Challenges of Night Time Road Construction in the City of Johannesburg, South Africa

Khotso Dithebe, Clinton.O Aigbavboa, Ayodeji.E Oke, Wellington.D Thwala and Chuma Mnyande

Sustainable Human Settlement and Construction Research Centre, Faculty of Engineering and the Built Environment, University of Johannesburg, South Africa
khdithebe@gmail.com, caigbavboa@uj.ac.za, emayok@gmail.com, didibhukut@gmail.com and mnyandechumisa@gmail.com

Abstract

The rapid population growth in South Africa has contributed enormously to the current traffic congestions, hence the call to restore and expand the current road infrastructure. Government has invested in night time road construction. The study envisaged to determine challenges that affect night time road construction in Johannesburg, South Africa. A structured questionnaire was distributed to construction professionals. A Quantitative method was adopted whereby only 50 out 55 questionnaires were retrieved. To analyse, Statistical Packages for the Social Sciences was used. The study revealed that the productivity of workers, traffic control, insufficient lighting and glare, reduced visibility of workers, quality of work and the escalation of the construction costs were the alarming challenges experienced during night time road construction. Adequate attention should be given to the environment of the workers working during the night, this includes providing sufficient lighting equipment, safety measures against reckless drivers should also be provided and including adequate and appropriate signs declaring working zone. More so, regulatory bodies and construction inspectors should play a leading role to ensure a conducive environment for both night time workers and road users, frequent inspections during the night should be undertaken and reports filed on the status of each project.

Keywords: South African National Roads Agency Limited, night time construction, employee productivity, traffic congestion, road infrastructure developement

1. Introduction

South Africa is one of the quickest developing economies in the Southern region, in terms of population. The population growth in urban cities is enormously growing each year. Urbanisation is one of the key occurrences contributing to the population growth. Estimated 4.4 million people living in Johannesburg account for about 36% of Gauteng's population and 8% of the national population and require new and improved road infrastructure (Local Government Handbook, 2016). As a result of urbanisation, amongst other issues cities are expected to provide appropriate and adequate infrastructure for the wellbeing of the citizens. Road construction is one of the key developments that contribute immensely to the growth of any developed and developing economies (South African National Roads Agency Limited, 2009).

Road infrastructure development is needed in South Africa to expand, rehabilitated and maintain the existing roads. To cater for the population growth something must be done. Over the years there has been many day time road projects to expand and maintain the current road infrastructure. However this has become a challenge to undertake the work during the day. According to Jackson (2005) due to high traffic volumes during the day on many highways, it is a challenge to perform work operations in or near travel lanes since there is a disruption of traffic flow and it is risky for both workers and road users. In order to alleviate the problems associated with working during the day, road work is therefore partially scheduled for night time (Elrahman, 2008).

Given the disadvantage and advantages of night time construction Espey *et al*. (2013) states that the main factor considered when planning for night time construction is traffic congestion. Traffic volumes are usually higher during the day and if operations are done during the day the effect of lane closures can have extreme impacts, which will result in queuing, congestion and consequent delays. However, if operations are performed during the night, delays and stops will be greatly minimised due to low traffic volumes at night (Moleli, 2012). The client and contractors should decide to perform road construction and maintenance works at night to avoid delays mentioned above. Time is of utmost importance and people have places to be during the day, people get frustrated during the day, having to wait in traffic, traffic caused by the road construction works. Therefore the study determined challenges of night time road construction and determined whether it is wise to fully adopt night time construction or not.

2. Challenges of night time road construction

"Night time conditions tend to create legitimate safety concerns such as inadequate lighting, inferior visibility, glare, and reduced levels of alertness for workers and drivers (due to fatigue, sleepiness and alcohol abuse)" (Jackson, 2005). As a result it is logical to expect that the risk of being involved in a traffic accident in work zones is higher at night. The study envisaged to review literature on pivotal challenges contributing to the failure of night time road construction in South Africa, particularly in Johannesburg. Elrahman and Perry (1994) stated that safety is a main determinant guiding the decision whether to pursue night time construction or not. With night time construction there are certain issues that may be of concern such as, poor/reduced visibility, insufficient lighting, workers being tired, driver condition and substance abuse which can cause hazardous situations for both drivers and workers. More so, as a result of less traffic congestion during the night, motorists are likely to drive at higher speed which this could potentially cause accidents. Therefore, careful considerations should include adequate planning for night time construction so as to ensure that work zones are visible for motorist and other individuals other than the workers within that vicinity.

