids would not prefer not work at night as it presented a risk to their marriage (Holguin-Veras *et al.*, (2003). Elrahman (2008) also claims that scheduling of personnel for work at night may be more difficult due to local ordinances and restrictions from unions

2.8 FACTORS THAT INFLUENCE NIGHT-TIME PRODUCTIVITY

Problems associated with productivity are a challenge faced by the construction industry and generally linked with the performance of workers. Numerous factors affect the performance of workers and these are generally related to time, cost, and quality (Soekiman *et al.*, 2011). Hancher and Taylor (2001) report that the costs of a project can escalate due to losses in productivity during night-work. One particular contractor in their study reported that, for reasons unknown to him, his productivity was greater during the night shift. Other contractors in the same study reported that they never complete work at night. It is commonly known that quality and productivity differs from one roadwork site to another during night-time road construction. Some roadwork sites can perform well while others are worse off. Fewer traffic intrusions and faster material deliveries are the reasons reported by Elrahman (2008) for higher night-time productivity. Extensive

operational hours is the other reasons for greater productivity (Douglas and Park, 2003). In a study on asphalt paving, Minchin Jr *et al.*, (2008) reported that 23 % more tonnage per hour was laid during the night than during the day.

Some researchers report that the advantages and disadvantages of night-time construction are contentious. Enhanced productivity is expected due to the following: cooler working environment as compared to high day-time during summer conditions; and faster delivery of material (Hinze and Carlisle, 1990). On the other hand, insufficient lighting and reduced visibility decrease night productivity, particularly when the traffic-control mechanisms and lighting apparatus are down (Arditi *et al.*, 2003).

Even though there are downfalls linked with limited workers and a lack of apparatus service and truck accessibility, productivity tends to rise if enough labour and equipment are available (Arditi *et al.*, 2003). With regard to other industries that practice night shifts, Vidacek *et al.*, (1986) in Douglas and Park (2003) did a study on female night shift workers in the electronic components manufacturing sector. The study found that productivity was lowest on Monday, increased until Wednesday, then decreased after Thursday and Friday. This is represented in Figure 2.3

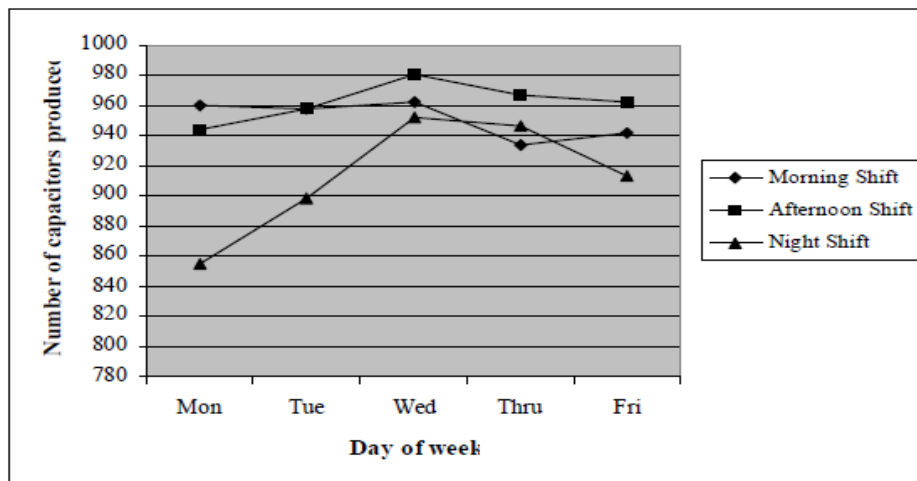


Figure 2.3: The trend in productivity

Source: Vidacek *et al.*, (1986) in Douglas and Park (2003).

In a study of the risks involved in the night-time construction work zones, Mukhopadhyay et al., (2011) report that inadequate lighting, poor visibility, poor worker morale and fatigue, problems with availability and supply of material, and the extra time required to erection and disassemble safety equipment might decrease the productivity of night-time work. There are therefore many factors that influence productivity in night-time construction. Some of these, as stated by the above authors, are sometimes unknown to the contractors and some are somewhat contentious. As these factors are vast and vary from site to site, they need to be categorised into groups to facilitate an accurate study. Liberda *et al.*, (2003) in Jergeas (2001) categorise the factors that affect productivity into three: “*human factors, external factors and management factors*”. These three categories were used in the present research project to group the factors that influence the productivity of night-time road construction.

2.8.1 Human factors

Rebholz *et al.*, (2004) claim that night productivity rate is negatively affected by “*workers’ morale, sleep deprivation and fatigue*”. Workers’ sleep deprivation, fatigue, the effect of circadian rhythm, and social adjustment difficulties will contribute to lack of energy, low morale and eventually reduce workers’ performance (Jackson, 2005).

The authors emphasise that night work negatively affects the workers’ health and this will influence their performance and ultimately the productivity rate. Workers are the labour component of any construction and without them work will not progress. Working at night means that the natural human activities are disturbed, including sleeping patterns that are essential for humans. Night scheduling cannot be the only aspect that is attributed to lack of sleep. El-Rayes *et al.*, (2003) cite Falzon (2001), who claims light pollution is also known to be detrimental to human health as it also disturbs sleep. Road construction is not the only sector where night work is performed. The practice has been adopted in several work sectors such as manufacturing, civil and building construction, mining and other service industries. Elrahman (2008) claims that even though night work affects workers’ health negatively, it is no different to any other night shift work and the

tolerance of working at night is dependent on individuals. The only difference in road night work can be that the work is more labour intensive; it is not routine work, and requires the workers to be more alert. This can also be exacerbated by long working hours, as claimed by Minchin Jr *et al.*, (2011), who mention that night work usually demands long shifts that negatively affect workers' sleeping patterns, raise their stress level, and alter their eating habits. Holguin-Veras *et al.*, (2003) also report that sometimes workers work 12-14 hours, which means they will not have adequate quality sleep.

The lack of sleep or a change on one's sleeping patterns is known to affect other human bodily functions. Minchin Jr *et al.*, (2011) cite Ullman *et al.*, (2004), who claim workers' response and vigilance, which are needed for effective performance, are greatly affected by night work. These are all attributable to fatigue of the human body. Abraham *et al.*, (2007) claim that disrupted circadian rhythms cause fatigue and will result in reduced productivity levels of night-time construction. Workers that are always tired cannot perform their required tasks and will produce work of undesirable quality. Rebholz *et al.*, (2004) argue that ultimately, the "*circadian rhythm or biological clock*" are changed to effectively suite working at night, but the only argument is the length of time it will take for the human body to adapt. Working at night not only affects sleep patterns and workers' fatigue levels; workers' social lives are also affected by working at night. The available literature suggests that workers do not want to work during the night because it disrupts their private lives (Park *et al.*, 2001). Normal human activities and social interaction take place during the day when everyone is active. Workers that work during the night have to rest during this time to enable them to recuperate so they can have enough energy to work. Rebholz *et al.*, (2004) report that night shift workers complain about not being unable to spend enough time with their families, but also reiterate that this is not a significant problem in instances where all workers work at night. From the literature, one gets a sense that the workers value social interaction in any form and must feel that they are all equal when it comes to the time they spend outside of work. Holguin-Veras *et al.*, (2003) suggest that night-time construction has an economic value since congestion is avoided on the roads and that saving should be transferred to the

workers that make the work possible. This suggests that workers who perform night work need to be compensated for not having proper sleep, and suffering fatigue and social deprivation. Although this will not reduce the negative effects of working at night, it will surely motivate the workers and boost their morale.

2.8.2 External factors

In a study done by Hancher and Taylor (2001), resident engineers in the State of Kentucky stated that conditions related to temperature were the primary factors for opting to carry out night work. Lower temperatures at night have also been reported to lead to more comfortable working conditions and better quality in the summer. The literature suggests that working at night is more favourable for workers as they are less affected by the heat. Workers are not the only aspect of productivity affected by the effects of temperature; the application of certain types of material is also dependent on the temperature. Jackson (2005) suggests that curing of concrete pavement and bridge deck placing is reduced due to cooler temperatures at night during warm weather. Furthermore, the workability of hot mix tarmac is reduced in cooler weather at night. This suggests that the effects of temperature can be negative or positive depending on the materials application used. The placing of concrete is more favourable in cooler temperatures because during the day high temperatures and direct sunlight may speed up evaporation and setting time, making it more difficult to work with (Hinze and Carlisle, 1990). The effects of the changes in temperature would also affect the workers' performance during the winter months, as low temperatures are unbearable to work in.

2.8.3 Management factors

Park *et al.*, (2001) point out that lighting is mostly linked to the quality of night-time work. The authors argue that with sufficient lighting, quality of work performed during the night will be similar to that of day-time work. Jackson (2005) concurs, stating that operations at night are nearly as good as those performed during the day if adequate lighting is available. One could argue that, conversely, poor lighting will produce poor quality work and hinder the productivity, as remedial work will be needed the next day. Arditi *et al.*, (2003)

also hold a similar view in that lighting affects quality, productivity and safety directly and it is a critical part of any night-time construction work job. Abraham *et al.*, (2007) points out that lighting increases the visibility of workers and motorists, and also offsets the fatigue workers experience due to disrupted circadian rhythms. The author continues that if adequate lighting is provided and placed appropriately workers can see the activities better. Night time brings the challenge of not having the advantages of natural lighting required for visibility.

The literature points out the importance of providing lighting for night-time construction activities, some authors even arguing that quality of work will not be satisfactory if the lighting is inadequate. According to Bryden and Mace (2002), visibility needs of workers and motorists using the area determine the lighting requirements. Lighting is not only essential for workers and motorists. Abraham *et al.*, (2007) suggest that visibility is also required to ensure proper finishing and compaction of night-time construction products such as concrete and asphalt paving.

Hinze and Carlisle (1990) state that lack of ability to see at night is a limitation to night-time construction. The authors further continue that lighting from shops in proximity or highways is not enough to make the work area properly visible. This suggests for proper lighting of the work area a secondary light source is needed. Bryden and Mace (2002) suggest that three types of lighting configuration, namely “*temporary systems, portable systems and mobile equipment based systems*”, can be used to provide adequate lighting for night-time construction activities. The authors make further suggestions on the classification of lighting levels to be used for different work areas and tasks.

The lighting requirements need to be properly designed to achieve the required level to allow workers to carry their tasks. If the lighting requirements are not properly designed, it may cause difficulty with work area. As much as lighting is essential, it also comes with its own problems. El-Rayes *et al.*, (2003) have identified important factors of lighting problems as “*insufficient lighting levels, glare to workers, glare to road users, non uniformity of lighting levels, light trespass to adjacent facilities, availability of suitable lighting equipment,*

reliability of lighting equipment, difficulty retrofitting construction equipment with additional lighting equipment, placement of lighting equipment, lack of experience in lighting design, lack of lighting design guidelines, and cost of lighting equipment”.

Elrahman (2008) reports that light pollution and glare are often the complaints heard from adjacent neighbourhoods. The author further reports that high towers, intended to produce sufficient light for the work while avoiding the harsh effects on workers and drivers’ eyes, exacerbate the problem of glare. Hancher and Taylor (2001) remark that glare is the major setback linked with lighting on construction sites. Reduction of glare to both workers and on-coming traffic is the key concern. From the literature reviewed, glare, which can be defined as *“the sensation of annoyance, discomfort or loss of visual performance and visibility produced by experiencing luminance in visual field significantly greater than to which the eyes are adapted”* (Triaster, 1982 cited by El-Rayes *et al.*, 2003), is the most prominent of all the lighting factors.

The challenge is to reduce the risk of glare but still provide adequate lighting for the workers.

El-Rayes *et al.*, (2003) state that glare is caused by excessive and improper lighting arrangements. The author further suggests that the three measures to minimise glare are as follows:

- *“selection of lighting source that minimizes glare on site”;*
- *“proper design and arrangement of lighting equipment”;*
- *“utilizing of glare control equipment”.*

With effective glare control measures in place and selection of lighting source that will provide sufficient lighting, the literature points out that difference in the quality and productivity between day time and night-time work would be minimal. Poor visibility, inadequate lighting, workers’ fatigue, and driving conditions create a hazardous situation for drivers, workers and pedestrians (Jackson, 2005). Workers will be more comfortable to do work if they feel that the work area is safe to work in. If the workers feel that the working environment is

not safe they will tend to be more focused on safeguarding themselves rather than concentrating on the task. Accidents may also cause delay of the work, if work needs to be postponed to allow the accident to be attended to. Furthermore, the loss of personnel that are involved in accidents and need to be replaced may also hinder the progress. This makes safety a contributor to the productivity factors that are affected by night-time construction activities. Lack of visibility for vehicles operators as well as drivers' exhaustion and inebriation are some of the unique risks that night-time construction poses for workers' safety (Ellis and Kumar, 1993).

The absence of natural lighting at night makes it more difficult for the work zone to be visible to drivers and puts the workers in danger. Park *et al.*, (2001) report that safety was a primary factor when it came to importance of determining daytime vs. night-time construction; this is due to the seriousness of accidents at night even though they are rare. Jackson (2005) states that the factors affecting night accident rates are: “(1) *inadequate lighting*, (2) *inadequate public lighting*, (3) *lane closures duration decreasing or increasing exposure to hazardous conditions*, (4) *portion of lane closed*, (5) *type of work being done*, (6) *length of the closure*, and (7) *type of traffic control devices*”.

Another argument by Hinze and Carlisle (1990) is that lack of visibility and large amount of intoxicated or distracted motorists cause a more risky situation but safer working conditions may also be created by the reduction of higher frequency in traffic. Workers struck by traffic inside the work area as well as workers struck by construction equipment are the most frequent night-time accidents (Arditi *et al.*, 2003). Jackson (2005) reports that vehicles increase their speed when passing road construction areas and those on foot are less vigilant due to the reduction of traffic at night. This places workers' visibility and speeds of the cars travelling thorough the work zone as the major concerns of night-time construction safety. Hinze and Carlisle (1990) suggest that if motorists decrease their pace when passing the construction areas, the safety will improve. The literature points out that to reduce the frequency of accidents, the work zone and the workers need to be visible to drivers. Drivers need to be aware that there is a work zone ahead and

reduce their speed accordingly. If the drivers are unaware of the work zone or it is not visible to them under the night light and as a result, they increase or maintain high speeds, the likelihood of them causing an accident will increase. According to Rebholz *et al.*, (2004), one of the key methods for decreasing accidents involving workers is “*community awareness, coupled with appropriate traffic control, sufficient lighting and added caution*”.

