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Effects of Construction Logistics in Bonny Metropolis: A case study of NLNG Train 7 project.

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Abstract

This research study investigates the effects of construction logistics in Bonny Metropolis and specifically the NLNG Train 7 project. A mixed-method approach was used for data collection, combining structured questionnaires and direct noise level measurements, obtained using a sound level meter. 97 of the questionnaires were completed and accounted for in the 120 questionnaires that were administered. The respondents comprised 63 males and 34 females, with 40 graduates and 57 non-graduates. Among the respondents are project managers, engineers, academicians, artisans, and local residents. Statistical Packages for Social Sciences (SPSS) were used to analyze the data. The noise level surveys found significant noise pollution in the metropolis due to construction logistics. 8% of Bonny Metropolitan experience a moderate level of noise pollution within the acceptable range of 60 - 70 dB, while 92% (36% and 56%) of Bonny Metropolitan experience high noise pollution. Traffic congestion also had a major effect on construction logistics. Results show that 12.4% of respondents described traffic as moderately affected, 16.4% as partially congested, 23.7% as congested, and 47.4% indicated over-congestion largely due to the movement of construction materials and heavy equipment. Respondents suggested several mitigation strategies that could assist in addressing these problems, which include scheduling construction events for off-peak hours or at night, sound barriers, placing specific construction routes, and improving logistics planning, among others. The results conclude that construction logistics influences both noise and traffic patterns in Bonny Metropolis.

Keywords: Metropolis; Questionnaire; Construction Logistics; Pollution; Traffic

1. Introduction

In Nigeria, the problem of noise pollution has gained increasing attention, especially in urban centers where economic and population growth has fueled increased traffic congestion, commercial activities, and the use of power-generating equipment. The construction industry is expanding rapidly in global economies and is at the center of world economies (McKinsey Global Institute 2017). The urban population increases, and economic growth raises an increased demand for construction, repair, and renovation work in cities. Construction projects can have more attractive, sustainable, and economically viable urban spaces once completed. But the transport of construction materials does inevitably do damage to the surrounding community if not properly handled. Construction logistics consists of the planning, coordination, and management of materials, equipment, and workers needed for construction projects. It covers all logistics, as well as providing all the resources available when and where necessary to complete a project on time and to deliver a successful result (Thunberg & Persson, 2014). The construction industry has a broad and intense link with other industries of economic activity and enhances quality of life by providing necessary infrastructure such as hospitals, roads, schools, and other basic facilities (Rahman et al., 2013). As the urban population continues to grow and the economic crisis worsens, demand for construction, repair, and renovation in cities increases. Construction projects

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contribute to more attractive, sustainable, and economically viable urban areas once they are done. Yet transport related to construction works has negative effects on the surrounding community if not handled properly. The logistical sector accounts for one of the largest sources of carbon monoxide emissions (van Luik et al., 2019). This is why construction logistics is the largest transporter of freight across cities, and it also forms the largest contributor to air and noise pollution. Transport activities that involve construction works can have a negative impact on the surrounding community if not handled properly. In cities, it is estimated that 15 to 20 percent of heavy goods vehicles are related to construction and 30 to 40 percent of light commercial vans (Connekt, 2017). The complexity of construction projects is increasing with the high amount of interconnected processes and many stakeholders (Oesterreich & Teuteberg, 2016). In such a way, the challenges to construction projects are complicated because of the differing features of construction tasks, such as longer completion time, funding, and dynamic organization structures (Taylan et al., 2014). Construction-related transport was one of the biggest challenges to the road infrastructure and surrounding residents in the Bonny Island Niger Delta region as the Train 7 project continues. The high concentration of local workers and inadequate roads and transport create pressure on the roads and accommodation services, which may not be easily handled by the community. The case study method utilized in this study was based upon a field survey and case study methodology of construction logistics in the city of Bonny Island. The logistical effects differ from the transports and include poor roads, noise pollution, traffic congestion, and non-coordinated material/equipment movement. All of the study sites indicate Bonny metropolis is experiencing logistic difficulties because of poor traffic coordination and poor planning.

