Severity of Impact of Music Acoustics on Sustainability Performance of Buildings in Anambra State Nigeria

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Abstract This study examined the severity of the impacts of loud music sounds on the sustainability performance of buildings across three main cities in Anambra State Nigeria. Being a survey research, questionnaires were distributed to the users and occupiers of different classes of buildings in the study area. The survey results were analysed using means score index and severity index percent. The study found that loud music sounds severely affect the sustainability performance of buildings socially, environmentally, economically and technically with average means scores and severity index percent ranging from 3.73 to 4.64 and 54.89% to 100% respectively. The study further found that there was no significant difference in the severity of the impacts of loud music sounds on the sustainability performance of the buildings between the three main cities in Anambra State except for social sustainability which was due to differences in the social status of the three cities. Based on this, the study calls for change in the design and construction of buildings that would incorporate the provisions of National Building Code as regards to sound control in buildings. It suggested a review and reactivation of existing zoning laws and policies in the State, and a need to borrow a leaf from Lagos State Government by enacting a law against noise pollution. It further suggested promotion of acoustic practices that would improve sustainability performance of the buildings and reduce the consequential effects of music sounds in buildings.

Keywords Building Performance, Loud Music, Music Acoustics, Music Impact, Sustainability

1. Introduction

Scholarly interests in the relationships between music and nature have a long history, reaching back into the nineteenth century, but for reasons that perhaps reflect

current global discourses of diversity and ecology, sustainability resonates widely and loudly in contemporary culture [1]. Sustainability and ecomusicology have brought up the concept of soundscape to awaken people to their natural acoustic surroundings in an increasingly noisy world. Music and all sounds are considered in vibrational terms as transferable energy, which impinges upon our body and our senses [2]. Acoustically, music is energy that pulsates through and across a medium; the structural interpretation and aesthetic conceptualisation of which occur when the sound has been processed, decoded, and interpreted in our nervous system [3].

Music industry no doubt has potential for economic and cultural sustainability. According to Wolcott [4], music has a critical role to play in the transition towards a culture of sustainability. Hawkes [5] suggests that cultural vitality which encompasses music is as essential to a healthy and sustainable society as social equity, environmental responsibility and economic viability. In terms of cultural ecology, music embraces a multilevel interconnection with organism, population, and community [6]. To this end, music becomes extremely cost-effective and powerful language that all cultures relate with, a direct and potent tool that sustain urban and rural community buildings as well as the healing process of individuals and communities [7]. Titon [8] sees music as bio-cultural resource that is renewable.

Economically, music industry in Nigeria, as in most parts of the world holds great potentials [7]. Available statistics shows that the record sales in Nigeria in 1981 was about 4.5 million; in 1986 it was 5.5 million; in 1991, 8.5 million and in 1995, 12 million records were sold nationwide [9]. Environmentally, music has been used to advance advocacy towards environmental sustainability [10-14].

1.1. Statement of the Problem

In the midst of a global warming crisis, we are currently

living and running against the clock to counter the rapid depletion of natural resources in an increasingly technology-run world [15]. The tension added to the environment as a result of sounds emanating from the music soundscapes in our society today is a source of concern and a threat to the sustainability performance of our buildings. According to Janjua et al. [16], a sustainable building is the one that expresses a design philosophy that strives to enhance effective resource efficiency, and reduce negative impacts on human wellbeing and dignity, in a cost-effective manner.

Welch and Fremaux [17,18] reveal that loud sound is present, in many activities, which are considered to be recreational, such as fitness canterers, sports events, personal audio systems, live music events, bars, and night clubs, which all have high levels of sound. For example, Williams et al. [19] found that clubbers experience on average an equivalent continuous noise level of 98 dBA Leq over an average attendance time of 5h a week with an exposure of $12.2 \text{ Pa}^2 \text{ h}$. Similarly, an estimated 104 million individuals were found to had annual $L_{EQ(24)}$ levels $> 70 \text{ dBA}$ (equivalent to a continuous average exposure level of $> 70 \text{ dBA}$ over 24 hr) in 2013; and were at risk of noise-induced hearing loss with tens of millions more at risk of heart disease, and other noise-related health effects [20].