Holguin-Veras *et al.*, (2003) point out that prioritising police enforcement around the work zone because high-speed motorists are the key concerns of night-time construction workers. Police enforcement is a sufficient deterrent for speeding motorists and safety enhancement in the construction area (Arnold, 2003). Motorists may tend not to adhere to road signs around the work zone requesting them to reduce speeds. High speeds need to be monitored and controlled by authorities who have the right to penalise. A good traffic management and illumination strategy and system will address the problem of visibility (Jackson, 2005).

The presence of law enforcement officers makes motorists aware of the importance of reducing speed when passing through the work zone. The literature also suggests that a traffic control and lighting plan will increase the visibility of the work zone, thus improving safety.

The visibility of the work zone to motorists is important, but the workers in the work zone also face a risk of being run over by motorists who accidentally enter the work zone or by moving equipment in the work zone. Arditi *et al.*, (2003) report that workers being struck by traffic as well as workers struck by construction equipment inside the work area are the most common night-time accidents. Inadequate visibility of workers at night can be linked to most accidents. Protection of workers and personnel who operate on highway construction sites can be provided by high-visibility safety clothing. Reflective strips are fitted to traffic barrels, cones, equipment and person protective gear. The reflective strips are designed to become visible in the dark when they are struck by light. Safety is compromised and the potential of accidents will increase if sufficient lighting is

not provided on the worksite (Abraham *et al.*, 2007). High visibility garments depend on light to function effectively. The literature emphasises that the two elements of safety and lighting cannot be separated. Lighting not only helps perform the tasks under the vague light of the night but also assists with the visibility and the safety of workers.

2.9 CONCLUSION OF LITERATURE REVIEW

The literature has defined key terms related to the study, namely night-time and productivity. The concept of night-time construction was also discussed and it was revealed the only difference between day time and night construction was the fact that night-time construction is done between sunset and sunrise. Traffic accommodation was the main reason for contractors and roads agencies to decide to carry out work at night. Regarding construction activities done at night, there was little to no difference from activities done during the day. The benefits and challenges of night-time construction were also discussed. In terms of human factors that influence the night-time road construction activities, performance of workers was noted as the main cause of loss of productivity. The literature review revealed that night-time road construction productivity was volatile and most contractors did not know the reason behind their increase or decrease in productivity at night. With regard to other industries, the review revealed that in the manufacturing industry, the productivity was inconsistent on different days of the week. The literature search also found that fatigue of workers, sleep deprivation, social adjustment, and negative impact on workers' health would affect the workers' productivity and ultimately the productivity of the night-time project.

Factors that influence productivity were separated into three categories, namely human factors, external factors, and management factors. In terms of external factors, temperature was found to be an important issue in night-time road construction. Low temperatures were found to be unfavourable for the workability of certain materials and for the workers' performance. Lighting and safety of workers were the factors of night-time road construction discussed under management factors. Visibility and glare were the two main factors of lighting;

the literature also suggested that different lighting categories be used for various night-time construction activities. Accidents in the work zone and worker visibility were the main factors associated with safety: if the workers are not visible, they are more likely to be involved in accidents. If these factors are pertinent in the South African night construction industry, then they will have a consequent effect on productivity.

The next chapter presents a discussion of the research methodology for this investigation.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

“Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how the research is done scientifically. In it we study the various steps that are generally adopted by the researcher in studying his research problem along with logic behind them” (Lingayas, 2012).

The purpose of this chapter is to detail and justify the research methodology adopted for this study. Firstly, the chapter details the research philosophy and research approach. The chapter continues with an explanation of the research strategy, process, data collection sampling and data analysis method. Finally, the chapter describes the ethical concerns while collecting and analysing the data.

The “research onion”, figure 3.1, shows how the research was applied to this study to assist the researcher in selecting the appropriate methodology.

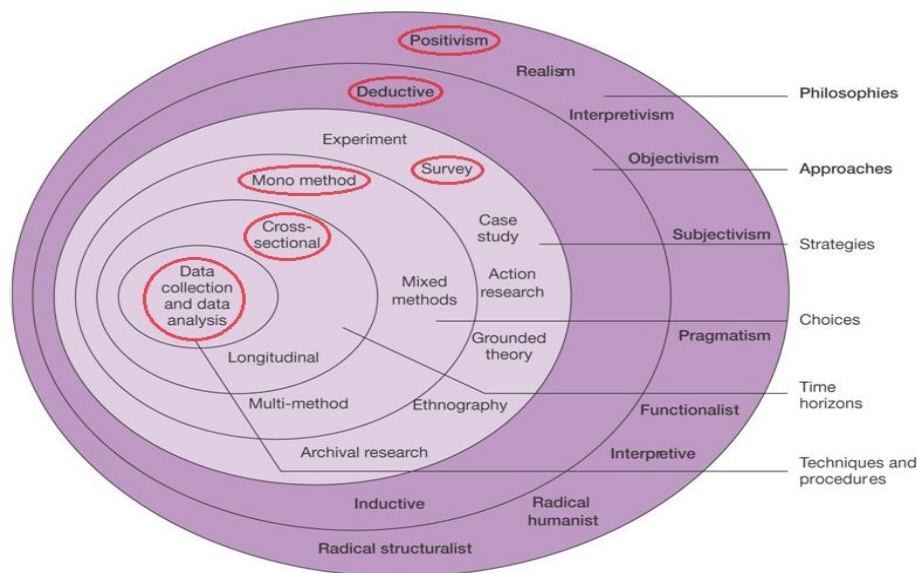


Figure 3.1: “Research onion”

Source: Saunders *et al.*, (2006) in Saunders *et al.*, 2007.

3.2 RESEARCH PHILOSOPHY

The technique by which information about a phenomenon is gathered, analyzed and used is based on the principles of the research philosophy (Davidson, 1998). The “*research onion*” in figure 3.1 shows that a researcher can choose from a number of research philosophies. Those methods include “*positivism, realism, interpretivism, objectivism, subjectivism, pragmatism, functionalist, interpretive, radical humanist and radical structuralism*”. This study adopted the positivist philosophy:

“A positivist approach to the social sciences ... assumes things can be studied as hard facts and the relationship between these facts can be established as scientific laws. For positivists, such laws have the status of truth and social objects can be studied in much the same way as natural objects” (Smith 1998 in Crossan, 2003).

The study subscribed to this method because of its practicality in using experiments and analyses to test the formulated hypothesis. Night-time construction was studied through literature and surveys, the relationship between night road construction and productivity was established and a conclusion was formulated on the factors of night road construction that affect productivity.

3.3 RESEARCH APPROACH

The “*research onion*” indicates that there are two main research approaches, “*deductive*” and “*inductive*”. Deductive research is concerned with the development of a theory and testing it through research, while inductive research is concerned with observation and analysis of the patterns and then formulation of a hypothesis and development of a conclusion (Butt, 2011). A deductive research approach was adopted in this study as it follows the structure of the study, which is concerned with developing a clear path to tackling the research problem. The study formulated a hypothesis that “*night time construction has an effect on productivity*”, and this hypothesis was broken down into researchable questions and objects. Through a review of the literature, the factors were identified and the

research questionnaires developed, distributed, collected and analysed. The hypothesis was tested through the response data and its analysis.

3.4 RESEARCH STRATEGY

The research onion also shows a number of possible research strategies. The study utilized surveys as a research strategy to investigate the research questions and achieve its aims. Survey research uses questionnaires or statistical surveys to establish information on individuals and their behaviour (Butt, 2011). The researcher uses a survey to capture what is happening in an environment at a particular time by means of closed-ended and open-ended questions to sample data from a collective to attain a representation of the population (Williams, 2007). Three sets of questionnaire were formulated and circulated to role players involved in night-time construction activities. Each of the questionnaires had three different sections that were related to the factors identified through the literature. The first section asked questions related to human factors on night-time road construction projects, the second comprised questions related to external factors, and the third included questions linked to management factors. The first questionnaire was circulated to road agencies who are involved in night-time construction activities to obtain information on management and external factors that affect night-time productivity. The second set of questionnaires was targeted at contractors involved in night-time construction activities to ascertain human, external and management factors related to night-time activities. Workers involved in the daily labour activities were also targeted for the last human and external factor questionnaire. Distribution of surveys was through self-administration, email administration and electronic/internet administration.

3.5 CHOICES

Three methods presented by the research onion are available to the researcher: the mono method, which uses a single data collection method and corresponding analysis methods, as well as mixed and multi methods, which use both qualitative and quantitative techniques to investigate the research question in one study (Butt, 2011). Quantitative research techniques involve *“quantifying data and generalising results from a sample to the population of interest”* (Snap Survey

Ltd, 2012). Quantitative research establishes the relationship between only two variables (independent or dependent variable). The method uses one of two research techniques to undertake the study: either descriptive or experimental (Hopkins, 2000). This study utilised a mono method of quantitative research. From the data collected in the literature review and the surveys, descriptive analysis through graphs and tables was done and a conclusion was drawn.

3.6 TIME HORIZONS

The research onion shows that two time horizons exist in any research, namely “*cross-sectional studies*” and “*longitudinal studies*”. Cross-sectional studies are used when the research is constrained to a restricted period and longitudinal studies are used when the study is done over different periods (Butt, 2011). The present study was cross sectional.

3.7 DATA COLLECTION

Lingayas (2012) states the following: “*In dealing with any real life problem it is often found that data at hand are inadequate, and hence, it becomes necessary to collect data that are appropriate*”. There are two types of data that a researcher can collect as evidence to answer the research question adequately. The researcher may generate primary data through survey, experiments, case studies, etc., or opt to analyse existing data through literature review (Van Wyk, 2012). Duval (2005) suggests that “*primary data collection is necessary when a researcher cannot find the data needed in secondary sources*”. The researcher has a number of data collection methods available for collecting primary data, including “*observations, focus groups, personal interviews (one on one), telephone interview/surveys and self administered (mail or internet) surveys*” (Duval, 2005). Secondary data is data that has been published in any form. Literature review in any research can be regarded as secondary data (Hubpages, 2013).

This study selected to use self-administered surveys (hand delivered and internet) as a method of collecting primary data. The study used a literature review as the secondary source of data.

3.8 SAMPLING

In any study the items under evaluation can be regarded as a universe or population (Lingayas, 2012); however, in studies that involve a large population it is not always possible to get information of the entire population and in such cases we study a sample of the population as a representative of the entire population (Mamia, 2006). *“The items so selected constitute what is technically called a sample. The researcher must decide the way of selecting a sample or what is popularly known as the sample design”* (Lingayas, 2012). Several sample design techniques are available to the researcher, such as *“deliberate sampling, simple random sampling, systematic sampling, stratified sampling, quota sampling, cluster and area sampling, multi-stage sampling, and sequential sampling”* (Lingayas, 2012).

This research selected deliberate sampling as the sample design. This method involves purposely or deliberately selecting certain individuals from the population as a sample version of the whole population (Lingayas, 2012). The sample of the study was deliberately taken from the Gauteng region in South Africa. Construction companies and workers on night-time road construction projects were chosen as the respondents of the survey. The survey also selected project managers from the South African Roads Agency Limited (SANRAL) as another respondent group. The sample size for each of the different focus groups was limited to 45 participants, with the total sample size of the study being 135 respondents.

3.9 DATA ANALYSIS

Analysis of the data requires categorising the data, coding the unprocessed data, tabulation and statistical inferences (Lingayas, 2012). The study collected questionnaire results, analysed the data through simple descriptive statistics and the reported inferences. Inferences from the data were obtained and a chain of events was established through the data to support the inferences. The data was classified under three categories, namely human factors, management factors and external factors. Data received from the three questionnaires was also categorised under these headings.

3.10 REALIBILITY AND VALIDITY

“Reliability is defined the extent to which a questionnaire, test, observation or any measurement procedure produces the same results on repeated trials. Validity is defined as the extent to which the instrument measures what it purports to measure” (Miller, 2011).

Miller (2011) states that, reliability and validity are the most essential feature of any measurement procedure. In this study, triangulation of the findings is used as the strategy for reliability and validity.

3.11 ETHICAL CONSIDERATIONS

This study adhered to the framework and policies of the University of the Witwatersrand’s School of Construction Economics and Management Research Ethics Committee.

Information given by the participants (construction workers) may not favour their employers; hence, names of participants in the survey were not disclosed. Furthermore, the responses were kept confidential and remain property of the university.

One of the questionnaires targeted low-level workers who might not be proficient in English, and this would have discriminated against them when answering the questions. The questionnaire was therefore translated to the language of their proficiency for those not proficient in English.

Responses from the contractors may taint their relationship with the road agencies that employed them; hence, contractors’ names and names of those employees who answered the questionnaire on their behalf were not published as part of this study.

Furthermore, no data was obtained under duress and all participants were informed of their right to discontinue participation in this research at any time without reason.

Persons below the age of 16 were not allowed to participate in the questionnaire and confirmation of this was obtained from the participants before answering any questions.

3.12 SUMMARY

This chapter has provided detail of the research methodology subscribed to in this study, which used the research onion as a guideline for the choice of the appropriate methods.

The chapter has provided a detailed account of the research philosophy, approach and strategies. Furthermore, the chapter has discussed the choices, time horizons and research techniques and procedures adopted by the study, which used positivism as the main research philosophy, then further elected a deductive approach to tackle the research question. Surveys were used to collect data from respondents and simple descriptive analysis to analyse the data.

The next chapter details the data analysis and presents the results of the study.