1.1. Statement of the Problem

The roads of Bonny Island are not wide enough to adequately accommodate heavy trucks delivering materials to the various construction sites, and they pose great safety challenges for pedestrians and vehicles. Most safety and risk concerns are growing, and the number of large trucks involved in property damage and fatal crashes is growing. Overcrowding is a problem, as pedestrians, cyclists, motorists, and public transporters often take advantage of the same limited space as freight traffic. These require decisive coordination in a bonny metropolis. Most road users move about the same time in the morning and evening, and congestion in already narrow roads becomes worse, and eventually time consumption is increased in the distribution chain. This timing factor is particularly important in construction projects where distribution is situated within the city, when congestion and unloading are time-consuming, and thus timely delivery is not possible. One of the major problems freight vehicles carry in the Bonny metropolis is noise pollution. When noise and vibration occur, the health effects and quality of urban life can be affected by the intensity and duration of exposure. But, there is an inefficient supply chain as a result of poorly coordinated supply chain planning and an unnecessarily high number of transport movements. This usually leads to a lot of noise pollution because there are many trucks and equipment that discharge several activities at the construction site. The logistical segment in this study is limited to material/equipment coordination and traffic management and does not focus on waste disposal, inventory management, lead time assessment, supply and demand planning, customer services, or material handling.

1.2. Objectives of the Study

The primary aim of this research focuses on the effects of construction logistics in Bonny Island metropolis. The study is guided by the following specific objectives:

- Assess the extent of noise pollution generated by construction logistics activities in Bonny Island metropolis.
- Evaluate the level of traffic congestion caused by the movement of construction materials and equipment.
- Examine the relationship between construction logistics and residents experience of environmental disturbance (noise and congestion).
- Identify potential mitigation strategies for reducing the negative impact of construction logistics in Bonny Island metropolis.

1.3. Study Area

The research was conducted in Bonny Island, an ancient coastal city and a Local Government Area in Rivers State in southern Nigeria. The island is located approximately 40 km south of Port Harcourt [3]. The Island lies on the Lat. 4° 27N and Long 7° 10E with an estimated population of 270,000, and is known for its strategic economic importance, rich natural resources, and unique environmental setting. The Island has a relatively flat topography on an elevation of 3.05 atmospheric mean sea level with a total land area of 214.52 m2 [4].

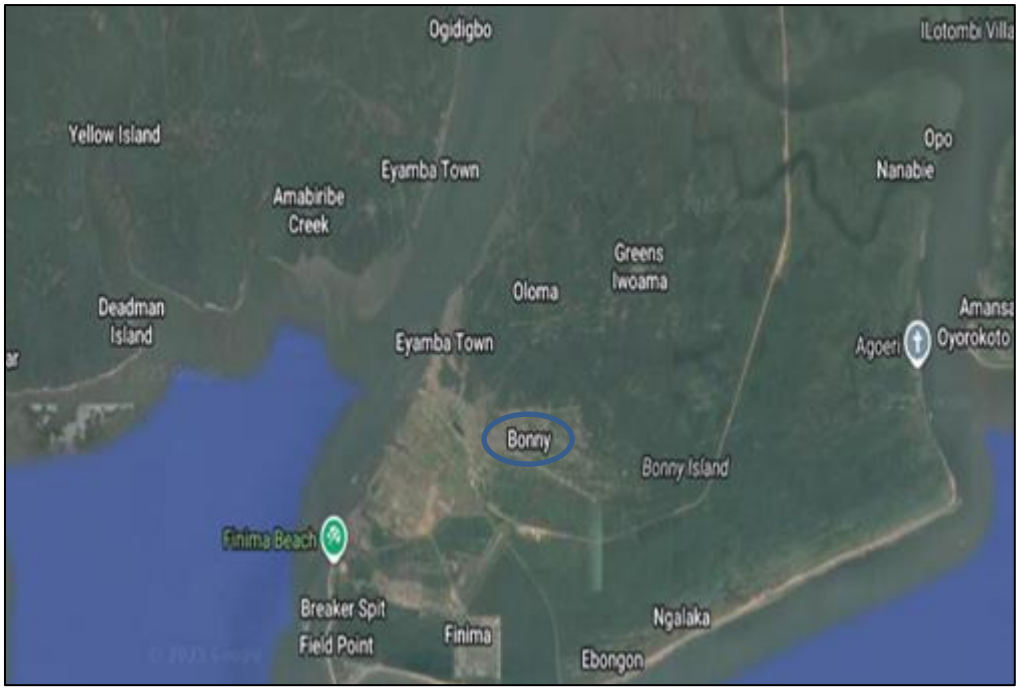

Figure 1 Map showing Bonny L.G.A (Google Map)