Although listening to soothing music no doubt reduces stress, blood pressure and post-operative trauma when compared to silence [21]. Working with louder music as well as listening to it over a long period of time may systematically lead to a permanent hearing damage or to a listening fatigue, which makes proper attention being impossible [22-24]. A more precarious situation is the acoustic quality of the buildings where we spend 90% of our time [25,26]. In this regard, high acoustic performances are unavoidable requirements which influence the quality and value of buildings [27].

Furthermore, music performance goes beyond the frontiers of mere entertainment activity but is geared more towards socio-cultural dimensions due to its ability to socialise, consolidate values and other utilitarian exigencies [28]. Titon [29] opines that ecomusicology should consider music's direct impact on the environment and flow of music and sound in the environment, rather than how musical compositions represent the environment as has shown by studies such as [30-33]. Unfortunately, the environmental movement in music is typically associated with the folk music genre, mostly because as an acoustic musical style, it lends itself well to conveying environmental messages through the lyrics [15].

The implications on the occupants and users of building as regards to building sustainability performance therefore, are many and varied owing to the makeup and nature of buildings in our cities. This development notwithstanding, has not attracted much scholarship interest. Most studies only centred on the effects of loud music sounds on the building users/occupants other than the building

performance. It is against this backdrop that this study was aimed at examining the severity of the impacts of loud music sounds on the sustainability performance of buildings across the three main cities in Anambra State, Nigeria.

2. Literature Review

2.1. Building Acoustics and Sustainability

The goal of sustainable building concept is to create buildings that preserve the environment and conserve natural resources, as well as to provide a healthy environment for its occupants [34]. The acoustic performance of a building is one of the crucial factors which contribute to its quality [35]. Acoustic quality is also important in ensuring a healthy and workable working environment [36]. While a healthy environment is one that does not cause disease, promotes wellbeing and, in the case of places for work and learning, promotes productivity [34]; a good acoustic environment is absolutely essential to maintaining a high level of satisfaction and moral health among residents [37]. Therefore, considering the importance of health and wellbeing of persons inhabiting or working in a building, sound protection became an important indicator for social sustainability [38] and environmental sustainability aspects of buildings.

2.2. Sources of Music Sounds

As a sequence of waves of pressure that move, or propagate, through air or another medium, sound when propagated through a space, can be reflected (bounced back), refracted (bent), or attenuated (weakened) by the materials they come into contact with [26]. Environmental noise can be regarded as one of the agents of deterioration in people's quality of life in an urban environment [39]. According to Treasure [40], the acoustics of a space have a disproportionate impact on the wellbeing and productivity of its occupants.

Meanwhile, Oyati and Stephen [41] had identified mosques, churches, markets, schools, household appliance, events (wedding and birthday ceremonies) and loudspeakers among other sources as noise-generating centres in Auchi, Nigeria. Ganiyu and Adediji [42] also observed noises from vehicular traffic, pedestrian traffic and religious buildings as the major sources of external noise, while those from generating sets, telephone/mobile phones, radio and television sets constitute the major sources of internal noise in Akure, Nigeria. Other sources of loud sounds include; cultural, sporting and leisure activities, music from clubs, concerts and festivals, indoor parties and music, etc. Ironically, most of the noises emanating from these centres are as a result of sounds from music or music related events.

2.3. Effect of Music Sounds

Inasmuch as the characterisation of sound as noise is often subjective and it can vary across individuals [43], many other studies have demonstrated how sound environment can influence the peoples' behaviours positively and negatively [44-48]. Meng et al. [49] found that sound environment can affect human perception, and human perception can influence individual and crowd behaviour in both indoor and outdoor spaces. While Basner et al. [50] found that music sounds are usually continuous and if not controlled could have physical and mental health effects, psychological and non-auditory effects, and physiological and auditory effects; Treasure [40] revealed that the long-term exposure to excessive sound waves has been explicitly linked to the appearance or worsening of chronic conditions such as high blood pressure and heart disease. Challe [15] also stated that the high levels of noise interference can cause stress and hearing loss. As for Alves et al. [51], it can cause discomfort. Recent studies [52,53] have also shown that anthropogenic noise is potentially a threat to life on earth.

Even in the civilised cities of the world, music sound has been found to be causing acoustic pollutions [54,55]. Although the physical effects can be subjective to individuals depending on their personal and physical bearing [56,57], Association of Australian Acoustical Consultants [58] showed that sound had a knock-out effect on health and psychological bearing leading to decreased productivity. According to Reybrouck et al. [3] listening to loud music, seems to activate primitive mechanisms of experience, evoking to some extent an amodal kind of perception and surpassing to some extent boundaries between sensory modalities. This view is shared by Mujeebu [59] who found that acoustic comfort in a building has a crucial impact on the health, wellbeing, communication, and productivity of the occupants, and can be affected by factors such as the geometry and volume of a space, generation of sound within or outside the space, airborne noise transmission, impact noise, and the acoustic characteristics (absorption, transmission, and reflection of sound) of the interior surfaces.

