

## EVALUATION OF ENVIRONMENTAL NOISE POLLUTION IN ABUJA, THE CAPITAL CITY OF NIGERIA

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### ABSTRACT

Abuja the capital city of Nigeria has experienced rapid development and high influx of people with the implication of increased generation of noise. Hence the need to evaluate the noise pollution level of the city. Measurement of equivalent noise level was carried out in 35 locations around the city using a CR811C integrated sound level meter. Result showed that the day time mean equivalent noise level of the city ranged from 73.2 dBA to 83.6 dBA. Result also showed that the night time mean equivalent noise level of the city is of good quality as it ranged from 44 dBA to 56.8 dBA. The night time therefore serves as a recovery time for those who are exposed to high noise value during the day. Result further showed that the Central Business District of Abuja has the highest day-night noise value of 82 dBA while the lowest day-night noise level was obtained from Asokoro district with a value of 71 dBA. The average day-night noise level of the City was obtained as 76.4 dBA. It is recommended that those whose daily activities confine them to areas with unhealthy noise level should make sure they have at least 10 hours of recovery time in areas where the sound level is less than 65 dBA. The government is called upon to improve the traffic situation in the city so as to prevent traffic built up in areas with high noise values.

**Keywords:** *Noise, Decibel, Sound level, Abuja.*

### 1. INTRODUCTION

Noise is an environmental pollutant that is increasing very rapidly as a result of improvement in commercial, industrial and social activities. It is referred to as an undesirable sound which results from the activities of man [1]. The study of sound covers all fields of sound production, propagation and reception and is measured as sound pressure [2]. Sound pressure level depends on the power output of the noise source and the environment. The ear has the remarkable ability to handle an enormous range of sound. However, sound becomes a problem when it interferes with our activities such as sleep, work, recreation and reading [1].

The human hearing mechanism responds to changes in sound pressure in a relative rather than absolute manner. This is why a logarithmic scale called the decibel (dB) is used to measure sound pressure level. The weakest sound that the human ear can detect is referred to as the threshold of hearing and it corresponds to 0 dB. On the other hand, the level of sound pressure that will cause pain to the ear is referred to as the threshold of pain and it corresponds to 120 dB [3]. A change of 3 dB in sound level is just enough to make such a change noticeable. However, an increase of 10 dB is perceived as doubling the loudness of the sound [3]. In the measurement of sound, two weighting network namely the A and C network are employed. However, for environmental purposes, the measurement is made using an A-weighted scale (dBA) because this scale measures sound level in approximately the same way as the human ear [2].

Noise pollution has been recognized as a major treat confronting the world today. The WHO reveals that noise is a dangerous agent which affects human health and the environment [4, 5]. However, People in Nigeria do not pay significant attention to the seriousness of noise pollution and its dangerous environmental consequences. This is however not the case with other countries of the world where necessary actions have been put in place to control and regulate this peril [6, 7, 8]. The determination of noise level in some towns in Delta State, Nigeria shows that most noise pollutions are caused by lack of public awareness and the ignorance of the people. This is why a lot of people in Nigeria are subjecting themselves to loud noises [8]. Anomohanran and Osemeikhian [8] also identify automobiles, commercial motorcycles, recording houses and the use of electricity generators as the factors responsible for most of the noise experienced in Nigeria.

In the same light, the study conducted at Agbor, Nigeria shows that noise from most points in the city are caused by big trucks such as lorries and luxurious buses and also by commercial activities [9]. However, Olayinka and Abdullahi [10] in a study conducted in Ilorin, Nigeria, observed that the population growth of the city which increased over 50% between 1980 and 2006 was partly responsible for the rise in noise pollution. They also asserted that road traffic is the predominant and most generalized noise source in Nigeria. This is also the case in other cities

such as Ghana [11]. In Turkey, noise is recognized as a serious public health concerns. This has accounted for why very many studies have been carried out to determine the noise level of major cities in Turkey [5, 12, 13, 14, 15, 16, 17, 18]. Report has it that the environmental noise level in small size city such as Corlu in Turkey is due mainly to road traffic. The noise value obtained is notably higher than the limits set by Turkish noise standards and policy to protect public health. Measures which include inspection of vehicle and educational solutions have also been introduced in Turkey to check environmental noise [12]. Essandoh and Armah [11] asserted that Cape Coast in Ghana is exposed to environmental pollution resulting from the increase in commercial activities and road traffic. The increase in these activities is caused by the increase in the economic life of the people and the country. This claim therefore associates environmental noise pollution to economy growth.