The island is a critical hub for Nigeria's oil and gas sector, hosting several multinational corporations, including the Nigeria Liquefied Natural Gas (NLNG) plant. The presence of these industries drives the local economy, providing employment and boosting economic activities. Bonny Island is home to a mix of indigenous communities and a significant number of migrants working in the oil and gas industry. The population is diverse, with a blend of different ethnic groups and cultures. This study conducted in Bonny Island was specifically focused on the following busy commercial junctions: Wilbros Junction, Akiama Junction, and Finima roundabout**.** These junctions were selected because of their high levels of traffic congestion, noise pollution, roadside trading, and general public activity.

2. Methodology

This study used a mixed-method approach that combined a quantitative survey with direct environmental measurements to measure the effects of construction logistics in the NLNG Train 7 Project in Bonny Metropolis. The primary data collection instrument was a structured questionnaire designed to capture respondents' perceptions of noise pollution, traffic congestion, road degradation, and general disruption caused by construction activities. Within the study area, a total of 120 questionnaires were administered, with only 97 duly completed and returned, representing a valid response rate of 80.83%, while the results were analyzed using SPSS and Excel. The demographic characteristics of respondents indicate an occupational diversity among project managers, engineers, academics, artisans, and local residents. The 97 respondents had 40 graduates and 57 non-graduates, which represented an unbiased representation of informed and community-based opinions. In addition to the survey, noise measurement was carried out to validate respondents' perceptions of noise pollution. A Sound Level Meter (SLM) mobile application that complies with basic sound monitoring standards was used. Noise readings were taken at selected points (Wilbros Junction, Akiama Junction, and Finima Roundabout) within the project corridor. The device was placed at an average height of 1.5 meters above ground level, the equivalent of the average human ear level, and located close to direct sources to minimize distortion.

Figure 2 Sound level meter

The measurements provided objective data on ambient noise levels during peak construction logistics activities.

3. Result and Discussion

The result of the investigations on Effects of Construction Logistics in Bonny metropolis is presented below in the form of tables, figures and charts.

Table 1 Gender Distribution of respondent

Gender	Frequency	Percent %	Validity parcent %	Cumulative Percentage %
Male	63	64.9	64.9	64.9
Female	34	35.1	35.1	100
Total	97	100.0	100.0	100.0

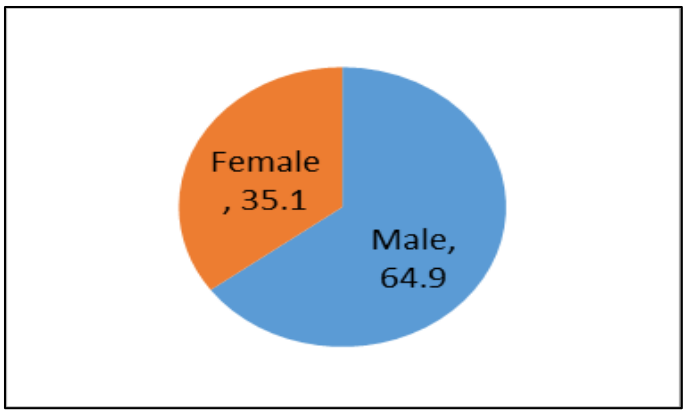

Figure 3 Gender percentage Distribution of respondent

The frequency table and chart above shows that out of 97 total respondents who participated in the study, 63 (64.9%) were male, while 34 (35.1%) were female. This indicates that male respondents constitute nearly two-thirds of the sample population. The valid percent column confirms that all the responses were valid and contribute to a complete (100%) dataset.