A related study on the effects of exposure to building construction noise by Ng [60] revealed significant wing effects ($p < 0.05$) on frequency heard, distractibility, and several perceived behavioural effects, such as being awakened, difficulty with relaxation and studying-related activities, and interference with conversation and television-watching. It further showed that the effects were significantly more severe for residents closest to the construction site than those further away.

Other studies such as [15,34,35,39,40,42,61-64] attributed relaxation disturbance, impair task performance, irritation, interference with speech comprehension, sleep disturbance, falling asleep difficulty, deregulation of the physiological system, increase of cholesterol and triglycerides level in the blood, which subsequently leads

to higher risk of heart attack, cardiovascular disease, cognitive impairment, tinnitus, annoyance, stress, attitude (negative emotion) and anxiety, nuisance, prolonged reaction time, lack of concentration, distraction and slowness of mental processing, increase in risk taking, increase of errors, and decrease in volume, speed and quantity to the effects of increased and irregular sounds of music. These impacts are mainly concerned with social and environmental performance of buildings. For Schiavi and Rossi [65], sound and architecture have mutual influence while Jablonska et al. [66] found that sound pressure induces vibration on the building.

Furthermore, a lot of research has shown that poor acoustic performance can have a negative impact on health, behaviour, and cognitive function, yet acoustics has been neglected in design and construction practices of buildings. Wilson [26] attributed this to partly due to a lack of awareness of how poor acoustic quality affects us and a total lack of understanding of acoustic as being an integral part of either aesthetics or functionality of a building.

A critical look at the buildings around us shows that most building envelopes have low sound attenuation due to ineffective insulation of the components of buildings. The condition is related to the non-consideration of acoustic criteria in our building designs and construction [67], unlike in the advanced countries [68]. Integrating acoustics into an established sustainable design and construction process is a balancing act to achieving a sustainable building, thus a more insight into the impact of different sources of acoustic problems (such as loud music) in building.

3. Methodology

This study was a survey research which made use of questionnaire administered to the occupants and users of buildings in the three cities of Awka, Onitsha and Nnewi in Anambra State. These cities are witnessing increased volume of musical events and activities due to their position in the State and the nature of activities going on in them. The researchers used selected sample from the population to discover the relative statistical distribution of selected sample of the population. The population for this study comprises all the users and occupants of buildings in the three cities.

The questionnaire was designed to elucidate the level of impact of loud music sounds on the sustainability performance of buildings in the three major cities of Anambra State, Nigeria. It was also designed to investigate the probability of occurrence and the severity of music sounds on certain sustainability criteria of buildings in the study area. The questionnaire consisted of two parts. Part 1 captured the respondents' demographic data (place of living, nature of user/occupant, type of building, age of respondents, location of building, and source of music sounds). Part 2 contained 29 items measuring the

frequency of occurrence and severity of impacts of loud music on the sustainability performance of buildings using a 5-point Likert scale measurement. The respondents were asked to express their opinion and observations based on their perception on the impact of loud music sounds on the identified sustainability criteria of the selected buildings on a 5-point scale where 1 = least severe, 2 = less severe, 3 = severe, 4 = more severe, 5 = most severe.

According to the National Population Census figure, the population of Awka, Nnewi and Onitsha cities in 2006, were 143,660, 233,658 and 261,604 respectively [69,70-72]. Although there was observed disparity in the growth rate of population in these three cities; nationally, the population averagely grows at 2.83% growth rate [69]. This growth rate was recommended for use by the National Population Commission (NPC) for Anambra State and has used by the UN-Habitat and Anambra State Bureau of Statistics [70-73] for population projections in the state before now.

Therefore, in 2019, Awka, Nnewi and Onitsha populations would have been increased exponentially. Using Malthusian growth model in equation 1, the current population for the three cities could be computed. This model predicts an exponential increase in the population with time.