CHAPTER 4: DATA ANALYSIS AND PRESENTATION OF RESULTS

4.1 INTRODUCTION

This chapter presents an analysis of the collected questionnaire results and reports inferences. Simple descriptive statistics were used to obtain the inferences from the responses. The chain of events was established through the data to support the inferences. Results were presented in categories of the various factors affecting the night-time road construction productivity, namely human factors, management factors and external factors. Finally, the chapter provides a summary of the overall analysis.

4.2 SURVEY RESPONSE

Forty-five questionnaires were distributed to construction workers on night-time construction projects in the Gauteng region. Eighteen were received, which is a 40% response. Table 4.2.1 shows the job category and the response rate of each category of workers that responded to the survey.

Table 4.2.1: Workers survey responses

No	Job category	Number of respondents
1	Foreman	3
2	Skilled labour	7
3	Unskilled labour	2
4	Other	6

In terms of responses to the contractors' survey, forty-five questionnaires were distributed to contractors on night-time road construction projects in the Gauteng region. Eleven out of the total distributed were received, which is a 24% response rate. Table 4.2.2 shows the job category and the response rate of each category of the contractors who responded to the survey.

Table 4.2.2: Contractors survey responses

No	Job category	Number of respondents
1	Director	2
2	Project manager	2
3	Site engineer	2
4	Other	5

In the SANRAL project manager's survey, 10 questionnaires were distributed to South African National Roads Agency Project Managers in the Gauteng region. Four completed surveys out of the total distributed were received, which is a 40% response rate. Table 4.2.3 shows the job category and the response rate of each category of the contractors who responded to the survey.

Table 4.2.3: Project managers survey responses

No	Demographics of job	Number of respondents
1	Project manager	4

Table 4.2.4 gives a representation of the survey respondents and the factors to which they responded.

Table 4.2.4: Questionnaires and respondents

	Human Factors	Management Factors	External Factors
Construction workers			
Contractors			
SANRAL project managers			
Number of respondents	29	15	33

The construction workers responded to questions mainly related to human factors and external factors, as those are the factors that would affect them directly whilst working at night. The contractors responded in all three categories, as they would get involved in human resources issues brought about by human factors and management issues in managing the works, and they have knowledge and control over the external factors. The SANRAL project managers were asked to respond to questions only related to management and external factors.

4.3 HUMAN FACTORS

The survey asked the workers about the number of working days per week on night-time construction projects. Most of them worked five days a week, as seen in figure 4.3.1.

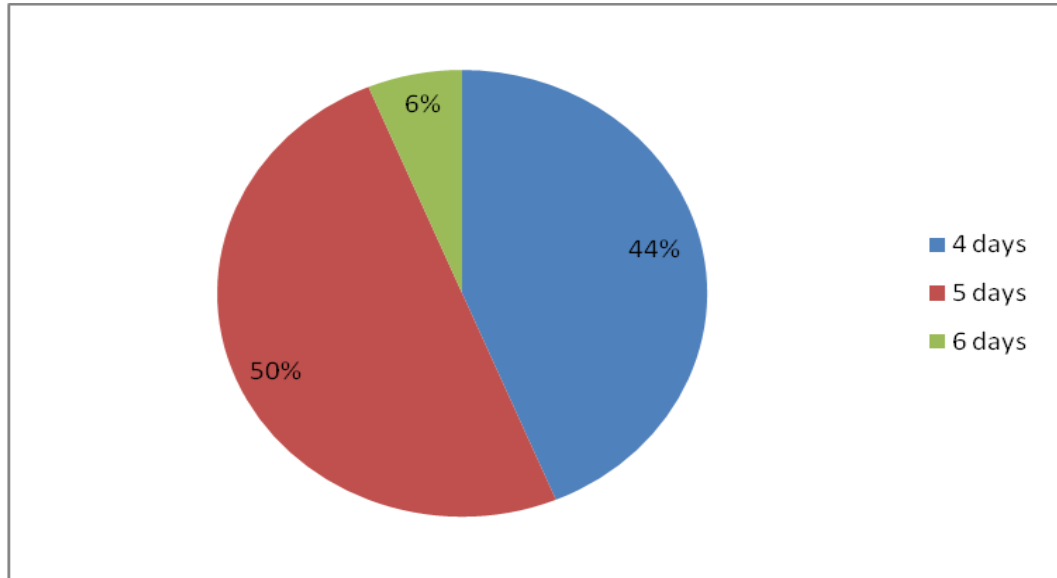


Figure 4.3.1: Workers' response on working days per week at night

This corresponds to the contractors' response as shown in figure 4.3.2 .

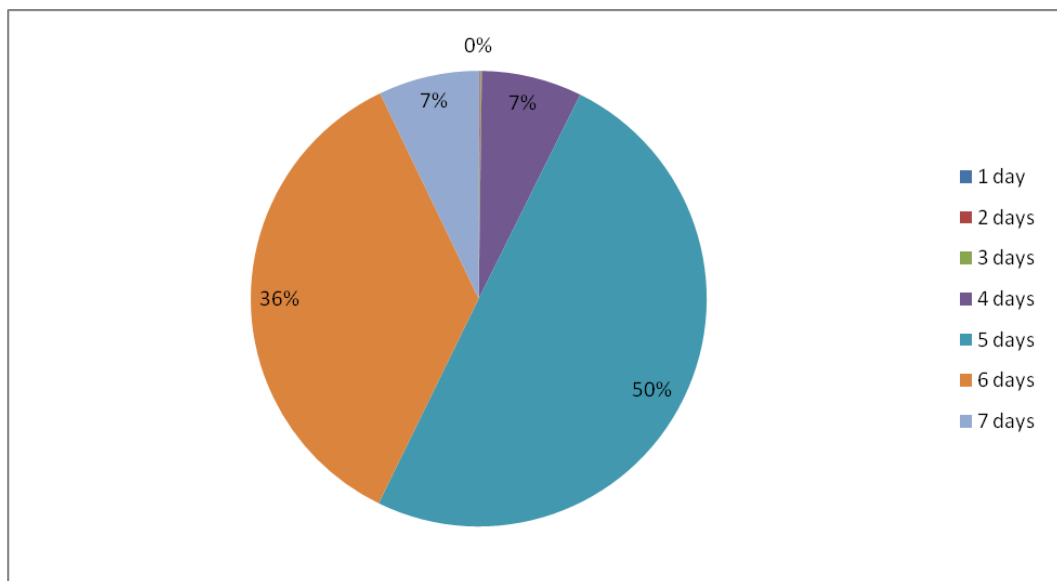


Figure 4.3.2: Contractors' response on workers' working days at night

The survey also asked how many hours the workers worked at night. Most of them worked for 12 hours at night, as can be seen in figure 4.3.3 .

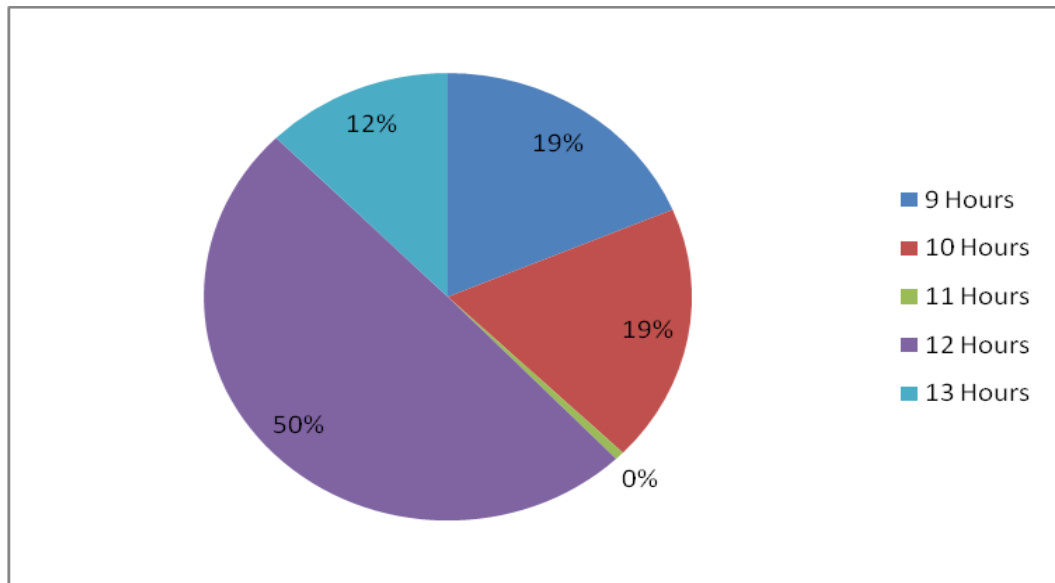


Figure 4.3.3: Workers' response on working hours at night

The contractors were asked how many hours of sleep the workers got during the day if they were scheduled to work night. Most of them responded that the workers got seven hours of sleep during the day if they were scheduled to work at night. Results are shown in figure 4.3.4.

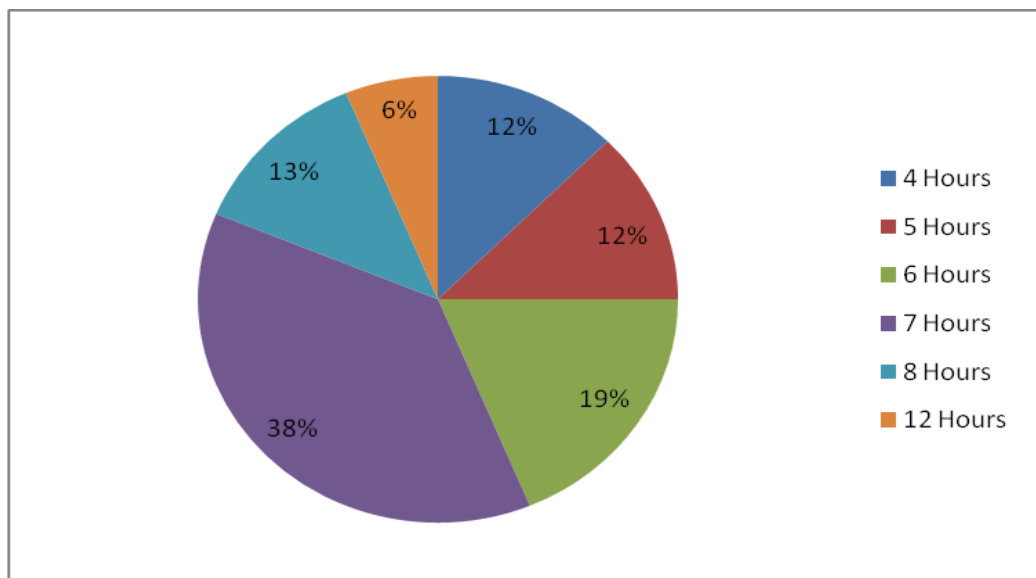


Figure 4.3.4: Workers' response on sleeping hours during the day

The survey asked the workers if they got adequate sleep during the day and whether they were not fatigued if they were to work at night. Most workers responded that they got adequate sleep and were not affected by working at night. Furthermore, the workers responded that they were alert when working at night, and that it did not influence their absenteeism or their social life. The results of the above are shown in figure 4.3.5 .

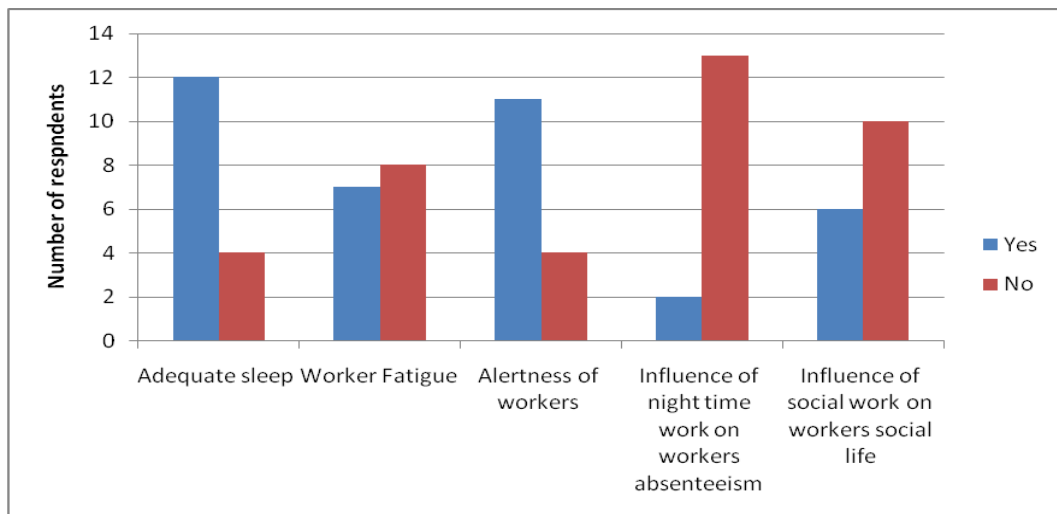


Figure 4.3.5: Workers’ response on influence of working at night on their sleep

From the survey, most of the contractors also confirmed the workers’ statements and responded that they did not receive complaints from workers being tired from working at night and that from their observations the workers were alert at night. The contractors were also asked if the workers received regular medical checkups and if they had rotational shifts on night-time projects to assist with their recuperation. They responded that the workers did receive regular medical checkups and that they did employ rotational shifts on night-time projects. Results of the above are shown in figure 4.3.6.