Environmental noise pollution has been known to have serious health implication. Noise pollution damages hearing, and has adverse effects on the health of the people. It is known to cause stress related health problems. Noise is known to elevate blood pressure, causes heart attack and fatigue, disturb sleep, increases frustration and anxiety in concentrating [19, 20]. Persistent loud noise can eventually lead to deafness [21]. The generally accepted standard to minimize hearing risk is based on an exposure of 90 dBA for a maximum limit of eight hours per day, followed by at least ten hours of recovery time at 65 dBA or lower [22]. The recommended maximum noise level near residential area, hospitals and educational establishments is 65 dBA [2].

Onuu [23] observed that all those in charge of the development of the city will need to know the area where the equivalent noise level due to road traffic noise is low so that schools and hospitals can be sited there. Noise experts, researchers and other environmentalist will need to know the noise level in an already existing area before they can assess the impact of environmental noise and control same in such area. This study is aimed at evaluating the noise pollution level in Abuja city and analyzes its level of severity. The result of this study will be essential in the further planning and development of the city.

## 2. MATERIALS AND METHOD

The study area is Abuja, the capital city of Nigeria located between latitude  $8^{\circ}55^1$  to  $9^{\circ}05^1$ N and longitude  $7^{\circ}23^1$  to  $7^{\circ}34^1$ E (Fig. 1). It has a population of 776 298 people according to the 2006 census figures [24].

In carrying out the noise level measurements, five locations each from the seven districts as shown in fig. 1 were carefully selected for this study. The measurement of the sound level was carried out using a CR811C model noise meter which is a type 1 integrated sound level meter. This instrument is very suitable for environmental noise survey.

The instrument was mounted at a height of 1 m above the ground for all the 35 locations for consistency of measurement with the antenna pointing to the sound source. The instrument was set at the A-weighting network and the equivalent noise level ( $L_{eq}$ ) which is the constant noise level that expands the same amount of energy over the same period, was measured for the various locations. This measurement process was carried out for the 35 locations at four different times of the day which are: 7.00-8.00am, 11.00-12.00noon, 5.00-6.00pm and 10.00-11.00pm. The instrument was set at automatic mode to run continuously for one hour. This is because the instrument faithfully follows all the fluctuations, stores them in its memory and at the end of the measurement calculates an average energy which is recorded in decibels (dBA).

The measured equivalent noise level were used as input data in the calculation of the day time noise level ( $L_D$ ) and the night time noise level ( $L_N$ ). These calculations were carried out using equations 1 and 2 [10].

$$L_D = 10 \log \left[ \frac{1}{2} \left\{ \left( 10^{L_{AeqM}/10} \right) + \left( 10^{L_{AeqA}/10} \right) \right\} \right] \quad (1)$$