The Equation is given as:

$$P_n = P_0 e^{rt} \quad (1)$$

Where P_0 denotes the initial (base year) population;

P_n denotes Population in the current year (required population);

r denotes the growth rate = 2.83% (0.0283) (i.e. average population growth rate of Anambra State); and t denotes the time interval (years) = 13 years.

From Equation 1, the population of Awka, Nnewi and Onitsha in 2019 would have been approximately 211,880, 337,566 and 377,940 respectively. Therefore, the total population of the study was 927,386. To determine the sample size, Israel [74] had suggested different ways including; census for a small population, sample size of a similar study, published table, and the use of formulas.

Hence, to determine the appropriate sample size for this study, Cochran's [75] sample size calculation procedure was used. The equation is appropriate when the population of the study is large [75]. Cochran's return sample size formula was first determined using Equation 2.

$$n_0 = \frac{(t)^2 x(p)(q)}{(d)^2} \quad (2)$$

Where n_0 is the sample size, t = value for selected alpha level of .025 in each tail = 1.96 (the alpha level of .05 indicates the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error), $(p)(q)$ = estimate of variance = 0.25 (maximum possible proportion (0.5) x 1-maximum possible proportion (0.5) produces maximum possible sample size), d = acceptable margin of error for proportion being

estimated = 0.05 (error researcher is willing to except).

However, if the computed sample size is greater than 5% of the population ($n_0 > 5\%$ population), the final and survey sample size would be calculated using Cochran's [75] correction formula in Equation 3. Otherwise n_0 would be adopt as the final and survey sample size for the study.

$$n_1 = \frac{n_0}{1 + \frac{n_0}{\text{population}}} \quad (3)$$

From Equation 3, the sample size

$$n_0 = \frac{(1.96)^2 x(0.5)(0.5)}{(0.05)^2} \approx 384$$

Since n_0 (384) < 5% of 927,386 (46,369), the survey sample size (n_1) = n_0 = 384. However, the sample size was proportionately divided as follows for the three cities, Awka (88), Nnewi (140), and Onitsha (156).

The survey adopted a multi-stage sampling procedure in selecting the desired samples (respondents). Firstly, a proportional stratified sampling was used to subdivide the samples into 3 sub-groups. Stratified sampling technique was used in selecting the building in which the respondents occupy or use based on some specified criteria. Lastly, a simple random sampling technique was used in choosing the respondents within the selected buildings. Meanwhile, for one to be included in the survey, the person must be an adult, live, use or occupy a building susceptible to the effect of loud music sounds, and a maximum of three respondents were selected per building. In all, 30, 47 and 52 buildings making a total of 129 were selected from Awka, Nnewi, and Onitsha respectively.

Since not all occupants/users of the buildings were interested in participating in a survey, buildings which occupants/users agreed to be included were first identified for familiarisation and consent. The objectives of the study were clearly explained to the participants. This made it easier during the actual survey because the respondents were already aware of what was expected of them, and with the help of assistants, the desired numbers of respondents were obtained. Thus, questionnaires were administered to 384 occupants/users of buildings susceptible to the effect of loud music sounds across the three cities. All were retrieved, but 26 were found to be invalid and subsequently discarded while the remaining 358 (84 from Awka, 133 from Nnewi and 141 from Onitsha) representing about 93.23% were found to be adequate and suitable, and then were used for analysis.

To ensure reliability of the result, the margin of error was computed at 95% confidence interval (C.I) within which the result would be acceptable. Margin of error (ME) is given as:

$$ME = \text{critical value} \times \text{standard error} \quad (4)$$

$$\text{Standard error} = \frac{\text{standard deviation}}{\sqrt{n}} \quad (5)$$

Where, n = the sample; The Alpha level (α): α = 1-C.I/100 = 0.05. and C.I = the confidence interval.

The critical probability (p^*): $p^* = 1 - \alpha/2 = 1 - 0.05/2 = 0.975$ given as:

The degrees of freedom (df): $df = n - 1 = 384 - 1 = 383$

In this case, it would be the t-statistic having 383 degrees of freedom and a cumulative probability equal to 0.975. From the t-Distribution, the critical value is found to be 1.96. Thus, the result of this study is reliable and acceptable within +/- 5%-point margin of error, and at the 95% confidence level. This is in line with Data Star [76] which suggested that an acceptable margin of error used by survey researchers falls between 4% and 8% at the 95% confidence level. Bartlett et al. [77] also recommended +/- 5%-point margin of error for this kind of data.