Table 2 Age Distribution of respondent

Age range	Frequency	Percent %	Valid Percent %	Cumulative Percentage %
25 – 65 years	97	100.0	100.0	100.0

All respondents fall within the age range of 25 to 65 years. This indicates that every participant in the study is a mature adult capable of providing informed and reliable responses concerning the effects of construction logistics in the area.

Table 3 Educational Qualification of respondent

Academic Qualification	Frequency	Percent %	Valid percent %	Cumulative Percentage %
Graduate	40	41.2	41.2	41.2
Non-graduate	57	58.8	58.8	100
Total	97	100.0	100.0	100.0

The results show that 40 respondents (41.2%) were graduates, while the remaining 57 respondents (58.8%) were non-graduates. The distribution suggests a higher proportion of respondents with secondary-level education or vocational training.

Table 4 Occupational Distribution of respondent

Occupation	Frequency	Percent %	Validity percent %	Cumulative percentage %
Project Managers	10	10	10.3	10.3
Engineers	15	15.5	15.5	25.8
Academicians/Scholars	15	15.5	15.5	41.2
Artisans	22	22.7	22.7	63.9
Locals/Residents	35	36.1	36.1	100
Total	97	100.	100	100

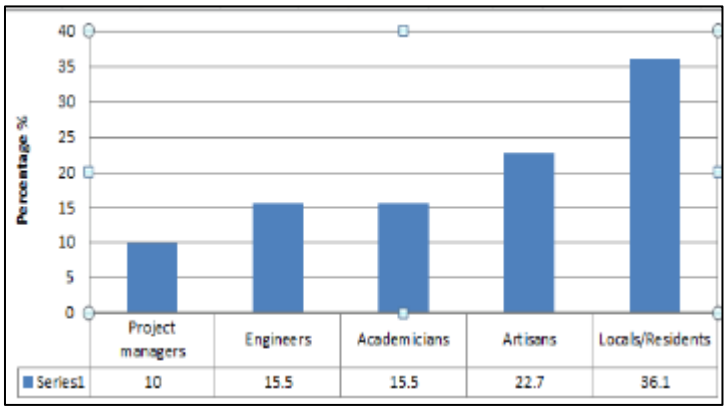

Figure 4 Occupational percentage Distribution of Respondents

The occupational distribution reveals that 36.1% of respondents were local residents, making them the largest group. Artisans represent 22.7%, while engineers and academicians each account for 15.5%. Project managers make up the remaining 10.3%. This diversity enhances the reliability of the research because it presents the perspectives of both technical stakeholders (engineers, managers) and those directly affected by construction activities (artisans and residents).

Table 5 A Frequency Table illustrating the level of noise pollution within Bonny Metropolitan as a result of construction logistics

Noise Level	Frequency	Percent	Valid Percent %	Cumulative Percent %
Normal/ Permissible limit	2	8.0	8.0	8.0
High Noise	9	36.0	36.0	44.0
Extremely high Noise	14	56.0	56.0	100.0
Total	25	100.0	100.0	100.0

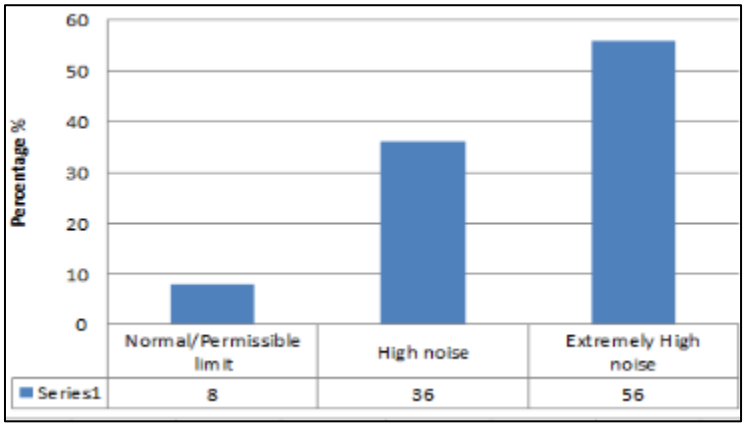

Figure 5 Percentage level of noise pollution within Bonny Metropolitan

Table 5 and Fig 6 above indicates that only 8% of Bonny metropolitan experience a moderate noise pollution level within the permissible limit (60 -70 DB) set by world health organization (WHO, 2018), which is generally safe for long term safety, while 92% (36% and 56%) of Bonny Metropolitan experience high noise pollution. This implies that respondents strongly agreed that heavy-duty trucks and material movements occur daily within the project corridor.