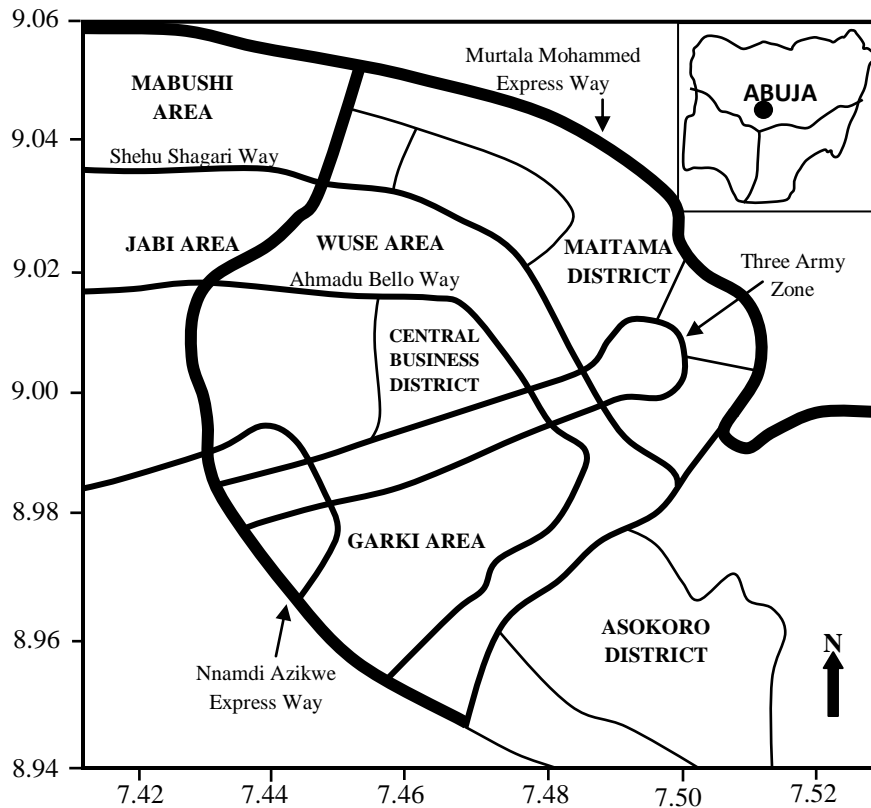


Fig. 1: Map of Abuja showing the Areas and Districts of study

$$L_N = 10 \log \left[ \frac{1}{2} \left\{ \left( 10^{L_{AeqE}/10} \right) + \left( 10^{L_{AeqN}/10} \right) \right\} \right] \tag{2}$$

where

- $L_{Aeq}$  = The A-weighted equivalent sound pressure level
- $L_{AeqM}$  = The equivalent sound pressure for the morning measurement
- $L_{AeqA}$  = The equivalent sound pressure level for the afternoon measurement
- $L_{AeqE}$  = The equivalent sound pressure level for the evening measurement
- $L_{AeqN}$  = The equivalent sound pressure level for the night measurement
- $L_D$  = Day time noise level
- $L_N$  = Night time noise level

The results obtained from equations 1 and 2, was used to determine the day-night noise level ( $L_{DN}$ ) of the City. This was carried out by using the relation shown in equation 3 [10].

$$L_{DN} = 10 \log \left[ \frac{1}{24} \left\{ \left( 15 \times 10^{L_D/10} \right) + \left( 9 \times 10^{(L_N+10)/10} \right) \right\} \right] \tag{3}$$

### 3. RESULTS AND DISCUSSION

The record of noise level for the 35 locations in the city is presented in table 1. Table 1 shows the seven districts in the city and the various measuring points where measurements were taken. It also contains the day time sound level, the night time sound level and the day-night sound level calculated using equations 1, 2 and 3 respectively.

The results obtained from equation 1, 2 and 3 were compared with the day time and night time noise quality classification index as shown in table 2 [1, 25].