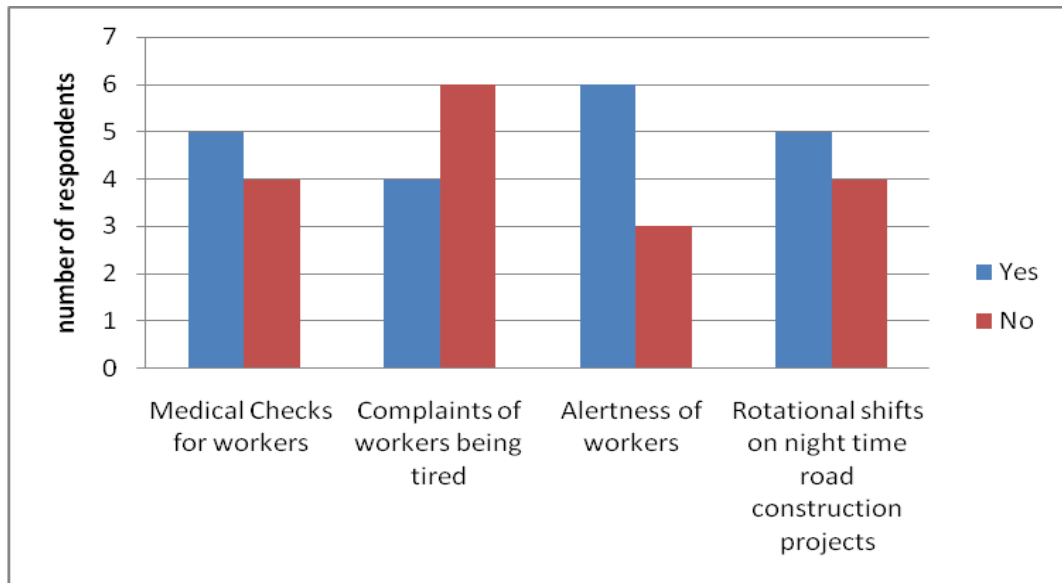


Figure 4.3.6: Contractors' response on influence of night work on workers' sleep

Contrary to the reaction of the contractors, most of the workers responded that they did not receive regular medical checkups but working at night did not influence their health or their ability to carry out their task effectively. Results of the above are shown in figure 4.3.7 .

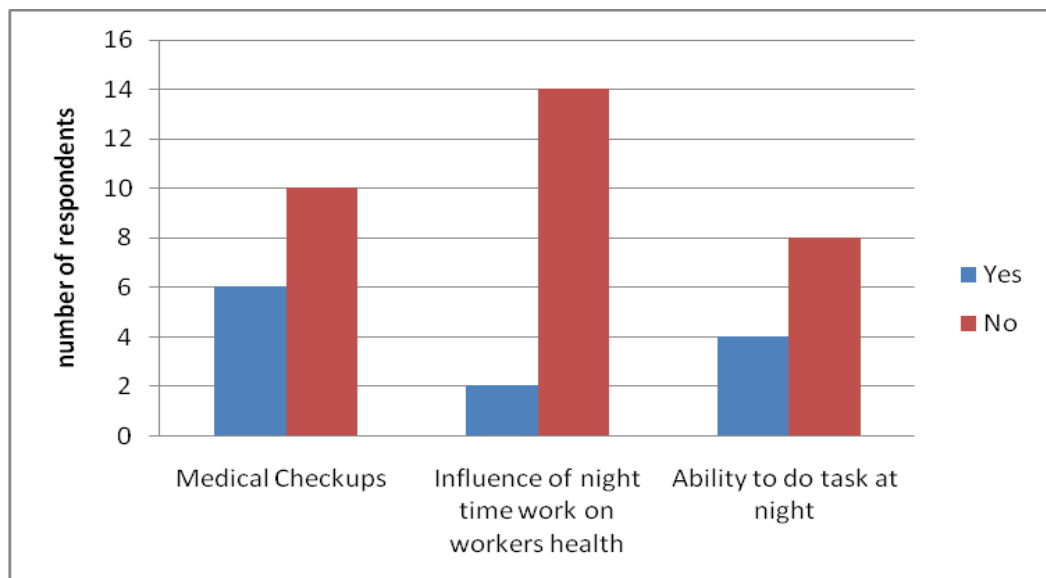


Figure 4.3.7: Workers' response on influence of night-time work on their health

Furthermore, most of the contractors stated that the workers were absent for one day per week on night-time construction work, as seen in figure 4.3.8.

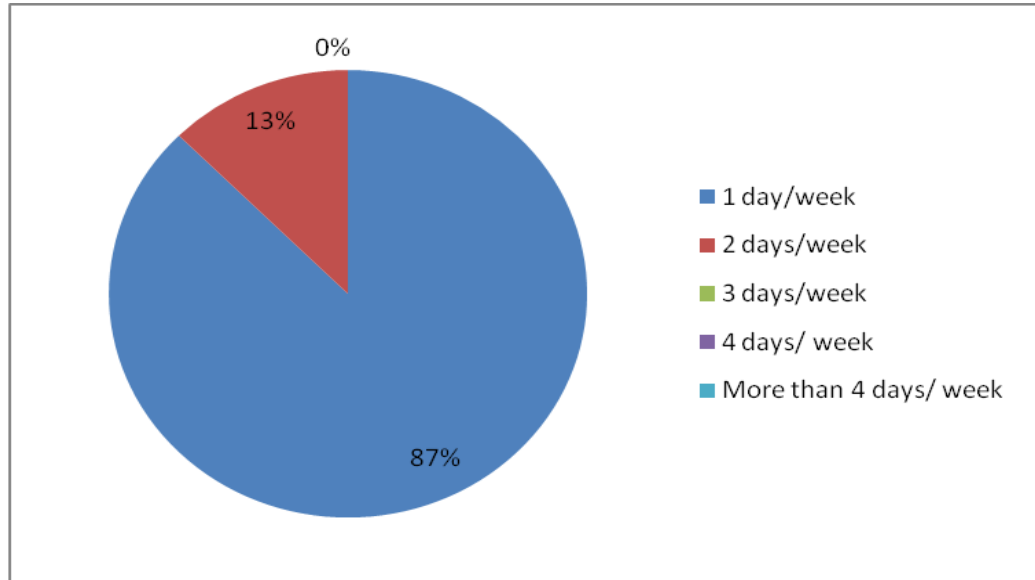


Figure 4.3.8: Contractors' response on workers' absenteeism on night-time projects

Figure 4.3.9 shows that most of the workers disagreed that their absenteeism on night-time work was caused by fatigue, lack of compensation, lack of sleep and social adjustment, i.e. wanting to be with their families during the day.

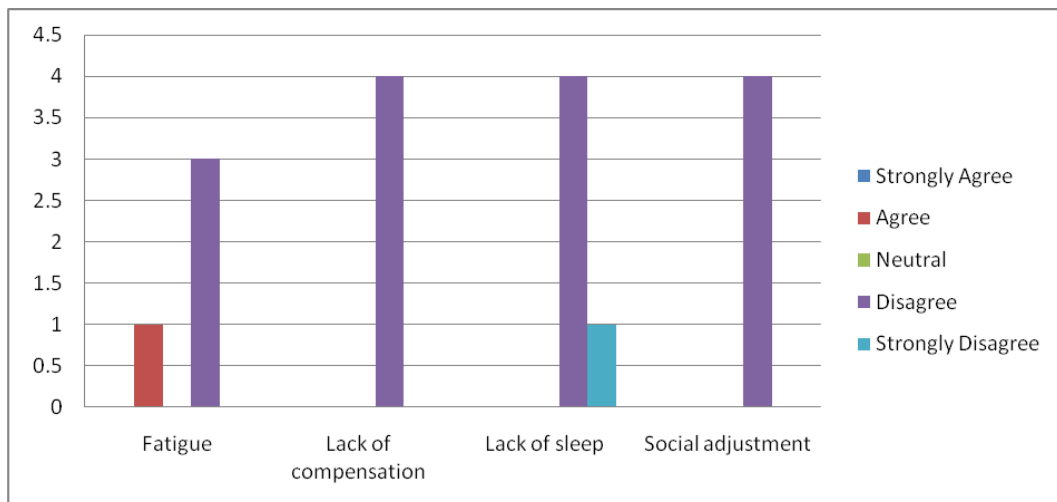


Figure 4.3.9: Workers' response on influence of night-time construction on absenteeism

The workers' sentiments concur with the contractors' response as they also strongly disagree that workers absenteeism is caused by any of the factors above, as can be seen in figure 4.3.10.

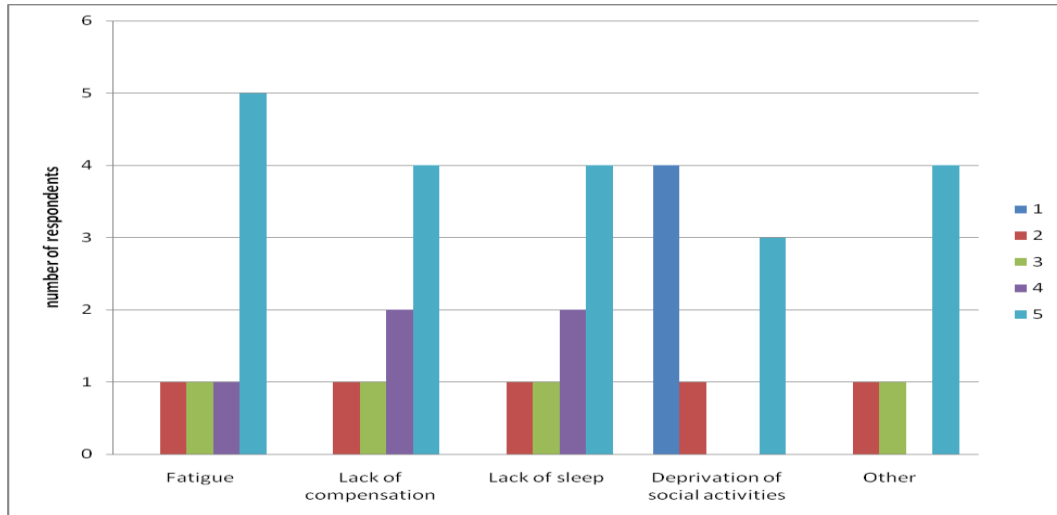


Figure 4.3.10: Contractors' response on influence of night-time construction on workers' absenteeism

Furthermore, the workers and the contractors agreed that the workers were motivated by extra compensation on night-time road construction projects and that there was a difference between normal overtime compensation and night-time compensation. Results are shown in figures 4.3.11 and 4.3.12 .

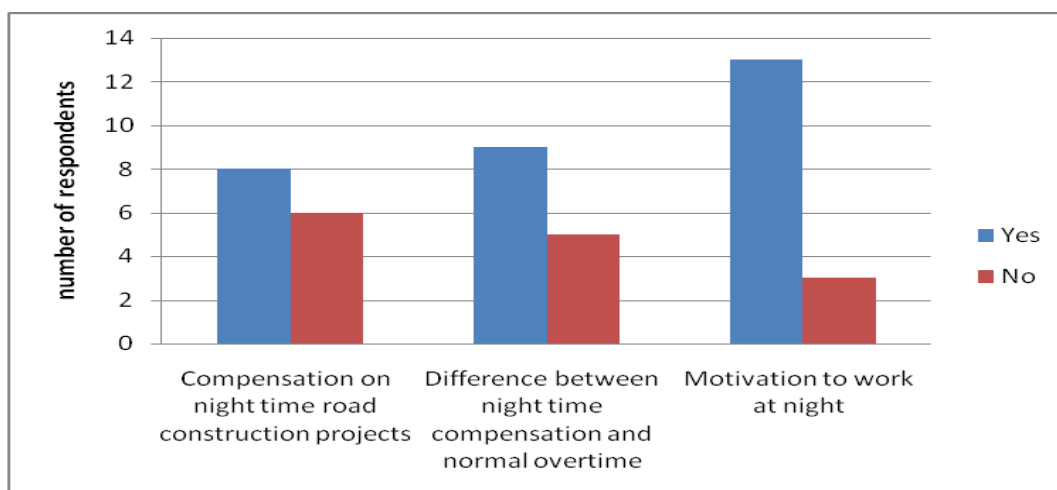


Figure 4.3.11: Workers' response on compensation and motivation of workers on night-time construction projects.

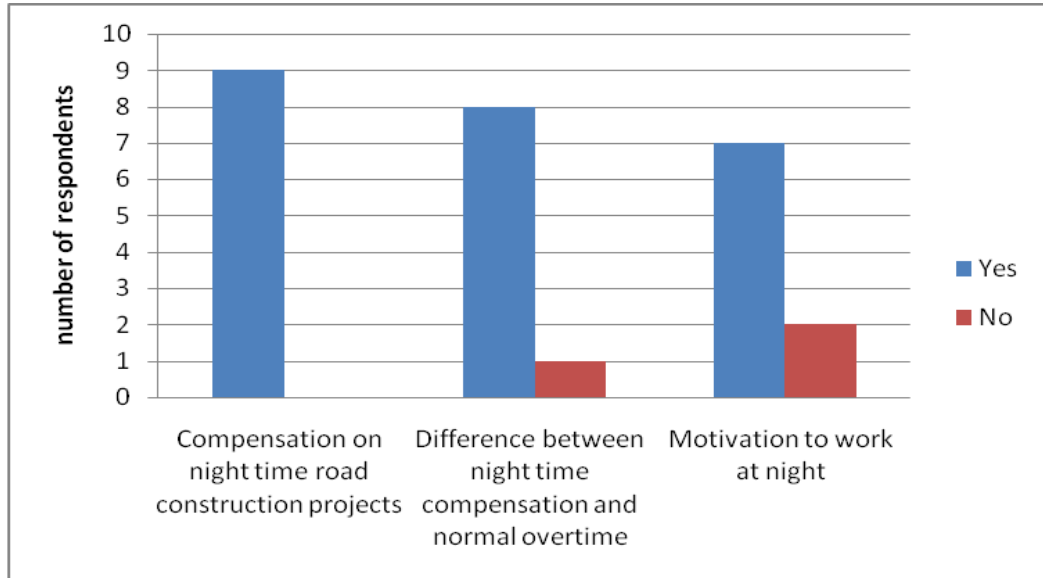


Figure 4.3.12: Contractors' response on compensation and motivation of workers on night-time construction projects.

The contractors responded that they did motivate the workers on night-time road projects and the workers agreed that extra compensation and extra leave were the reasons for them to stay motivated on night-time construction jobs. Results are shown in figure 4.3.13.