Wahid *et al.* (2014) stated that safety is a major concern when considering night time work and therefore it is important to ensure that there is sufficient lighting and any other devices that will help improve the visibility. The authors further explain that there are two important safety considerations that should be focused on; namely the safety of the workers as well as the safety of the road users. Workers should wear protective clothing that is clearly visible to drivers to ensure that the safety of workers (Arditi *et al.,* 2003). The work area should be clearly marked and provisions should be made to ensure that there is enough lighting for the site to be visible and for the workers to be able to see. Secondly, the safety of the road users should also be considered. When the work is about to commence, road users should be informed about the road works that will be occurring in that area, they should be informed of any alternative routes that can be used if possible and provide signage to warn the road users of any road works ahead (Bryden, 2003). Challenges of night time construction include;

According to Arditi *et al*. (2003) and Bryden and Mace (2002) there is not a definite answer as to whether productivity is a challenge or a benefit, there are certain conditions that make night time work favourable and other factors that make night time undesirable. Factors such as reduced traffic congestion, safer working conditions, cooler temperatures during summer months and quicker material delivery cycles, make night time work desirable and thus also improves productivity, however, factors such as poor lighting and higher risk of accidents negatively affect productivity (Mahapa, 2014). Generally, productivity is higher when there is an availability of workers and machinery. Another factor that can negatively affect productivity, is if machinery or any equipment can break down there might not be any service providers available at that time to respond and fix the problem. Material availability is another challenge for night time construction. Acquiring materials during the night can either be impossible or come at an inflated price, both of these possibilities pose a challenge to night time construction projects. Also, equipment maintenance normally requires more time during night time (parts may not be available until next day) (Rebholz *et al.* 2004). Due to the fact that materials will at times not be able to be procured during the night, this will result in a delay in the works being done and completed on time. The expenses will escalate due to companies charging higher rates for repairing machinery during the night

More so, the quality of work done during night time construction is tempered with compared to day time construction. According to Shane (2012) factors that reduce or affect the quality of the work are similar to the factors that affect productivity namely; reduced visibility, insufficient lighting, poor supervision and inspection of the works, and demotivated workers. Wahid *et al.* (2014) and Hancher and Taylor (2001) stated that specific works' quality might be compromised during the night, for instance the drying period of surfacing of road works might be affected because at night conditions may be dry and humid as compared to sunny, hot and dry conditions during the day. However, activities such as demolitions of existing roads, placing up new road dividers and permanent road signs, hoisting up pre-cast road structures or any other works that do not need drying are do not affect the required quality. In addition to challenges of night time construction there is an aspect of physical and psychological effects towards workers. According to Elrahman and Perry (1994) "night work usually raises concerns about worker sleep deprivation and fatigue, the effect of circadian and social and domestic adjustment difficulties, all of which may contribute to low energy levels and poor morale which could result to the productivity and quality of the final product being reduced". Prior to work completion at night some of the workers may not be able to cope, due to psychological and physical effects incurred, such as inadequate sleep or a change in sleep patterns even after the project has been completed. There is less time to spend with their respective families or even attend any social events, and all of this can cause low levels of energy and workers may end up becoming demotivated thus affecting productivity (Bryden and Mace (2002).

Hazards from road users is amongst the ighly recognised challenge of night time construction. Minchin *et al.* (2013) shared that scheduling for night time work may contribute to serious safety hazards, often people drive recklessly during the night, while other motorists drive under the influence of alcohol and other substances. Wahid *et al.* (2014) elaborates further that drivers tend to drive faster at night due to less traffic, not only that, but some drivers drive drunk, while some drive while drowsy, this is concerning because accidents can easily occur. There is only so much workers and contractors can do to ensure that the work area is visible and that workers are visible as well. As a result, it is also the responsibility of the road users to ensure that they drive safely and remain vigilant on the road. It is arguable that these hazards can be a result of insufficient lighting and glare. For a conducive environment for the safety of workers and road users, it may be hard at night to provide sufficient lighting for them, and that poses a challenge to workers that have to perform the works (El-Rayes *et al*., 2003). Additionally, road users may struggle to drive through the work area or even notice the work area from a distance. Therefore, it is imperative that provisions be made to ensure that there is enough lighting equipment to increase visibility, though there is not much that can be done about glare (Rebholz *et al.* 2004).