**Table 1:** Results of the equivalent noise level of different locations in Abuja.

| Districts                                | Locations          | L <sub>D</sub><br>(dBA) | L <sub>N</sub><br>(dBA) | L <sub>DN</sub><br>(dBA) | Mean<br>L <sub>D</sub> (dBA) | Mean<br>L <sub>N</sub> (dBA) | Mean<br>L <sub>DN</sub> (dBA) |
|--|--------------------|-------------------------|-------------------------|--------------------------|------------------------------|------------------------------|-------------------------------|
| Central<br>Business<br>District<br>(CBD) | Fed. Secretariat   | 81                      | 42                      | 79                       | 83.6                         | 44.0                         | 82                            |
|  | Head of Service    | 89                      | 46                      | 87                       |                              |                              |                               |
|  | Police Hqt.        | 85                      | 49                      | 83                       |                              |                              |                               |
|  | Central Bank       | 85                      | 40                      | 83                       |                              |                              |                               |
|  | Sheraton Area      | 78                      | 43                      | 76                       |                              |                              |                               |
| Asokoro<br>District                      | Julius Nyerere St. | 76                      | 51                      | 74                       | 73.2                         | 46.4                         | 71                            |
|  | Army Barrack       | 74                      | 50                      | 72                       |                              |                              |                               |
|  | Ecowas             | 80                      | 45                      | 78                       |                              |                              |                               |
|  | Aso Hospital       | 69                      | 45                      | 67                       |                              |                              |                               |
|  | Roundabout         | 67                      | 41                      | 65                       |                              |                              |                               |
| Maitama<br>District                      | Cuits Close        | 84                      | 48                      | 82                       | 73.6                         | 45.0                         | 72                            |
|  | Guest House        | 75                      | 43                      | 73                       |                              |                              |                               |
|  | Aguiyi Ironsi      | 77                      | 40                      | 75                       |                              |                              |                               |
|  | Maitama Hospital   | 65                      | 45                      | 63                       |                              |                              |                               |
|  | Panama Street      | 67                      | 49                      | 65                       |                              |                              |                               |
| Wuse<br>District                         | Wusi Plaza         | 85                      | 57                      | 83                       | 82.6                         | 56.2                         | 81                            |
|  | Kashim Way         | 82                      | 47                      | 80                       |                              |                              |                               |
|  | Wuse Clinic        | 79                      | 60                      | 77                       |                              |                              |                               |
|  | Park & Shop        | 81                      | 60                      | 79                       |                              |                              |                               |
|  | Wuse Market        | 86                      | 57                      | 84                       |                              |                              |                               |
| Garki<br>District                        | Garki Market       | 81                      | 59                      | 79                       | 75.8                         | 56.8                         | 77                            |
|  | Zuba Road          | 78                      | 51                      | 76                       |                              |                              |                               |
|  | Area 7             | 69                      | 43                      | 67                       |                              |                              |                               |
|  | Ladoke Akintola    | 76                      | 83                      | 89                       |                              |                              |                               |
|  | Garki Hospital     | 75                      | 48                      | 73                       |                              |                              |                               |
| Mabushi<br>District                      | Shopping           | 84                      | 58                      | 82                       | 77.2                         | 47.6                         | 75                            |
|  | Works Ministry     | 89                      | 49                      | 87                       |                              |                              |                               |
|  | Setaco Area        | 81                      | 42                      | 79                       |                              |                              |                               |
|  | Clinic Area        | 69                      | 47                      | 67                       |                              |                              |                               |
|  | Mabushi School     | 63                      | 42                      | 61                       |                              |                              |                               |
| Jabi<br>District                         | Jabi Market        | 80                      | 45                      | 78                       | 79.4                         | 47.6                         | 77                            |
|  | Mr. Biggs Area     | 79                      | 50                      | 77                       |                              |                              |                               |
|  | Motor Park         | 86                      | 47                      | 84                       |                              |                              |                               |
|  | Edo Line Area      | 78                      | 52                      | 76                       |                              |                              |                               |
|  | Jabi River Area    | 74                      | 44                      | 72                       |                              |                              |                               |

**Table 2:** Noise quality description for day time and night time duration.

| Day time     |                              | Night time   |                              |
|--------------|------------------------------|--------------|------------------------------|
| Leq<br>(dBA) | Noise Quality<br>Description | Leq<br>(dBA) | Noise Quality<br>Description |
| 0 – 30       | Excellent Quality            | 0 – 30       | Excellent Quality            |
| 31 – 40      | Very good quality            | 31 – 40      | Very good quality            |
| 41 – 60      | Good quality                 | 41 – 50      | Good quality                 |
| 61 – 75      | Satisfactory quality         | 51 – 65      | Satisfactory quality         |
| 76 – 90      | Unsatisfactory               | 66 – 75      | Unsatisfactory               |
| 91 – 110     | Hazardous quality            | 76 – 90      | Hazardous quality            |
| >111         | Not allowed                  | > 90         | Not allowed                  |

Analysis of table 1 using the model in table 2 shows that the Central Business District (CBD) has the highest day time equivalent noise value of 83.6 dBA in the City. This high value is attributed to the fact that the area is the bill hap of activities during the day time. The volume of vehicles plying the network of roads in the area is very high coupled with the high business activities going on in this area on a daily bases. This result agrees with the finding of Essandoh and Armah [11] that most environmental noise results from road traffic and commercial activities. This point is also supported by the work of Anomohanran et al. [9] and Sisman and Unver [12]. The day time equivalent noise level of Wuse is next to CBD with a value of 82.6 dBA. This area is also characterised by high traffic built up, commercial and business activities. Asokoro and Maitama districts have less commercial and business activates hence their day time mean equivalent noise level is comparatively lower with values of 73.2 and 73.6 dBA respectively. Mabushi and Jabi district have a day time noise level of 77.2 and 79.4 dBA respectively.