The data generated through the questionnaire were descriptively and quantitatively analysis. The impacts of loud music sounds occurrence were calculated using Mean Score Index (MSI) and Severity Index Percent (SI%) as shown in Equations 6 and 7 respectively.

$$MSI = \frac{\sum_{j=1}^5 J \times N_j}{\sum_{j=1}^5 N_j} \quad (6)$$

Where MSI = mean score index; J = rating scale (integer value between 1 and 5), and N_j = number of the respondents selecting a rating equal to j .

$$SI\% = \frac{\sum_{k=1}^5 K \times N_k}{A \sum_{k=1}^5 N_k} \times \frac{100}{1} \quad (7)$$

Where SI = severity index; K = rating scale (integer value between 1 and 5), N_k = number of the respondents selecting a rating equal to k , and A = the highest weight (in this case, 5).

Thereafter, one-way ANOVA was used to establish the significance of the effect of loud music sounds on the sustainability performance of buildings in the study area. ANOVA or F-statistic can be calculated from Equation 8.

$$F_{STAT} = \frac{S_B^2}{S_W^2} \quad (8)$$

I.e. the ratio of the variance between groups (S_B^2) and the variance within group (S_W^2).

Where S_B^2 = the sample variance between groups or means square between (MSB) which is a measure of variability of group means around the grand mean and is given in Equation 9 as:

$$S_B^2 = \frac{SS_B}{df_B} \quad (9)$$

Where SS_B = sum of squares between groups and is

$$SS_B = \sum_{i=1}^k n_i (x_i - \bar{x})^2 \quad (10)$$

Where n_i = the size of group (i); x_i = the mean of group (i); and $\bar{x}$ = the grand mean.

This statistic has degree of freedom (df)

Where

$$df_B = K - 1 \quad (11)$$

And k = the number of groups.

Likewise, S_W^2 represents the sample variance within groups or mean square within (MSW) which quantifies the spread of values within groups. It is calculated as:

$$S_W^2 = \frac{SS_W}{df_W} \quad (12)$$

Where SS_W = the sum of squares within and it's given as:

$$SS_W = \sum_{i=1}^k (n_i - 1) S_i^2 \quad (13)$$

And degree of freedom (df) within is

$$df_W = N - K \quad (14)$$

Where S_i^2 = Variance of groups (i), N = the grand frequency, and K = the number of group.

Under this case, the null hypothesis will be tested and the test statistic has an F sampling distribution with df_1 and df_2 degrees of freedom and significant level (α) of 0.05 (5%).

Decision: Reject H_0 , if F stat calculated is greater than $F_{critical}$ at $\alpha = 0.05$ and df_1 and df_2 otherwise accept H_0 and conclude.

4. Results and Discussion

Table 1 showed the general background information of the respondents. It revealed that the respondents were made up of 74.58% of male and 25.42% of female. Of this figure, 12.29% were aged between 18-30 years, 29.34% were aged between 31-40 years, 27.37% were aged between 41-50 years, 19.27% were aged between 51-60 years, and 11.73% were aged above 60 years. While 16.48% were single, 77.09% were married, 4.47% are widow/ widower, and 1.96% separated.

Table 1 also showed that majority (86.87%) of the respondents had one form of formal education or the other and only about 13.13% did not had any form of formal education. This implied that the respondents were in good position to provide the necessary information for the study. Similarly, more than half (54.19%) of the respondents were employed, 33.24% were self-employed and 12.57% were either unemployed or retired. This also shows that they can give good account of buildings in which the occupy or use.

Table 1. Demographic information

Variable	Responses (%)
Sex Distribution	
Male	74.58
Female	25.42
Age Distribution	
18-30 years	12.29
31-40 years	29.34
41-50 years	27.37
51-60 years	19.27
Above 60 years	11.73
Marital Status	
Single	16.48
Married	77.09
Widow/widower	4.47
Separated	1.96
Educational Level	
No Formal Education	13.13
Primary	20.67
Secondary	35.47
Tertiary	30.73
Employment status	
Employed	54.19
Self employed	33.24
Unemployed/ Retired	12.57
Building use	
Business/commercial	20.39
Residential	37.71
Recreational	4.19
Office	15.08
Mixed use	22.63
Period of occupancy/use	
Less than 1 year	1.68
1-5 years	13.13
6-10 years	37.15
11-20 years	31.28
Above 20 years	16.76

In terms of the type of building being use/occupied by the respondents, 20.39% were business/commercial building, 37.71% were residential building, 4.19% were recreational building, 15.08% were office building, while about 22.63% were of mixed use. For the period of time the respondents have either used or occupied the building, 1.68% indicated less than 1 year, 13.13% 1-5 years, 37.15% 6-10 years, 31.28% 11-20 years and 16.76% said

that they have used or occupied the buildings for more than 20 years. This also shows that the respondents could be able to give information on what happens to the buildings and the building performance having used or occupied the buildings for a substantial number of years.