3. Research Methodology

The study determined challenges of night time construction, road construction in particular. The study was undertaken in the city of Johannesburg in the Gauteng Province, South Africa. A quantitative method was adopted for the study, using convenience sampling. Data was obtained from both primary and secondary sources, for primary data; a well-structured questionnaire was distributed to Architects, Engineers, Quantity Surveyors, Construction Managers and Project Managers. A total of 55 questionnaires were sent out and only 50 were returned representing a 91% response rate. The questionnaire adopted was designed in two sections with the first section seeking data on the background information of the respondents. The second section sought data on challenges of night time road construction. The following five point Likert scale was adopted; 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly agree. The data collected was analysed using Statistical Package for the Social Sciences (SPSS) computer software. The method of data analyses include the use of percentage to analyse the background information of the respondents, whilst for Section B Mean Item Scores, and Standard Deviations were used to rank the challenges of night time road construction.

4. Findings, Analysis and Discussions

4.1 Background information of respondents

Findings revealed that 58% of the respondents were male and 42% were female. Respondents' age group revealed that 6% of the respondents were within the age group of 21-25 years old, 22% were within 26-30 years old, 36% were within 31-35years old, 16% were within the age group of 36-40 years old, 6% were within 41-45 years old, 8% were within 46-50 years old and 4% were 51-55 years and 2% were above 55 years. Furthermore, findings revealed that 66% of the respondents were black and 34% were white. With regards to the respondent's highest qualification, findings revealed that 10% of the respondents had certificate diploma, 36% had a bachelor's degree, 42% had an honour's degree, and 12% had a master's degree and none of the respondents had a doctoral degree. The current position the respondents hold in their work place, findings revealed that 26% were Quantity Surveyors, 46% were Civil Engineers, 14% were Construction Managers and 14% were Construction Project Managers. More so, respondent's duration in the specific profession, findings revealed that 6% had up to 5 years' experience, 30% had between 5-10 years' experience, 34% had 10-15 years' experience, 20% had 15- 20 years' experience and 10% had more than 20 years' experience. Lastly, findings revealed that 38% of the respondents work as consultants, 44% work for contractors and 18% for government. All this is shown in Table 1.

Table 1: Characteristics of the respondents

CHARACTERISTICS	FREQUENCY	PERCENT
Gender		
Female	21	42
Male	29	58
Respondents age group		
21-25 years old	3	6
26-30 years old	11	22
31-35 years old	18	36
36-40 years old	8	16
41-45 years old	3	6
46-50 years old	4	8
51-55 years old	2	4
55 years old and above	1	2
Highest qualification		
Certificate diploma	5	10
Bachelor's degree	18	36
Honour's degree	21	42
Master's degree	6	12
Ethnic group		
Black	33	66
White	17	34
Current position		
Quantity surveyors	13	26
Civil engineers	23	46
Construction managers	7	14
Construction project managers	7	14
Years of experience		
Up to 5 years' experience	3	6
5-10 years' experience	15	30
10-15 years' experience	17	34
15-20 years' experience	10	20
More than 20 years' experience	5	10

4.2 Challenges of night time road construction

Prior to the review of literature on challenges of night time road construction, a structured questionnaire was created and distributed to the nominated respondents. Data collected was then analysed and ranked according to their mean item scores and standard deviations, tabulated in a descending order. A 5 point Likert scale was adopted for the rating with 5 being Strongly Agree, 4 being Agree, 3 being Neutral, 2 being Disagree, and 1 being Strongly Disagree. Findings in Table 2 shows the ranking of the identified challenges. From the table below it is apparent that the productivity of workers (MIS=4.38; SD=0.49), traffic control (MIS=4.22; SD=0.58), user costs (MIS=4.06; SD=0.65), insufficient lighting and glare (MIS=4.04; SD=0.67) and reduced visibility for workers (MIS=4.04; SD=0.53) are prominent challenges affecting a holistic adoption of night time construction, road construction in particular. Unlike economic factors (MIS=2.98; SD=0.65) which has a minimal impact on night time road construction physical and psychological effects towards workers (MIS=3.72; SD=0.76), safety for road users and workers (MIS=3.70; SD=0.71), material availability and equipment maintenance (MIS=3.68; SD=0.74), quality of work (MIS=3.62; SD=0.78), construction costs (MIS=3.62; SD=0.70) and accidents costs (MIS=3.56; SD=0.67) were amongst the recognizable challenges that negatively affect the progression of night time road construction in South Africa.

The findings expressed above are in agreement with Wahid *et al*. (2014) that the productivity of workers during night time construction is minimised, as compared to the productivity levels revealed during day time road construction. Reviewed literature enunciates that poor productivity during night time is usually caused by limited lighting, troubled eyesight and possible crime activities. This justification is complemented by both Elrahman and Perry (1994) as well as Bryden and Mace (2002) in declaring that productivity is amongst the pivotal challenges experienced during night time construction. However, Arditi et al (2003) adds that there is not a definite answer as to whether productivity is a challenge or a benefit when it comes to night time construction.