The map showing the day time noise spread of the city is presented in figure 2. Figure 2 shows that the noise value reduces from the CBD in all direction. The reduction towards the east and southern direction is twice as less when compared with the reduction in the north and western direction. This shows that the west and north can be classified as being more of a commercial and business area than the east and northern part of the city.

The night time mean equivalent noise measurement shows that Garki district possess the highest value of 56.8 dBA followed by Wuse district with a value of 56.2 dBA. The rest of the districts have values less than 50 dBA with the least being the CBD with a value of 44.0 dBA. This is followed by Maitama district with a noise value of 45.0 dBA. The reason for the low value from CBD is the lack of commercial and residential activities in this area at night. You could only occasional hear the sound of vehicles plying the road. Wuse and Garki districts are characterised by commercial and residential activities during the night hence they possess the highest values of night time equivalent level as shown in table 1. Maitama and Asokoro districts are high profile residential area with very little or regulated commercial activities during the night. This accounts for the low noise value recorded for both districts.

The night time noise map is as shown in figure 3. From figure 3, it is observed that the noise level from the two highest points (Garki and Wuse) reduces towards the centre of the city. The reduction in noise level also spreads outward in all direction. With figure 2 and figure 3, one can decide where to work if he has an option and where to live. Even where there is no option of where to work, one can decide where to live in to cushion the effect of noise from work environment.