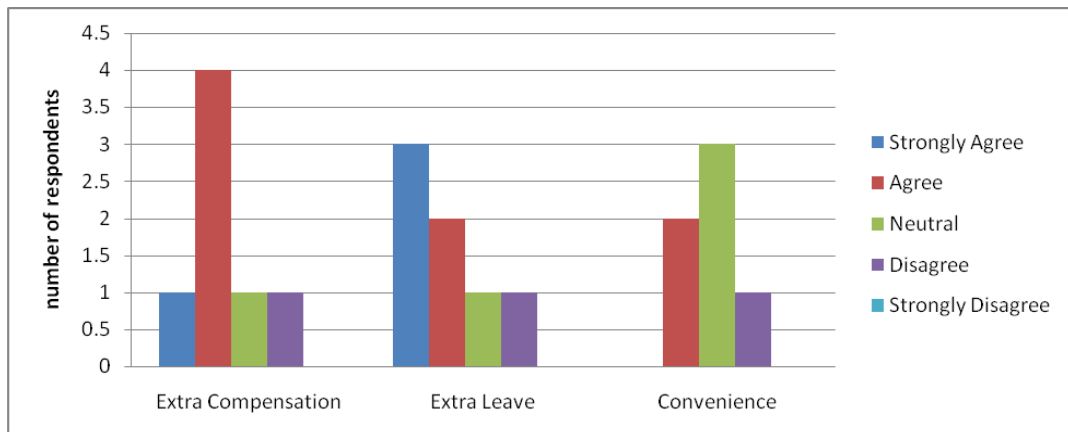


Figure 4.3.13: Workers' response on motivation factors on night-time projects

This was also the response of the contractors; most of them agreed that extra compensation motivated the workers on night-time construction projects. Results can be seen in figure 4.3.14.

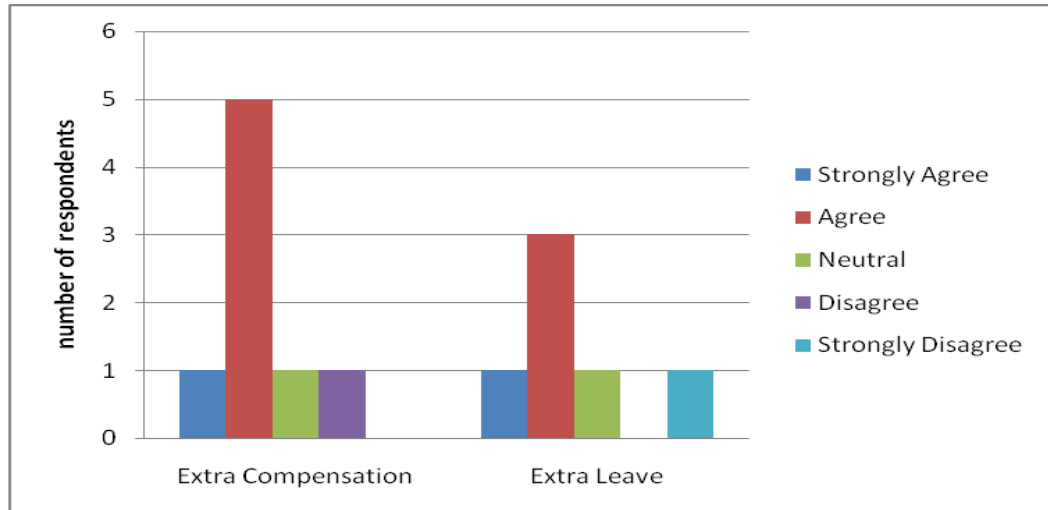


Figure 4.3.14: Contractors' response on motivation factors on night-time projects

4.4 MANAGEMENT FACTORS

The survey asked the contractors if they had different lighting categories for various types of work on night-time construction projects. Most of the contractors responded negatively, which means that they use the same lighting for all types of work. Results can be seen in figure 4.4.1.

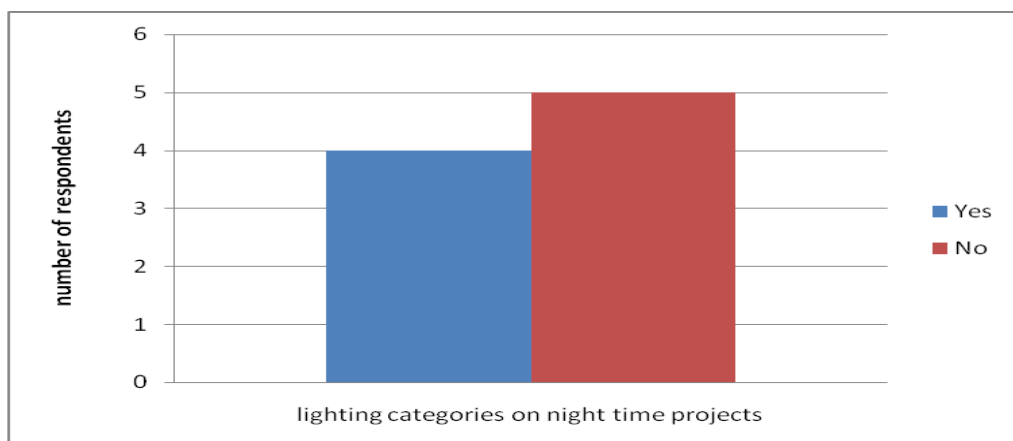


Figure 4.4.1: Lighting categories

Furthermore, the survey asked the project managers if their agency had regulations on different lighting categories. Most of them responded that they did indeed have different lighting categories, which is contrary to the contractors' response that they have no lighting categories. The project managers also mentioned that they had received complaints from motorists about glare from lighting luminaries. Results are shown in figure 4.4.2.

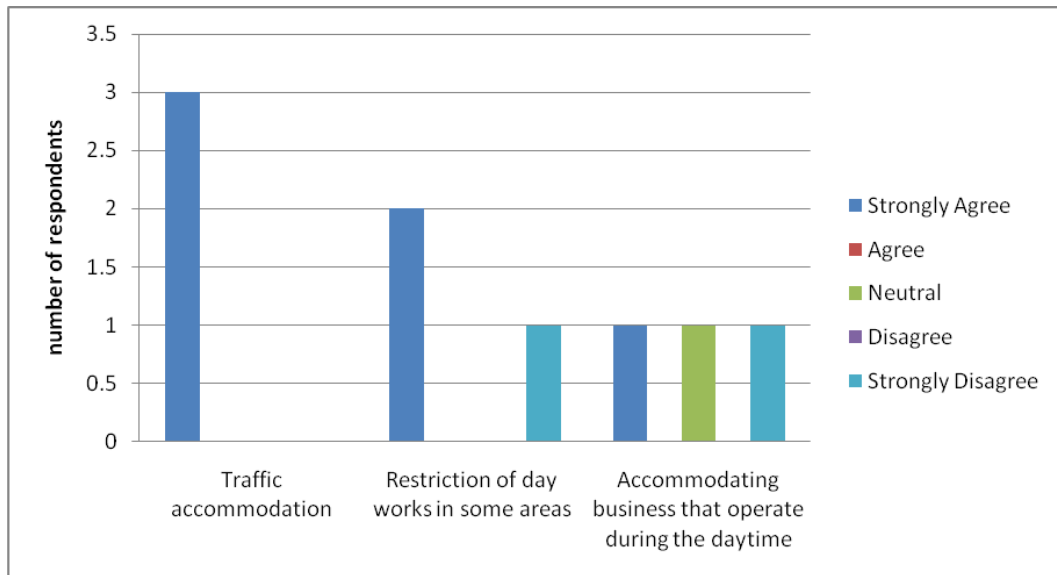


Figure 4.4.2: Project managers' response on lighting regulations and complaints

The contractors were also asked about the problems they experienced with lighting. Most of them denied that insufficient lighting levels, reduced reliability of lighting equipment, difficulty retrofitting construction equipment with lighting equipment, difficulty with placement of lighting equipment, lack of experience with lighting design, and lack of lighting design guidelines were the problems that they experienced with lighting. They responded that the problems they had with lighting on night-time construction projects were attributable to glare to workers and non-uniformity with lighting equipment. Results are shown in figure 4.4.3.

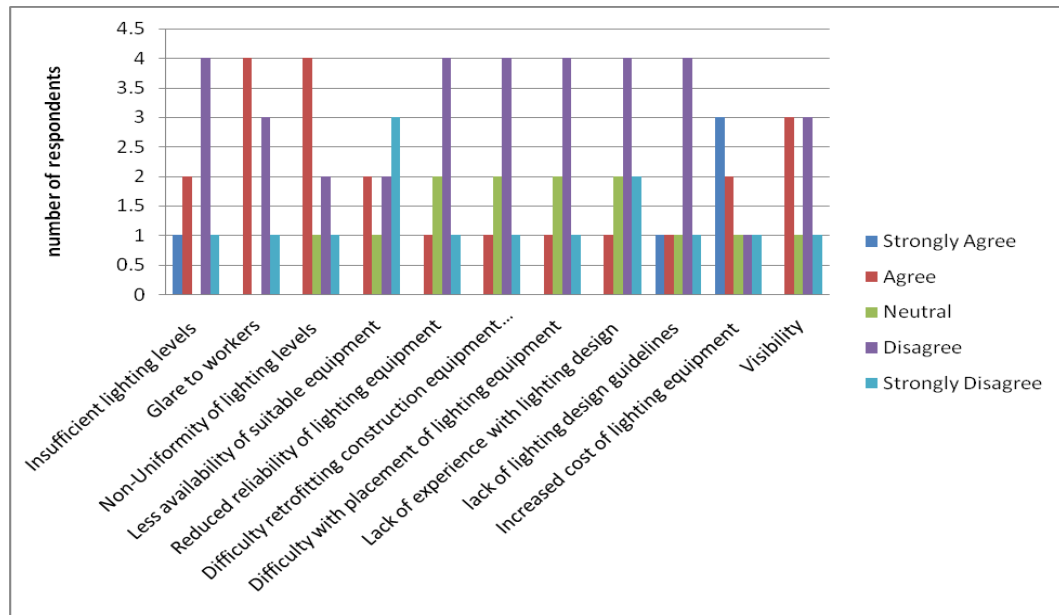


Figure 4.4.3: Lighting problems on night-time construction projects

Furthermore, when asked about safety precautions on night-time construction projects, most of the contractors did give the workers reflective clothing and did have reflective clothing guidelines. The contractors also stated that they conducted safety inductions, employed extra safety personnel and carried out safety inductions for night projects and public awareness about night-time construction project scheduling. Results are shown in figure 4.4.4.



Figure 4.4.4: Safety precautions on night-time construction projects.

The project managers' response concurs with the contractors, as they stated that their agency did carry out inspections at night and they did have guidelines on safety, traffic control and personal protective clothing. Furthermore, the project managers were neutral on whether they received reports on accidents on night-time projects, but the number of accidents were the same during the night as on day-time projects. Results can be seen in figure 4.4.5.

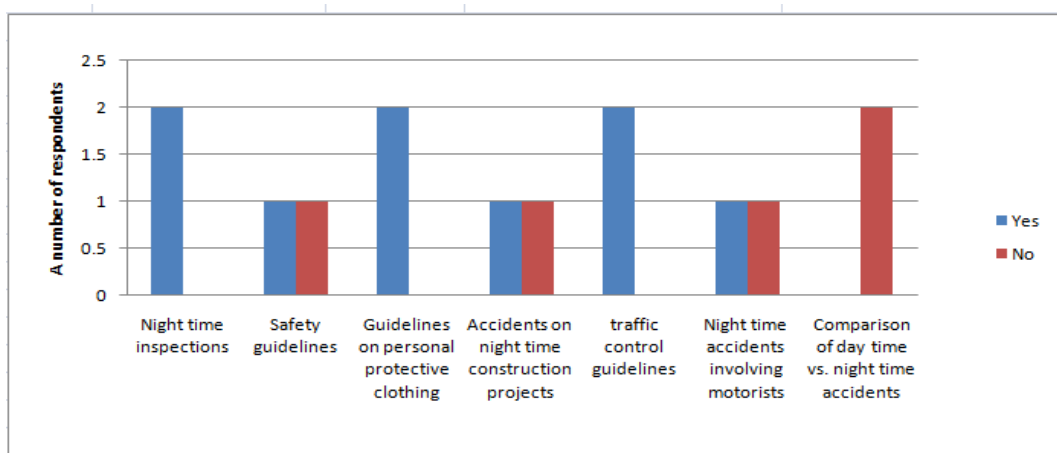


Figure 4.4.5: Safety guidelines on night-time projects

When asked about the cause of accidents on night-time construction projects, the contractors agreed that motorists entering the work zone were the main cause. The

contractors also disagreed that moving equipment, lighting failure, laziness of workers, lack of personal protective equipment (PPE), and lack of enforcement of safety guidelines were the cause of accidents. Results are shown in figure 4.4.6.

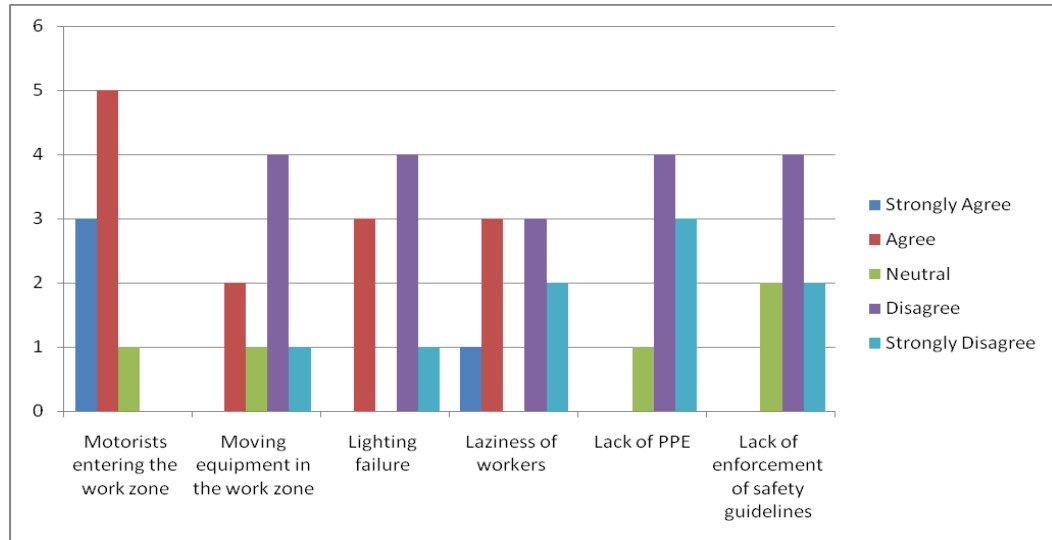


Figure 4.4.6: Cause of accidents on night-time construction projects.