Elrahman and Perry (1994) alluded that amongst other challenges experienced during night time construction, the escalation of construction cost of the project is one of the pivotal issues. The incurred costs during the night are expectedly higher that the ones incurred during day time construction. Another issue chartered by Minchin *et al.* (2013) is the safety of the workers and the road users themselves. If the caution signs for night time construction are not deliberately clear from miles away, people could suffer fatal injuries instantly. Bryden (2003) agrees that the possibility of motorists driving into the working stations is significantly high compared to day time road construction. Jackson (2005) and Hancher and Taylor (2001) also states that apart from other existing problems such as quality of work, construction costs, community resistance that are visible with night time road construction traffic control is immensely important. It is important to plan properly for this factor, especially in instances where there is lane closures, the drivers need to know where they can and cannot drive.

Table 2: Challenges of night time road construction

THE CHALLENGES OF NIGHT TIME ROAD CONSTRUCTION	MEAN	S.D	RANK
Productivity of workers	4.38	0.49	1
Traffic control	4.22	0.58	2
User costs	4.06	0.65	3
Insufficient lighting and glare	4.04	0.67	4
Reduced visibility for workers	4.04	0.53	4
Physical and psychological effects towards workers	3.72	0.76	5
Safety for road users and workers	3.70	0.71	6
Material availability and equipment maintenance	3.68	0.74	7
Quality of work	3.62	0.78	8

Construction costs	3.62	0.70	8
Hazards from road users	3.60	0.61	9
Noise disturbance to surrounding communities	3.56	0.73	10
Accident costs	3.56	0.67	10
Economic factors	2.98	0.65	11

5. Conclusion

The ultimate aim of the study was to determine prominent challenges of night time construction, particularly road construction in South Africa. The finding revealed that the productivity of workers, traffic control, user costs, insufficient lighting and glare and reduced visibility for workers were the highlighted challenges prohibiting the progress of night time road construction in South Africa. Other challenges including quality of work, construction costs, hazards from road users and accidents costs were also recognized as important challenges of night time road constructions. The study recommends that extra caution is given to night time construction, regulatory bodies such as the Construction Industry Development Board (CIDB) amongst other bodies should regulate and confirm the safety of these projects, and incentives to improve the productivity of workers should be sought. More so, regulatory bodies and construction inspectors should play a leading role to ensure a conducive environment for both night time road workers and road users, frequent inspections during the night should be undertaken and reports filed on the status of each project. As a result, the study recommends that attention is given to the environment of the workers working during the night, equipment to provide adequate lighting should be provided, safety measures against reckless drivers during the night should also be provided and adequate and appropriate signage declaring working zones should be visible. Lastly, it is imperative that when planning for night work, there are provisions made to ensure sufficient lighting and that workers are given time to rest to increase productivity. To reduce/eradicate the occurrence of accidents during night time road construction workers and the work station should be clearly visible.

References

Arditi, D., Ayrancioglu, M and Lee, D., Nighttime construction: evaluation of worker safety issues, *Project VD-H2, FY 00/01, Report No. ITRC FR 00/01-1*. Chicago, Illinois: Department of Civil and Architectural Engineering, Illinois Institute of Technology, 2003.

Bryden, J.E. (2003)., Traffic Control Handbook for Mobile Operations at Night: Guidelines for Construction, Maintenance and Utility Operations, *(No. FHWA-SA-03-026)*, 2003.

Bryden, J.E. and Mace, D.J., Guidelines for Design and Operation of Night time Traffic Control for Highway Maintenance and Construction. National Cooperative Highway Research Program, (NCHRP) Report 475. *Transportation Research Board, National Research Council, Washington, DC*, 2002.

El-Rayes, K., Liu, Y.L., Soibelma, L and Hyari, K., Night time construction: evaluation of lighting for highway construction operations in Illinois, *Department of Civil Engineering and Construction*, Bradley University, Illinois; Transportation Research Center, Peoria, Illinois, 2003.

Elrahman, O.A., Night-time road construction operations: Synthesis of practice. *Transportation Research and Development Bureau, New York State Department of Transportation, Albany, NY*, 2008.

Elrahman, O.A. and Perry, R.J. (1994). "Night-Time Construction Operations*"* (No. FHWA/NY/SR-94/116).

Espey, A., Craig, J., Booth, P. and McDonald, I., Major environmental and construction challenges faced in the upgrading of Main Road between St James and Kalk Bay, Cape Town: environmental engineering. *Civil Engineering= Siviele Ingenieurswese*, vol 21, no 7, pp. 51-56, 2013.