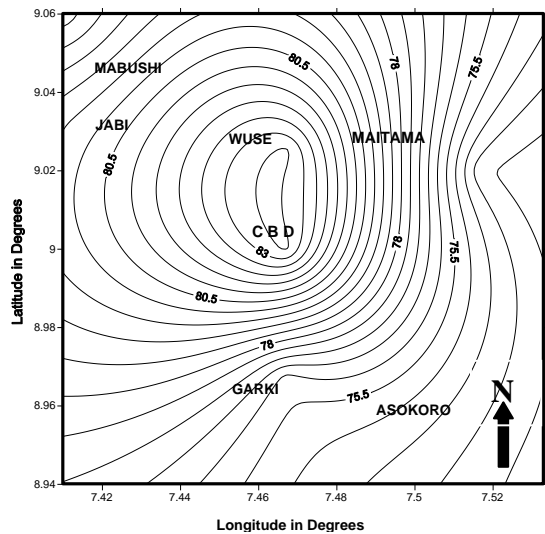


Fig. 2: Day Time Noise Map of Abuja in dBA

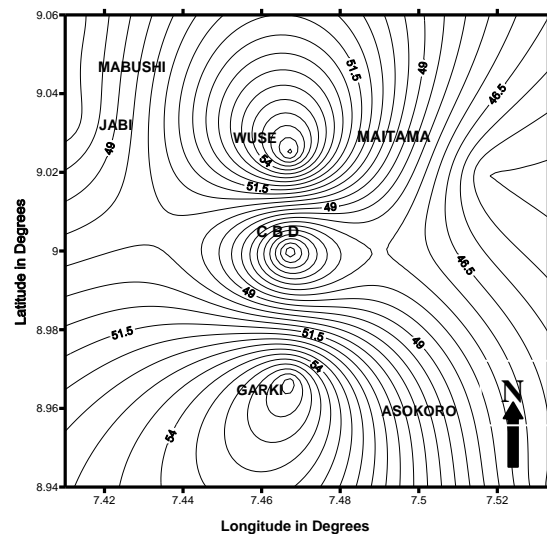


Fig. 3: Night Time Noise Map of Abuja in dBA

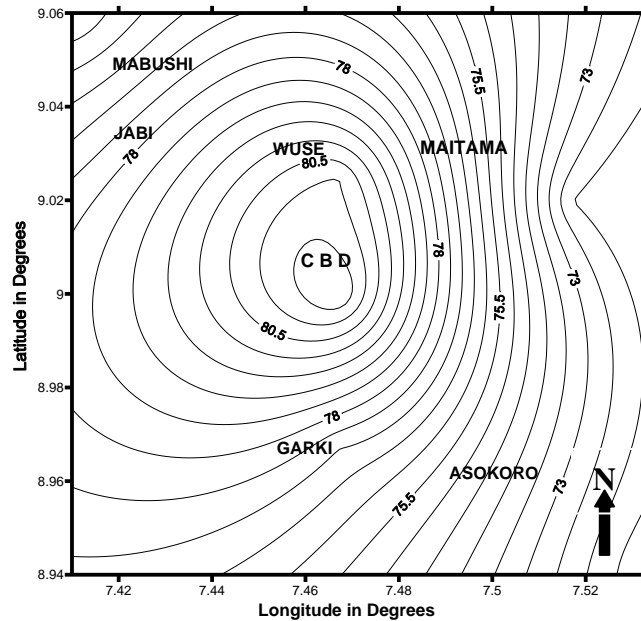
The day time and night time noise quality level of the city is as shown in table 3. Analysis of table 3 shows that the day time noise quality of Asokoro and Maitama districts is satisfactory. The Other five districts have unsatisfactory noise quality. This is because their noise value ranged between 75.8 and 83.6 dBA. A continuous exposure to this kind of noise without a corresponding period of recouping will certainly lead to one of the health related effect of noise as suggested by Agarwal and Swami [20]

**Table 3:** Table showing the day time and night time noise quality level of the City.

| LOCATIONS                 | Day time  |                           | Night time |                           |
|---------------------------|-----------|---------------------------|------------|---------------------------|
|                           | Leq (dBA) | Noise Quality Description | Leq (dBA)  | Noise Quality Description |
| Central Business District | 83.6      | Unsatisfactory            | 47.8       | Good quality              |
| Asokoro District          | 73.2      | Satisfactory              | 48.2       | Good quality              |
| Maitama District          | 73.6      | Satisfactory              | 45.0       | Good quality              |
| Wuse Area                 | 82.6      | Unsatisfactory            | 56.2       | Satisfactory              |
| Garki Area                | 75.8      | Unsatisfactory            | 56.8       | Satisfactory              |
| Mabushi Area              | 77.2      | Unsatisfactory            | 47.6       | Good quality              |
| Jabi Area                 | 79.4      | Unsatisfactory            | 47.6       | Good quality              |

Analysis of the night time noise level as shown in table 3, reveal that the CBD, Asokoro, Maitama, Mabushi and Jabi districts possess good quality noise level. Wuse and Garki have night time noise level that is satisfactory. Hence living in the capital city of Abuja at night is conducive and safe noise wise. It is also a good period of recouping after going through a noisy day at work [2].

The day-night noise level as determined from this study revealed that the mean day-night noise level in CBD is 82 dBA, Asokoro district is 71dBA, Maitama district is 72 dBA, Wuse district is 81 dBA, Garki district is 77 dBA, Mabushi district is 75 dBA and Jabi district is 77 dBA. Analysis of the day-night noise level shows that CBD, Wuse, Garki and Jabi districts have a day-night noise quality level that is unsatisfactory. The rest of the city namely Asokoro, Maitama and Mabushi districts have a satisfactory noise quality levels. The district with the lowest day-night noise value is Asokoro followed by Maitama district. The reason for the low values obtained from these two areas is that the two areas are high profile residential area in the City. The map showing the day-night noise level of the city is as shown in figure 4. From figure 4, an individual who works and live in a particular district will be able to ascertain if such combination is healthy or not. The map is also a guide for people to assess if they can work and live in the same area.



**Fig. 4:** Day-Night Noise Level Map of Abuja in dBA

**4. CONCLUSION**

Environmental noise level measurements have been carried out in the Capital City of Nigeria (Abuja). The study has shown that the City’s noise level at night is of good quality. However, the day time measurement shows that 71 percent of the City posses a noise level that is unsatisfactory and 29 percent of the city possess satisfactory noise level quality. The day-night analysis also proved that CDB, Wuse, Garki and Jabi districts have sound values that are above 75 dBA why Asokoro, Maitama and Mabushi districts have sound values of 71, 72, 75 dBA respectively. The average day-night noise level of Abuja city is 76.4 dBA which is an indication that the noise quality of the city

is on the average level. It is recommended that those whose daily activities confine them to areas with high noise level within and outside the study area should make sure they have at least 10 hours of recovery time in areas whose night time noise level is less than 65 dBA. The government is called upon to improve the traffic situation in the city so as to prevent traffic built up in the area. It is also recommended that development in the city of Abuja should be spread out rather than concentrating them in the CBD.

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