Table 6 A Frequency Table illustrating the participants' responses on traffic congestion in Bonny Metropolis as a result of movement of construction materials and Equipment

Traffic Congestion	Frequency	Percent %	Valid percent %	Cumulative Percent %
Moderate	12	12.4	12.4	12.4
Partially Congested	16	16.5	16.5	28.9
Congested	23	23.7	23.7	52.6
Over-congested	46	47.4	47.4	100.0
Total	97	100.0	100.0	100.0

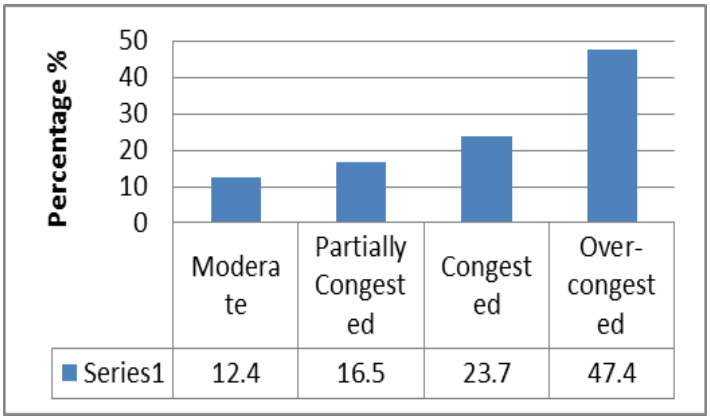

Figure 6 Percentage level of Traffic congestion in Bonny metropolis

Table 6 and Fig 7 above indicates that 12.4% of the respondents agreed that Bonny Metropolis is moderate (not congested) as result of movement of construction logistics, 16.5% believe it is partially congested; 23.7 reported that it is congested while 47.4% reported that Bonny Metropolis has become over congested due to movement of construction materials and equipment. This implies that 71.1% of the respondents believe that major areas in Bonny metropolis has become congested due to construction logistics.

Table 7 Cross-tabulation of suggested mitigation strategies by Type of Impact (Noise and Congestion)

S/N	Mitigation Strategy	Noise pollution	Traffic congestion	Total
1	Schedule construction at night or off-peak	16	11	27
2	Use sound barriers or noise shields	18	4	22
3	Dedicated construction routes	5	26	31
4	Improved logistics planning	16	19	35
5	Enforce regulations	9	21	30
6	Public awareness/ communication	11	14	25
	Total	75	95	170