The contractors also mentioned that the frequency of accidents was one accident per month, as seen in figure 4.4.7.

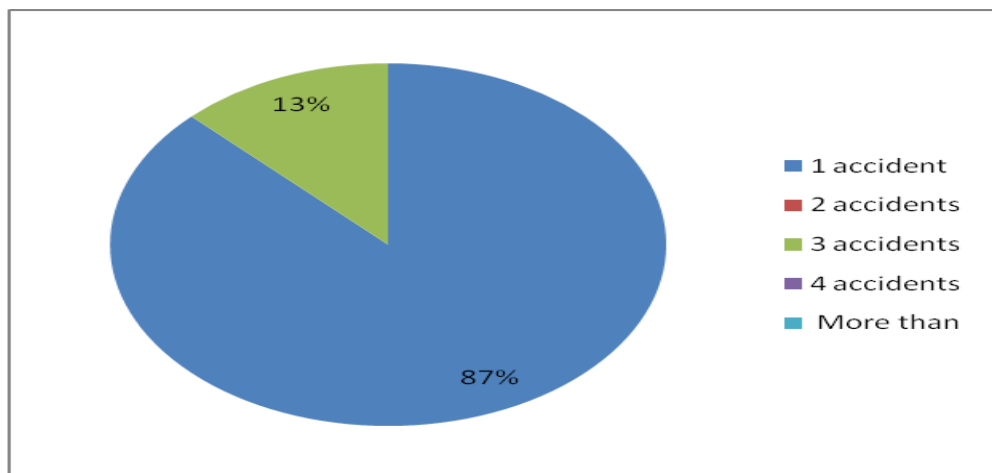


Figure 4.4.7: Prevalence of accidents

The contractors were asked the reason for carrying out work at night; most of them strongly agreed that traffic accommodation was the reason. The contractors added that another reason they carried out work at night was that it was part of

their contract requirements set out by the road agency. Results are shown in figure 4.4.8.

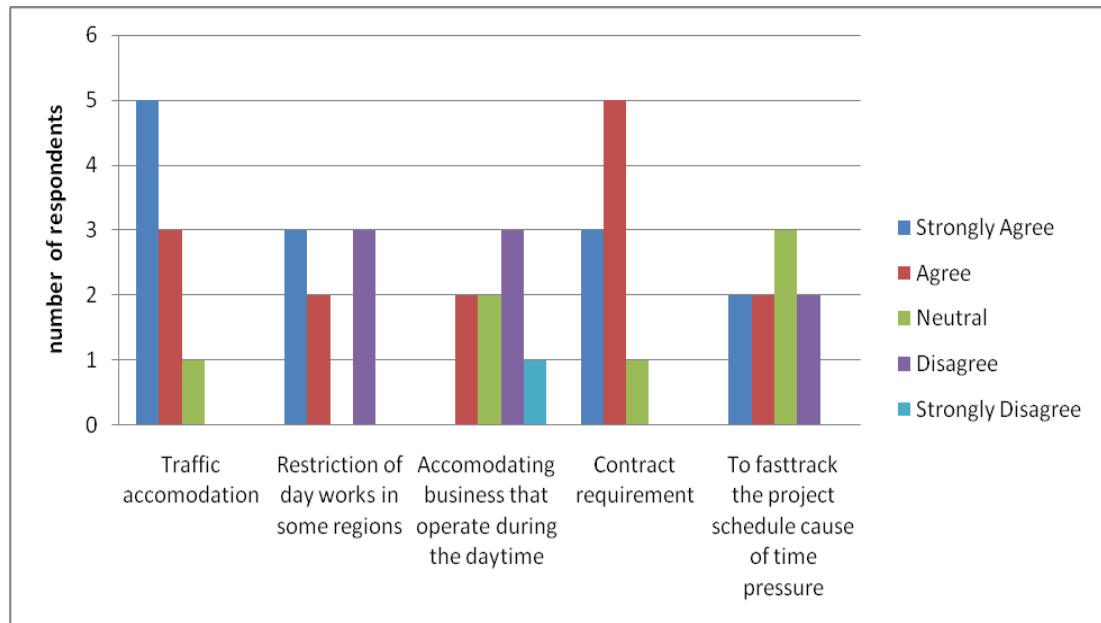


Figure 4.4.8: Reason for working at night

The project managers also strongly agreed with the contractors: traffic requirements were the reason for them to opt to carry out night-time work. Another reason was restrictions with day-time work in some areas. This can be seen in figure 4.4.9.

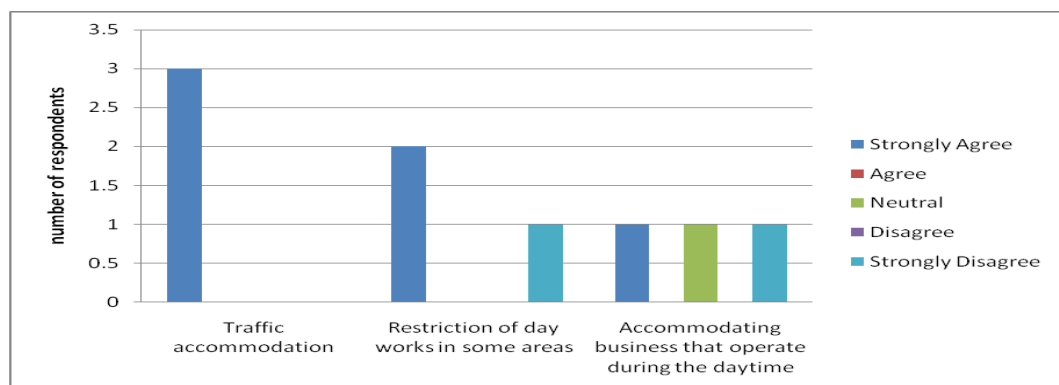


Figure 4.4.9: Project manager reason for carrying out work at night

Asked about the benefits of carrying out work at night, most of the contractors mentioned longer working periods, improved air quality, enhanced working conditions and reduced costs. Results are shown in figure 4.4.10.

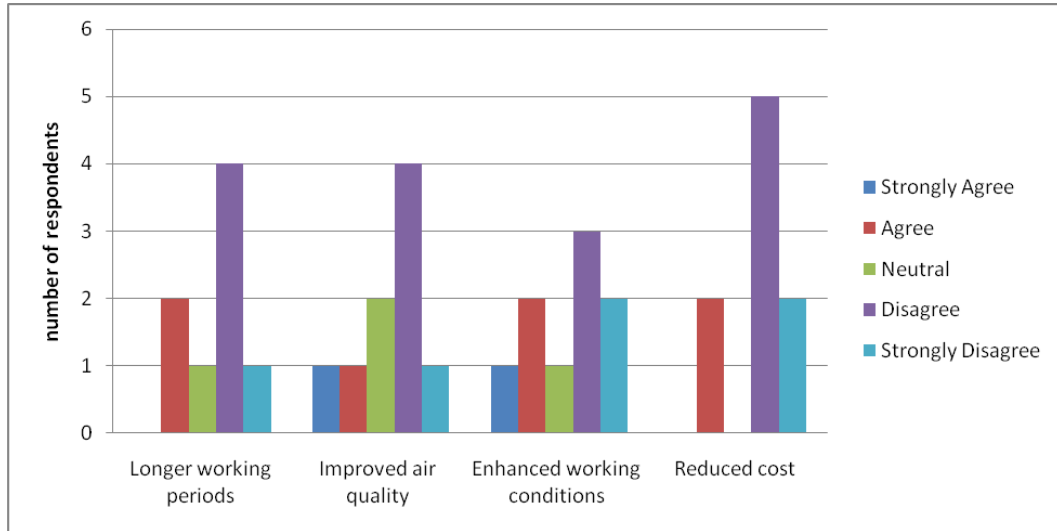


Figure 4.4.10: Benefits of night-time construction

Asked about the challenges of night-time road construction projects, most of the contractors mentioned working in low temperatures and difficulty with lighting. This is shown in figure 4.4.11.

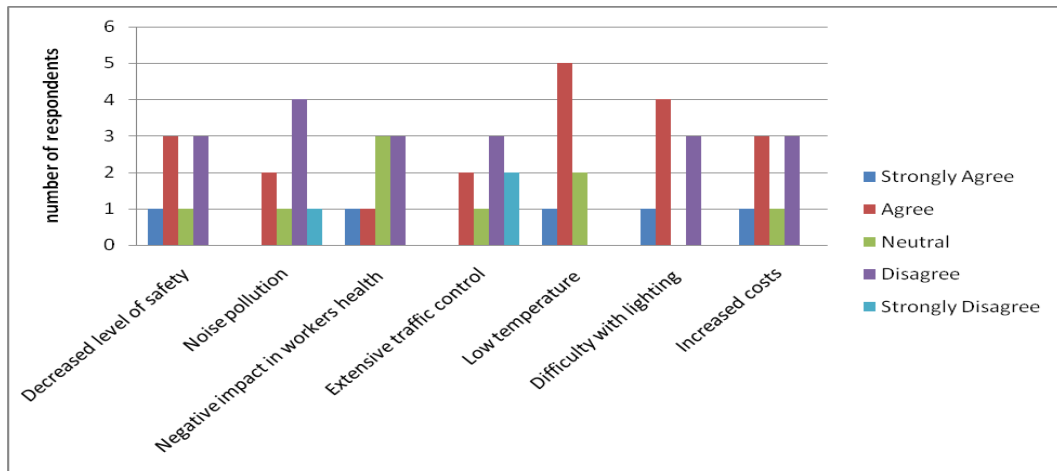


Figure 4.4.11: Challenges of night-time road construction

The contractors were asked about the daily start time of night-time road construction projects. Most of them agreed on 8 pm, the same time mentioned by the project managers. Results are shown in figure 4.4.12.

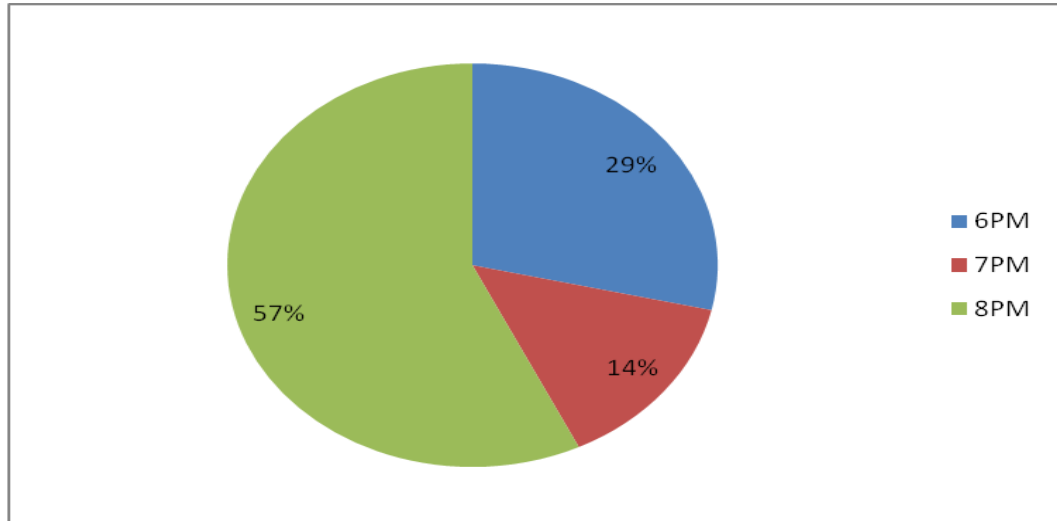


Figure 4.4.12: Daily start time on night-time construction projects

The contractors were also asked about the daily end time of night-time road construction projects. Most of them replied that work ended at 5 am, the same time that was mentioned by the project managers. Results are shown in figure 4.4.13.

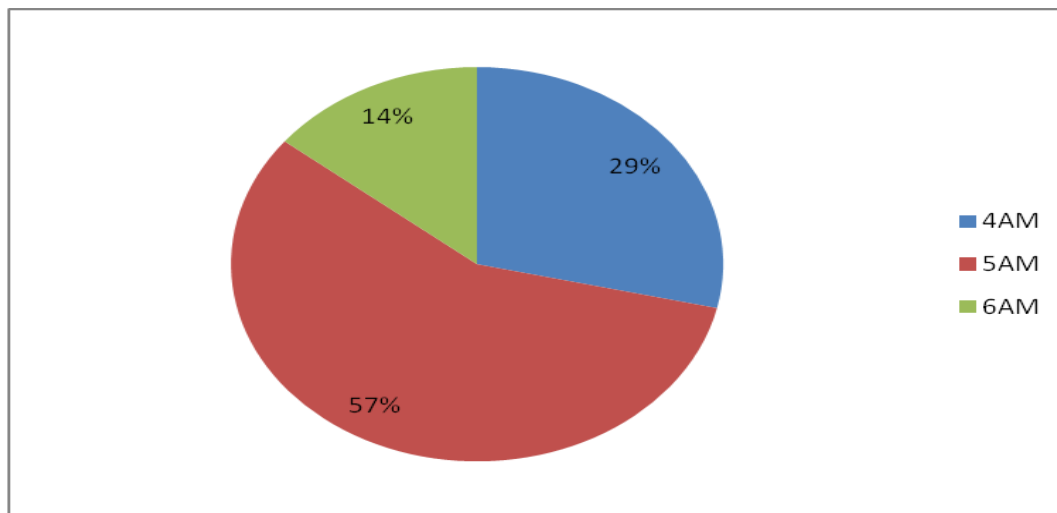


Figure 4.4.13: Daily end time on night-time construction projects

4.5 EXTERNAL FACTORS

According to the survey results, most of the workers are comfortable with the working temperature at night and receive PPE to protect them in extreme weather. The workers did not mention problems carrying out their individual tasks at night or with any maintenance or construction activities. Results are shown in figure 4.5.1.