Hancher, DE and Taylor, TR., Night-time construction issues, *Transportation Research Record 1761*. Washington DC: Transportation Research Board, 2001.

Jackson, J., Nighttime road construction: current issues. *Centre for Transportation Research and Education, Iowa State University,* Ames, Iowa, 2005.

Local Government Handbook., Geography, history and economy. Available at: http://www.localgovernment.co.za/metropolitans/view/2/City-of-Johannesburg-Metropolitan-Municipality#overview. [Accessed 07 January 2017], 2016.

Mahapa, R.R., An investigation into the factors influencing the productivity of night time road construction. *Dissertation submitted in partial fulfilment for the degree of Master of Science in Building*, Faculty of Engineering and the Built Environment: University of the Witwatersrand, South Africa, 2014.

Minchin Jr, R.E., Thurn, S.B., Ellis Jr, R.D. and Lewis, D.W., Using contractor bid amounts to estimate the impact of night construction on cost for transportation construction. *Journal of Construction Engineering and Management*, vol 139, no 8, pp.1055-1062, 2013.

Moleli, L.J., The impact of project management on road construction and maintenance at Emfuleni Local Municipality, *Mini-dissertation submitted in partial fulfilment for the degree Master of Arts in Development and Management*, North-West University: Vaal Triangle Campus, South Africa, 2012.

Shane, J.S., Kandil, A.A. and Schexnayder, C.J., A guidebook for night time construction: Impacts on safety, quality, and productivity, *Transportation Research Board*, vol 726, 2012.

South African National Roads Agency Limited., Gauteng freeway improvement project. [Online] Available at: http://www.nra.co.za/live/ content.php?Item_ID=260. [Accessed on 30 June 2017], 2009.

Wahid, A.M., Tharim, A.A., Ahmad, A., Ismail, N.A. and Zainol, H., Night-Time Highway Construction or Maintenance/Upgrading Works: An Analysis. In *MATEC Web of Conferences*. EDP Sciences, 2014.

Biographies

Khotso Dithebe, is a full time student at the University of Johannesburg, South Africa. He received his Baccalaureus Technologiae: Construction Management in 2016 from the Department of Construction Management and Quantity Surveying. He is currently pursuing a Magister Technologiae: Construction Management at the University of Johannesburg, South Africa. During 2017 academic year, he was employed as a tutor for research methodology, BTech level in his department. He continued in the same vain in 2018, tutoring and writing conference papers for various conferences.

Clinton.O Aigbavboa, is currently the Vice-dean: Postgraduate Studies, Research and Innovation (PSRI) of the Faculty of Engineering and the Built Environment (FEBE) of the University of Johannesburg. He also serves as the Head: Sustainable Human Development and Construction Research Centre, in the Department of Construction Management and Quantity Surveying, School of Civil Engineering and the Built Environment, FEBE. He is an Associate Professor in the Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa. As a Ph.D. candidate in 2013, he was among the top 10 researchers in UJ; while in 2014 and 2015, he was the leading research output contributor in the University. Prof Aigbavboa has published more than 400 peer-reviewed articles in journals, conference proceedings and in book chapters.

Ayodeji.E Oke, is a Quantity Surveyor by training and a Ph.D. holder in the same discipline. He bagged his B.Tech degree in Quantity Surveying from Federal University of Technology, Akure, Nigeria in 2006 with a first class (Hons.). He is a reviewer for various local and international reputable Journals. To his name and in collaboration with academia within and outside Nigeria, he has authored a good number of journal and conference papers both locally and internationally. He received 2016 Emerald Literati Award for the article on Structural Equation Modelling of Construction Bond Administration, as a highly recommended paper in the Journal of Financial Management of Property and Construction. He is one of the authors of the book titled sustainable value management for construction projects. He is currently a Post-Doctoral Research Fellow at the Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa.

Wellington.D Thwala, is the incumbent of the South African Research Chairs Initiative (SARCHI) in Sustainable Construction Management and Leadership in the Built Environment. He also serves as the Director: Sustainable Human Development and Construction Research Centre, in the Department of Construction Management and Quantity Surveying, School of Civil Engineering and the Built Environment, FEBE. He is an Associate Professor in the Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa. He is the current Editor-in-Chief of the

Journal of Construction Project Management and Innovation (JCPMI). Professor Thwala has varied research interests, including project management, construction management, construction health and safety, engineering design management, economic and social infrastructure delivery, business competitive intelligence, leadership.

Chuma Mnyande, is a graduate of the Department of Quantity Surveying in the Faculty of Engineering and Built Environment, at the University of Johannesburg. She received her Baccalaureus Technologiae: Construction Management in 2017.