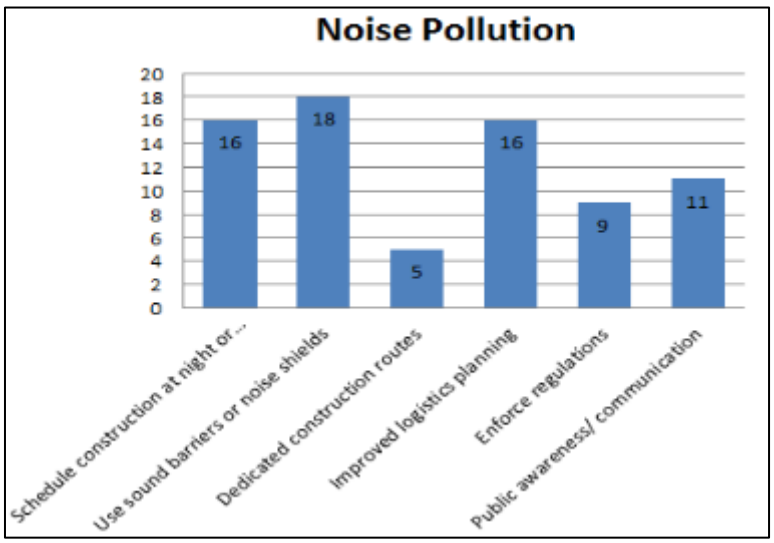

Figure 7 Frequency of Suggested Mitigation Strategy of Noise pollution

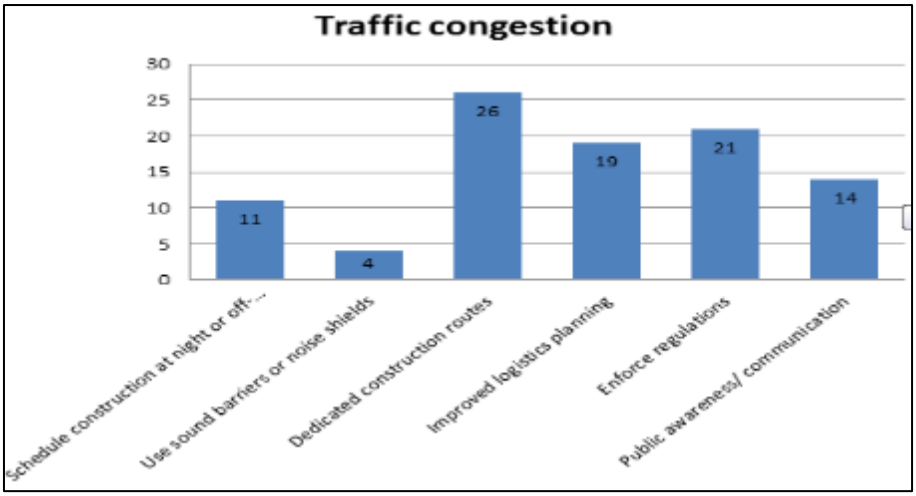

Figure 8 Frequency of Suggested Mitigation Strategy of Traffic congestion

The above cross-tabulation analysis shows respondents preferred several strategies depending on the type of impact. The most popular responses for noise pollution were ""use of sound barriers" (18 responses) and "schedule construction at night" (16 responses). While for traffic congestion, "dedicated construction route" (26 responses), "enforce regulations" (21 responses), and "improved logistics planning" (19 responses) were cited. This means that mitigation must be tailored to each specific problem.

4. Conclusion

Traffic congestion, noise pollution were analyzed as contributing negatively to the socioeconomic status of the residents in Bonny metropolis. The ongoing NLNG train 7 project has increased demand for material and equipment movement, trucks and other transport services within the locality. The results showed that high level of traffic congestion and noise pollution dominates major junctions such as Wilbros, Akiama and Finima roundabout especially during the daytime. Over 34% of respondents concluded that Bonny Metropolis is moderate (not congested) because of movement of construction logistics and 16.5% of those respondents described it as partially congested, 23.7 said that it is congested, 47.4% reported that Bonny Metropolis is over congested because of the movement of construction materials and equipment. This means that 71.1% of respondents believe building problems in Bonny metropolis entice large sections of the city. In addition, environmental concerns including road degradation and excessive noise are also closely related to construction logistics.

These findings lead to several important recommendations:

- Construction professionals and stakeholders in the construction industry need to deepen their knowledge about the adoption of construction logistics solutions which will be used across the length and breadth of Bonny metropolis regardless of size, capacity and scope of the project.
- In order to align interests and lessen the disparity in information, construction sites should be regulated by a set of rules and regulations, or a governance plan. In order to facilitate effective decision-making with regulations approved by all stakeholders, it is crucial to take into account the concerns of various stakeholders at an early stage of the construction process.
- Because Bonny's roadways are narrow, the movement of equipment and materials should be planned, and a Just-In-Time delivery system should be put in place to avoid high vehicle traffic on the city's main thoroughfares and decrease the requirement for a large amount of on-site storage space.
- Traffic Management should be strengthened through deployment of traffic wardens, installing road signs, and implementing temporary traffic controls around construction zones.
- The government and project managers should create designated routes exclusively for construction vehicles to reduce conflict with residential traffic.
- Construction-related traffic should be moved to night hours or non-peak periods to reduce traffic congestion.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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