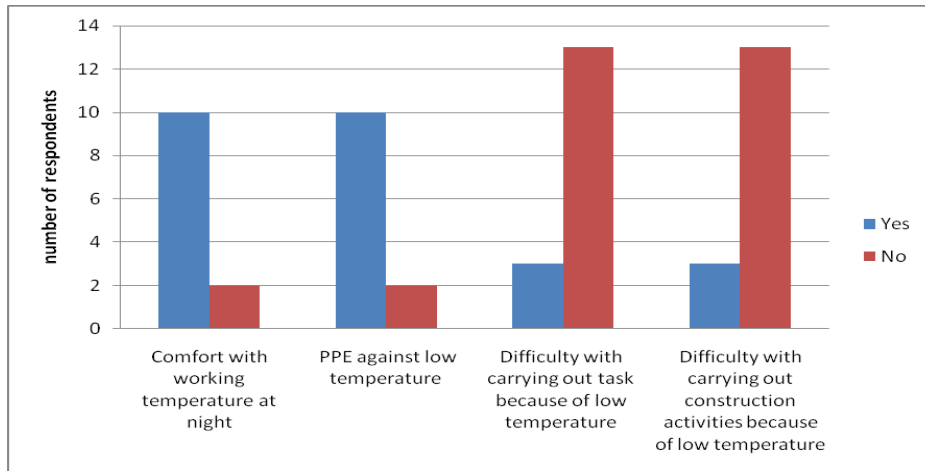


Figure 4.5.1: Worker's response on working temperature at night

The contractors' response concurred with the workers: they responded that the workers were comfortable with the working temperature at night but that there were construction or maintenance activities that could not be carried out at night. Results are shown in figure 4.5.2.

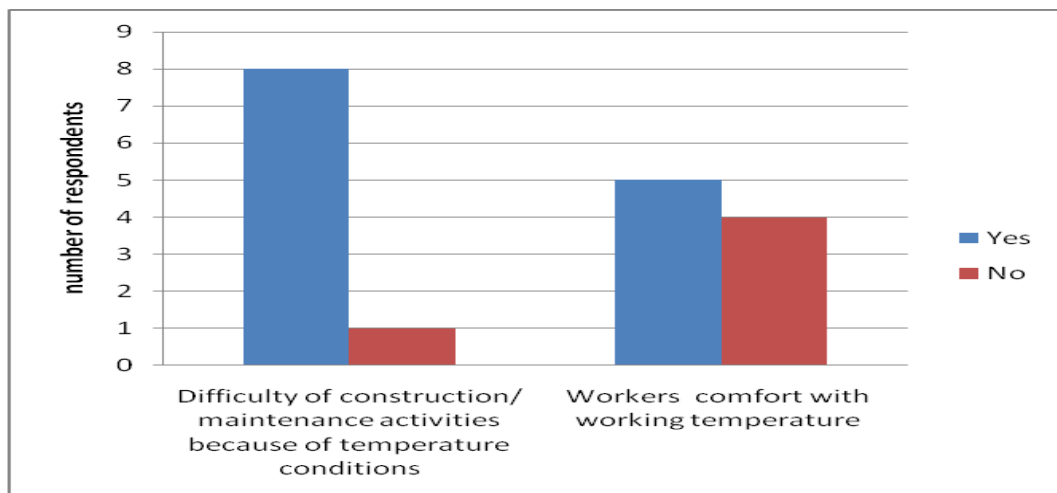


Figure 4.5.2: Contractors' response on working temperature at night

Asked about the type of PPE workers received to deal with severe low temperature, most of the contractors responded that workers received insulated jackets when working at night. Results are shown in figure 4.5.3.

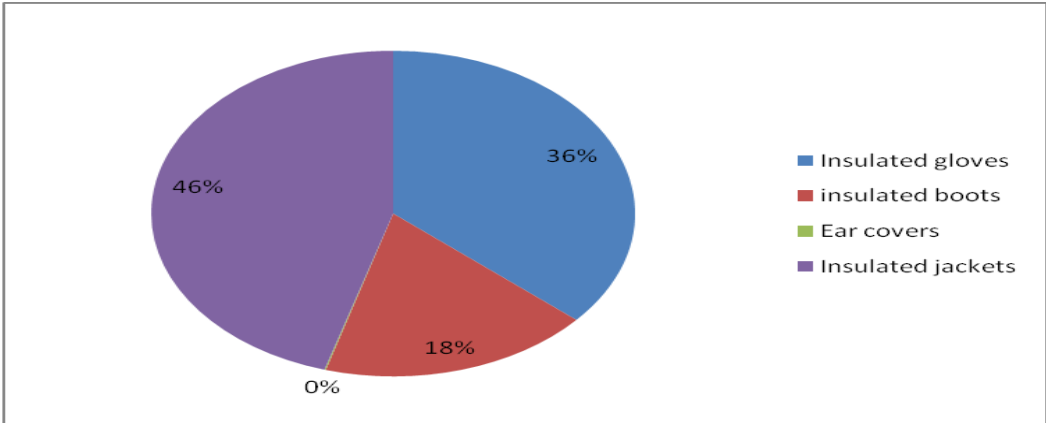


Figure 4.5.3: PPE on night-time construction projects

The project managers were asked about regulation working temperatures for certain activities and for workers on night-time projects. Most of them replied that their agency had regulations on working temperatures for certain construction activities and for the workers at night. When asked about remedial work for work done at night and delays caused by low temperatures, the project managers were neutral on both issues. Results are shown in figure 4.5.4.

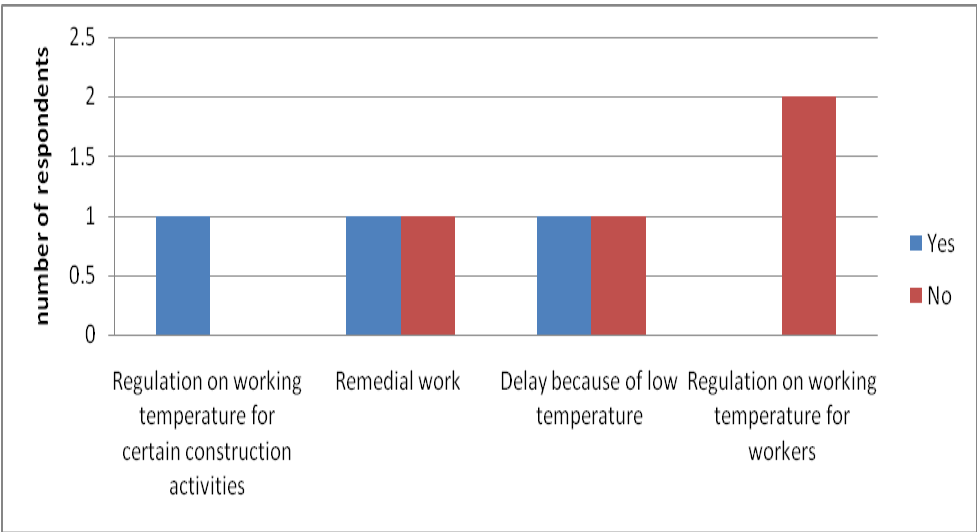


Figure 4.5.4: Project managers' response on working temperature at night

4.6 SUMMARY OF SURVEY RESULTS

The next section provides a summary of the survey results.

4.6.1 Human factors

Most of the workers responded that they got enough hours of sleep, were not fatigued and were alert when working at night, which coincides with the contractor's responses that the most of them had not received complaints and that workers were alert at night. However, most workers stated that they did not receive regular medical checkups, which contradicts the contractors' response; workers further stated that working at night did not affect their health and their ability to carry out their task. Moreover, working at night did not seem to have a negative effect on the workers' social lives and they were not more absent from work than they would be during the day shift. Both the workers and contractors ruled out all of the suggested reasons for absenteeism. Both the workers and the contractors agreed that the workers were compensated for working at night and that night-time compensation was more than ordinary day-time overtime compensation. The workers commented that they were motivated to work at night and most of the contractors stated that they motivated the workers. Extra compensation and extra leave were mentioned by both parties as motivation.

4.6.2 Management factors

The contractors reacted that they did not have different lighting categories on night-time projects, which is contrary to the project managers' response that their agency had lighting guidelines for different lighting categories. The project managers also replied that they did receive complaints from motorists about glare from lighting luminaries on night-time projects. Glare to workers and non-uniformity of lighting levels were problems experienced by the contractors.

Contractors said that they applied safety precautions on night-time construction projects such as providing workers with reflective clothing and doing public awareness education. This was consistent with the response of the project managers as their agencies had guidelines on safety precautions. Motorists entering the work zone were the main cause of accidents, according to the

contractors, while project managers stated that there were guidelines on traffic control and they did get reports of accidents involving motorists at night; however, accidents at night did not exceed the number of day-time accidents. The contractors reported one accident per month during night-time construction. Both the contractors and the project managers conceded that traffic accommodation was the main reason for carrying out work at night.

The contractors regarded difficulty with low temperatures and lighting as the challenge of night-time construction. Most of them agreed that there were construction activities that they could not do at night.

4.6.3 External factors

Most of the workers were comfortable with the working temperature and this concurs with the response from the contractors. There was no construction/maintenance activity that the workers could not do at night, which contradicts the contractors' response. Most of the contractors provided the workers with insulated boots and gloves to assist with low temperatures. The project managers mentioned that they had asked for remedial work on night-time construction projects because of poor work and had regulations on working temperatures.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This chapter discusses the literature review and the findings from the analysis of the surveys and the supporting literature. In addition, the chapter makes recommendations on how to improve productivity on night-time construction projects and provides suggestions for further studies.

5.1 CONCLUSIONS

The literature review was used to identify factors that influence night-time construction productivity. Those factors were grouped into three categories, namely human factors, management factors and external factors, followed by a further literature search. It was found that if those factors were significant on night construction projects in South Africa then they would have an effect on productivity.

A survey was conducted and a population of three groups was targeted as the participants, namely contractors, workers and project managers.

The results of the surveys appear to indicate that in South Africa the human factor will not be significant in night-time road construction; the workers were not tired working at night; got enough hours of sleep to enable them to carry out their task at night efficiently; were always alert; were not absent from work more than they would be during the day; and it did not affect their health and social life. The contractors had not received complaints of workers being tired.

External factors might be an issue; the contractors responded that there were some construction/maintenance activities that could not be done at night, not only because of the time of day but also because of low temperatures at night. No external factors, such as workers being comfortable with the working temperature, seemed to be an issue in levels of productivity.

Under management factors, glare and poor visibility were the only issues with lighting at night. In terms of safety factors, accidents in the work zone and motorists entering the work zone were the significant factors.

The results appear to indicate that human factors would not have a significant impact on night-time construction productivity, since

- the workers were not tired working at night;
- they were getting enough hours of sleep during the day to enable them to carry out their task efficiently;
- they were always alert, and were not absent from work more than they would be during the day;
- it did not affect their health and social life; and
- the contractors had not received complaints of workers being tired.

However, management and external factors might have a minimal impact on the productivity of night-time road construction projects. The conclusion can therefore be made that human, external and management factors will have minimal if no impact on the productivity of road work done at night in Gauteng.

5.2 RECOMMENDATIONS

This study recommends that the factors identified in the literature be further looked at in depth. External factors such as severe low temperatures will have some effect on productivity and cannot really be controlled, as it will hinder some construction/ maintenance activities. The option of hybrid projects should be explored, where some activities that cannot be done at night are scheduled for the daytime.

When it comes to visibility and glare, the literature recommends the types of lighting that must be used for different work activities. These must be implemented to mitigate the effect of lighting on productivity.

In terms of safety, as suggested by the literature law enforcement should be used to curb the accidents at night-time construction work zones and to control the traffic by preventing motorists from entering the work zone.

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APPENDIX A: WORKERS SURVEY

Issues influencing the productivity of night time road construction-Workers

Declaration

Dear Sir/Madam

This questionnaire is designed to elicit information on the issues influencing the productivity of night time road construction

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By participating in this survey, you express your consent to use the data for research as stated. You also confirm that you are not below the age of 16 and also acknowledge your right to discontinue participation in this research at any time without reason. The findings emerging from the study will be made available to all participants on request.

Yours Sincerely
Realeboga Ramatlakana Mahapa
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Issues influencing the productivity of night time road construction-Workers

1. What position do you hold at your employment?

- ☐ Foreman
- ☐ Skilled labour
- ☐ Unskilled Labour
- ☐ Other

Other (please specify)

2. Have you been involved in night time construction projects?

- ☐ Yes
- ☐ No

Issues influencing the productivity of night time road construction-Workers

3. How many night projects have you been involved in?

- ☐ 1-3
- ☐ 3-6
- ☐ 6-9
- ☐ More than 10

4. How many years have you been involved in night time construction projects

Issues influencing the productivity of night time road construction-Workers

Section B

5. How many days a week do you normally work at night?

6. How many hours do you usually work at night?

7. How many hours of sleep do you usually get during the day if you are scheduled for night construction work?

8. Do you feel tired after working at night more than you would if you worked during the day?

☐ Yes

☐ No

9. Do you get enough hours of sleep to enable during the day you to carry out your task at night?

☐ Yes

☐ No

10. Are you alert when you work at night?

☐ Yes

☐ No

11. Do you receive regular medical check-up when employed on a night project?

☐ Yes

☐ No

12. Working during the night effects my health?

☐ Yes

☐ No

Issues influencing the productivity of night time road construction-Workers

13. If yes, is your ability to do your tasks affected by your health problems associated with you working at night ?

- ☐ Yes
☐ No
☐ yo

14. Does working at night affect your social life?

- ☐ Yes
☐ No

15. Do you find yourself being more absent for night work than you would for day work?

- ☐ Yes
☐ No

16. If yes, what is the main cause of your absenteeism?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Fatigue	☐	☐	☐	☐	☐
Lack of compensation	☐	☐	☐	☐	☐
Lack of sleep	☐	☐	☐	☐	☐
Social adjustment	☐	☐	☐	☐	☐

17. Are you compensated for working at night?

- ☐ Yes
☐ No

18. If yes, is there a difference between normal day time overtime compensation and night time construction compensation?