Table 2 showed the result of the impact of loud music sounds on the sustainability performance of building from Awka City. It revealed that the sustainability performance of building could be affected by the loud music sounds in four areas: environmental, social, economic and technical. In terms of environmental sustainability, the result showed that release of environmental pollution (MSI = 4.87; SI% = 97.38) and decrease in indoor environmental quality (MSI = 4.85; SI% = 96.91) were the top severe impact loud music sounds have on buildings.

Similarly, increase annoyance, anger and frustration in users/occupants (MSI = 5.00; SI% = 100.00), increase eardrum damage or hearing difficulties (MSI = 5.00; SI% = 100.00) and decrease users' comfort and satisfaction (MSI = 4.96; SI% = 99.29) were the three top social impact exerted on the building by the loud music sounds. Economically, decrease housing price and value (MSI = 4.56; SI% = 91.19) and increase medical cost to users/occupants (MSI = 4.33; SI% = 86.97) were the top two economic impact of loud music sounds on buildings. In terms of technical impacts, increase sound induced vibrations in building (MSI = 5.00; SI% = 100.00) and deteriorate building fabrics (MSI = 4.40; SI% = 88.10) came top respectively.

Table 2 further revealed that social sustainability performance of building was mostly affected by loud music sounds with average mean score index of 4.64, followed by the economic sustainability (4.21), environmental sustainability (4.14), and lastly technical sustainability (3.87) respectively. The high average means scores imply that loud music sounds severely impact the overall sustainability performance of buildings in Awka city. This can be attested from the results of the severity impacts percent of the individual variables.

Table 2. Analysis of the impact of loud music sounds on the sustainability performance of building (Responses from Awka)

SN	Variable	1	2	3	4	5	Mean Score Index	Severity Index (%)	Group mean/ Std D.
Environmental Sustainability									
1	Increase energy consumption in building			13	58	13	4.00	80.00	4.14 0.90
2	Release volatile organic compounds (VOC)		11	39	29	5	3.33	66.66	
3	Release toxic air contaminants			8	33	42	4.36	87.14	
4	Decrease indoor environmental quality				13	71	4.85	96.91	
5	Release environmental pollution				11	73	4.87	97.38	
6	Disrupt biodiversity and natural habitats		13	32	29	10	3.43	68.57	
Social Sustainability									
1	Threat to security of building			27	45	12	3.82	76.43	4.64 0.58
2	Threat to health and wellbeing of users and occupants				5	79	4.94	98.81	
3	Increase workplace accidents and injuries				64	20	4.24	84.76	
4	Decrease users' comfort and satisfaction				3	81	4.96	99.29	
5	Sleep disturbance				12	72	4.86	97.14	
6	Create tension or anxiety within the building				9	75	4.89	97.86	
7	Psychological damage to users/occupants				19	65	4.77	95.55	
8	Increase annoyance, anger and frustration in users/occupants					84	5.00	100.00	
9	Increase blood pressure or stress levels in users/occupants				10	74	4.88	97.62	
10	Increase rate of sickness or absenteeism in users/occupants			13	38	33	4.24	84.76	
11	Decrease performance and productivity of users/occupants			22	41	21	3.99	79.76	
12	Increase Eardrum damage or hearing difficulties					84	5.00	100.00	
13	Speech interference				21	63	4.75	95.00	
14	Reduce quality of life				28	56	4.67	93.33	
Economic Sustainability									
1	Decrease housing price and value				37	47	4.56	91.19	4.21 0.84
2	Increase maintenance cost of building		10	15	35	24	3.87	77.38	
3	Increase medical cost to users/occupants		2	10	30	42	4.33	86.67	
4	Increase insurance premium		3	21	27	33	4.07	81.43	
Technical Sustainability									
1	Deteriorate building fabrics			14	22	48	4.40	88.10	3.87 1.04
2	Increase sound induced Vibrations in building					84	5.00	100.00	
3	Decrease structural stability and durability of building			64	15	5	3.30	65.95	
4	Reduce functionality and serviceability of building		6	55	19	4	3.25	65.00	
5	Induce reverberation and reflection		13	30	17	20	3.38	67.62	