- ☐ Yes
☐ No

Issues influencing the productivity of night time road construction-Workers

19. Are you motivated to work at night?

- ☐ Yes
☐ No

20. If yes, what motivates you to work at night?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Extra compensation	☐	☐	☐	☐	☐
Extra leave	☐	☐	☐	☐	☐
Convenience	☐	☐	☐	☐	☐

21. What else can motivate you to work at night?

22. Do you receive safety induction on night time projects?

- ☐ Yes
☐ No

23. Do you wear reflective clothing when working at night?

- ☐ Yes
☐ No

24. Is the reflective clothing sufficient to make you visible at night?

- ☐ Yes
☐ No

25. Do you feel unsafe working during the traffic flow at night?

- ☐ Yes
☐ No

26. Is your work progress reduced by the traffic at night as you have to pay more attention to prevent possible accidents?

- ☐ Yes
☐ No

Issues influencing the productivity of night time road construction-Workers

27. What safety concerns do you have with working at night?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Accidents in the work zone	☐	☐	☐	☐	☐
Motorists entering the work zone	☐	☐	☐	☐	☐
Not being visible to moving equipment and motorists	☐	☐	☐	☐	☐

28. What would make you feel safer working in night time work zones?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
More lighting	☐	☐	☐	☐	☐
More safety personnel	☐	☐	☐	☐	☐
Law enforcement controlling traffic	☐	☐	☐	☐	☐

29. Have you ever been injured while working at night?

- ☐ Yes
- ☐ No

30. If yes, what was the cause of the accident work zones?

- ☐ Moving equipment in the working zone
- ☐ Motorists entering the work zone
- ☐ Other

Other (please specify)

Issues influencing the productivity of night time road construction-Workers

Section C

31. Which problems did you encounter with lighting?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Glare	☐	☐	☐	☐	☐
Insufficient lighting	☐	☐	☐	☐	☐
Poor visibility	☐	☐	☐	☐	☐

32. What problems do you have with glare?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Sore eyes	☐	☐	☐	☐	☐
Blared vision	☐	☐	☐	☐	☐
Annoyance	☐	☐	☐	☐	☐

33. Do you receive equipment to help cater for the glare from vehicle light and the lights on site?

- ☐ Yes
☐ No

34. Does the glare from vehicle and lights on site affect your speed of work?

- ☐ Yes
☐ No

35. Are there any construction/ maintenance activities that you find difficult to carry out cause of insufficient lighting conditions at night?

- ☐ Yes
☐ No

If yes, (please specify)

36. Do you feel comfortable with the working temperature at night?

- ☐ Yes
☐ No

37. Do you receive sufficient protective clothing to accommodate the temperature variation at night ?

- ☐ Yes
☐ No

Issues influencing the productivity of night time road construction-Workers

38. Does the working temperature at night make it difficult for you to carry out your tasks efficiently?

- ☐ Yes
☐ No

39. Are there any construction/ maintenance activities that you find difficult to carry out cause of temperature conditions at night?

- ☐ Yes
☐ No

If yes, (please specify)

APPENDIX B: CONTRACTORS SURVEY

Issues influencing the productivity of night time road construction-

Declaration

Dear Sir/Madam

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Yours Sincerely
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Issues influencing the productivity of night time road construction-

Section A

1. What position do you hold at your employment?

- ☐ Director
- ☐ Project Manager
- ☐ Site engineer
- ☐ Other

Other (please specify)

2. Have you been involved in night time construction projects?

- ☐ Yes
- ☐ No

Issues influencing the productivity of night time road construction-

3. How many night projects have you been involved in?

- ☐ 1-3
- ☐ 3-6
- ☐ 6-9
- ☐ More than 10

4. How many years have you been involved in night time construction projects?

Issues influencing the productivity of night time road construction-

Section B

5. How many days a week do workers work at night?

- ☐ 1 day
☐ 2 days
☐ 3 days
☐ 4 days
☐ 5 days
☐ 6 days
☐ 7 days

6. Do the workers who work at night get regular medical checkups?

- ☐ Yes
☐ No

7. Do you do rotational shift for night workers?

- ☐ Yes
☐ No

8. How prevalent is absenteeism on night time construction projects in one month ?

- ☐ 1 day/week
☐ 2 days/week
☐ 3 days/week
☐ 4 days/week
☐ More than 4 days/week

9. In your opinion what is the main cause of absenteeism?

Please rank using order of importance (1 = most important to 5 = less important)

	1	2	3	4	5
Fatigue of workers	☐	☐	☐	☐	☐
Lack of compensation	☐	☐	☐	☐	☐
Lack of sleep	☐	☐	☐	☐	☐
Deprivation of social activities	☐	☐	☐	☐	☐
other	☐	☐	☐	☐	☐

Issues influencing the productivity of night time road construction-

10. Are workers who work at night compensated?

- ☐ Yes
☐ No

11. If yes, is there a difference between normal overtime compensation and night time construction compensation?

- ☐ Yes
☐ No

12. Do you motivate the workers who work at night?

- ☐ Yes
☐ No

13. How do you motivate the workers to work that work at night?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Extra compensation	☐	☐	☐	☐	☐
Extra leave	☐	☐	☐	☐	☐

14. What other ways do you use to motivate workers ?

15. How many hours do workers usually work on night time projects?

16. Do you receive any complaints of workers being tired after working at night more than you would if they work during the day?

- ☐ Yes
☐ No

17. Are workers fully alert when they work at night?

- ☐ Yes
☐ No

Issues influencing the productivity of night time road construction-

Section C

18. Which problems did you encounter with lighting in night time projects?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Insufficient lighting levels	☐	☐	☐	☐	☐
Glare to workers	☐	☐	☐	☐	☐
Non Uniformity of lighting levels	☐	☐	☐	☐	☐
Less Availability of suitable lighting equipment	☐	☐	☐	☐	☐
Reduced Reliability of lighting equipment	☐	☐	☐	☐	☐
Difficulty retrofitting construction equipment with additional lighting equipment	☐	☐	☐	☐	☐
Difficulty in Placement of lighting equipment	☐	☐	☐	☐	☐
Lack of experience in lighting design	☐	☐	☐	☐	☐
Lack of lighting design guidelines	☐	☐	☐	☐	☐
Increased Cost of lighting equipment	☐	☐	☐	☐	☐
Visibility	☐	☐	☐	☐	☐
Poor quality of work	☐	☐	☐	☐	☐
Accidents in the work zone	☐	☐	☐	☐	☐

19. Do you have different lighting categorise for various activities?

- ☐ Yes
- ☐ No

20. What type of lighting equipment do you use?

- ☐ Temporary
- ☐ Portable
- ☐ Mobile equipment based
- ☐ Other

Other (please specify)

Issues influencing the productivity of night time road construction-

21. What PPE do you provide for your workers against lighting ?

- ☐ Glare Screens
- ☐ Anti-Glare Safety Spectacles
- ☐ Other

Other (please specify)

22. Do you have guideline for night time construction lighting?

- ☐ Yes
- ☐ No

23. Are the workers comfortable with the working temperature at night?

- ☐ Yes
- ☐ No

24. What PPE do you provide to your employees against the severe low temperature ?

- ☐ Insulated gloves
- ☐ Insulated boots
- ☐ Ear covers
- ☐ Insulated Jackets

Other (please specify)

25. Are any construction activities affected by the night time temperature?

- ☐ Yes
- ☐ No

Yes (please specify)

Issues influencing the productivity of night time road construction-

Section D

26. In your opinion what are the benefits of night time construction project?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Longer working periods	☐	☐	☐	☐	☐
Improved air quality	☐	☐	☐	☐	☐
Enhanced working conditions	☐	☐	☐	☐	☐
Increased time	☐	☐	☐	☐	☐
Reduced cost	☐	☐	☐	☐	☐

27. In your opinion what are the challenges of night time construction projects?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Decreased level of safety	☐	☐	☐	☐	☐
Noise pollution	☐	☐	☐	☐	☐
Negative impact on workers health	☐	☐	☐	☐	☐
Extensive traffic control	☐	☐	☐	☐	☐
Low temperature	☐	☐	☐	☐	☐
Difficulty with lighting	☐	☐	☐	☐	☐
Increased cost	☐	☐	☐	☐	☐

28. What are the reasons for your organisation to opt to work at night?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Traffic accommodation	☐	☐	☐	☐	☐
Restriction of day works in some regions	☐	☐	☐	☐	☐
Accommodation businesses that operate during the daytime	☐	☐	☐	☐	☐
Contract Requirement	☐	☐	☐	☐	☐
To fasttrack the project schedule cause of time pressure	☐	☐	☐	☐	☐

29. What is the daily start time on night time projects?

30. What is the daily end time on night time projects?

Issues influencing the productivity of night time road construction-

31. Is it easy to schedule personnel to work at night?

- ☐ Yes
☐ No

32. Are there any construction/ maintenance activities that can't be done at night?

- ☐ Yes
☐ No

Yes (please specify)

33. Do workers wear reflective clothing on night projects?

- ☐ Yes
☐ No

34. Do you have guidelines on the reflective clothing on night projects?

- ☐ Yes
☐ No

35. Do workers receive safety inductions on night time projects

- ☐ Yes
☐ No

36. Do you employ extra safety personal at night

- ☐ Yes
☐ No

37. Do you do any public awareness of night time project schedules?

- ☐ Yes
☐ No

38. How prevalent are accidents on night time projects in one month ?

- ☐ 1 accident
☐ 2 accidents
☐ 3 accidents
☐ 4 accidents
☐ More than 4

Issues influencing the productivity of night time road construction-

39. What is the main cause of night time construction accidents?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Motorists entering the work zone	☐	☐	☐	☐	☐
Moving equipment in the work zone	☐	☐	☐	☐	☐
Lighting failure	☐	☐	☐	☐	☐
Laziness of workers	☐	☐	☐	☐	☐
Lack of PPE	☐	☐	☐	☐	☐
Lack of enforcement of safety guidelines	☐	☐	☐	☐	☐

APPENDIX C: PROJECT MANAGERS SURVEY

Issues influencing the productivity of night time road construction-Project

Declaration

Dear Sir/Madam

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Yours Sincerely
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Issues influencing the productivity of night time road construction-Project

Section A

1. Have you been involved in night time construction projects?

☐ Yes

☐ No

Issues influencing the productivity of night time road construction-Project

2. How many night projects have you been involved in?

- ☐ 1-3
- ☐ 3-6
- ☐ 6-9
- ☐ More than 10

3. How many years have you been involved in night time construction projects?

Issues influencing the productivity of night time road construction-Project

2. How many night projects have you been involved in?

- ☐ 1-3
- ☐ 3-6
- ☐ 6-9
- ☐ More than 10

3. How many years have you been involved in night time construction projects?

Issues influencing the productivity of night time road construction-Project

9. Does your Agency impose any contractual regulations with the contractor on health checkups for construction staff on night time projects?

☐ Yes

☐ No

10. If yes, specify the frequency that your Agency requires for checkups on night time workers?

☐ Every 2 months

☐ Every 6 months

☐ Other

Other (please specify)

11. Does your Agency impose any contractual regulation with the contractor on extra compensation for construction staff on night time projects?

☐ Yes

☐ No

Issues influencing the productivity of night time road construction-Project

Section C

12. Does your Agency have any lighting guidelines for night time construction work?

- ☐ Yes
☐ No

13. If yes, does your Agency enforce the regulation on the contractors on night time projects?

- ☐ Yes
☐ No

14. Have you received any complaints from motorists concerning glare from night time construction lighting?

- ☐ Yes
☐ No

15. Have you ever asked a contractor to do remedial work for work done at night cause of poor quality?

- ☐ Yes
☐ No

16. Does your Agency have any regulation on working temperature for night time workers?

- ☐ Yes
☐ No

17. If yes, does your Agency enforce the regulation on the contractors on night time projects?

- ☐ Yes
☐ No

18. Does your Agency have any regulation on working temperature for certain construction/ maintenance activities?

- ☐ Yes
☐ No

Issues influencing the productivity of night time road construction-Project

19. Has any project that is done at night been delayed cause of severe temperature at night?

☐ Yes

☐ No

Issues influencing the productivity of night time road construction-Project

Section D

20. In your opinion what are the benefits of night time construction project?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Longer working periods	☐	☐	☐	☐	☐
Longer working periods	☐	☐	☐	☐	☐
Improved air quality	☐	☐	☐	☐	☐
Enhanced working conditions	☐	☐	☐	☐	☐

21. In your opinion what are the challenges of night time construction projects?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Decreased level of safety	☐	☐	☐	☐	☐
Noise pollution	☐	☐	☐	☐	☐
Negative impact on workers health	☐	☐	☐	☐	☐
Extensive traffic control	☐	☐	☐	☐	☐

22. Does your Agency carry out any inspections at night?

- ☐ Yes
- ☐ No

23. Does your Agency have any safety guidelines for night time construction work?

- ☐ Yes
- ☐ No

24. If yes, does your Agency enforce the safety guidelines on the contractors on night time projects?

- ☐ Yes
- ☐ No

25. Does your Agency have any personal protective equipment guidelines (i.e. reflective clothing) for night time construction work?

- ☐ Yes
- ☐ No

26. If yes, does your Agency enforce the personal protective equipment guidelines on the contractors on night time projects?

- ☐ Yes
- ☐ No

Issues influencing the productivity of night time road construction-Project

27. Has your agency received any reports on night time construction projects accidents involving construction staff?

☐ Yes

☐ No

28. Does your Agency have any traffic control guidelines for night time construction work?

☐ Yes

☐ No

29. If yes, does your Agency enforce the traffic control guidelines on the contractors on night time projects?

☐ Yes

☐ No

30. Has your agency received any reports on night time construction projects accidents involving motorists?

☐ Yes

☐ No

31. Are there more accidents reported during night time construction as compared to day time construction

☐ Yes

☐ No

32. Do you receive any complaints of workers being tired after working at night more than you would if you worked during the day?

☐ Yes

☐ No