Table 3. Analysis of the impact of loud music sounds on the sustainability performance of building (Responses from Nnewi)

SN	Variable	1	2	3	4	5	Mean Score Index	Severity Index (%)	Group mean/ Std D.
Environmental Sustainability									
1	Increase energy consumption in building	9	10	32	64	18	3.54	70.83	3.80 1.11
2	Release volatile organic compounds (VOC)	17	34	55	20	7	2.74	54.89	
3	Release toxic air contaminants		10	19	48	56	4.13	82.56	
4	Decrease indoor environmental quality				36	97	4.73	94.59	
5	Release environmental pollution			14	32	87	4.55	90.98	
6	Disrupt biodiversity and natural habitats	12	18	54	39	10	3.13	62.56	
Social Sustainability									
1	Threat to security of building	7	22	42	50	12	3.29	65.71	4.48 0.57
2	Threat to health and wellbeing of users and occupants			4	18	111	4.80	96.09	
3	Increase workplace accidents and injuries			29	59	45	4.12	82.41	
4	Decrease users' comfort and satisfaction			10	33	90	4.60	92.03	
5	Sleep disturbance			6	20	107	4.67	93.38	
6	Create tension or anxiety within the building		10	21	36	66	4.19	83.76	
7	Psychological damage to users/occupants			13	33	87	4.56	91.13	
8	Increase annoyance, anger and frustration in users/occupants				19	114	4.86	97.14	
9	Increase blood pressure or stress levels in users/occupants		4	17	22	90	4.49	89.77	
10	Increase rate of sickness or absenteeism in users/occupants			41	39	53	4.09	81.80	
11	Decrease performance and productivity of users/occupants			15	65	53	4.29	85.71	
12	Increase Eardrum damage or hearing difficulties			12	33	88	4.57	91.43	
13	Speech interference		8	10	27	94	4.69	93.83	
14	Reduce quality of life			28	34	71	4.32	86.47	
Economic Sustainability									
1	Decrease housing price and value		19	22	30	62	4.03	80.30	4.01 1.00
2	Increase maintenance cost of building		22	14	53	44	3.89	77.89	
3	Increase medical cost to users/occupants			28	57	48	4.15	83.01	
4	Increase insurance premium		21	14	44	54	3.98	79.70	
Technical Sustainability									
1	Deteriorate building fabrics		16	14	22	81	4.26	85.26	3.93 1.03
2	Increase sound induced Vibrations in building			5	52	76	4.53	90.68	
3	Decrease structural stability and durability of building			58	40	35	3.83	76.54	
4	Reduce functionality and serviceability of building	8	26	42	30	27	3.32	66.32	
5	Induce reverberation and reflection		12	50	38	33	3.69	73.83	

Table 3 showed the result of the impact of loud music sounds on the sustainability performance of building from Nnewi City. The results revealed that the top three environmental impacts of loud music sounds on buildings were similar to that in Table 2 but with slight difference. Whereas decrease in indoor environmental quality has (MSI = 4.73; SI% = 94.59), release of environmental pollution has (MSI = 4.55; SI% = 90.98), and release toxic air contaminants has (MSI = 4.13; SI% = 82.56).

However, increase annoyance, anger and frustration in

users/occupants with (MSI = 4.86; SI% = 97.14), and threat to health and wellbeing of users and occupants with (MSI = 4.80; SI% = 96.09) were the two top social impact loud music sounds have on buildings.

In terms of economic sustainability, increase medical cost to users/occupants (MSI = 4.15; SI% = 83.01) and decrease housing price and value (MSI = 4.03; SI% = 80.30) were the top two impact of loud music sounds on buildings.

Technically, increase sound induced vibrations in building (MSI = 4.53; SI% = 90.68), deteriorate building

fabrics (MSI = 4.26; SI% = 85.26), and decrease structural stability and durability of building were also the top three impacts of loud music sounds on buildings sustainability performance respectively.

Generally, based on the means score index, Table 3 revealed that social sustainability performance of building with average means score index of 4.48 was mostly affected by the loud music sounds followed by the economic sustainability with MSI of 4.01, technical

sustainability with MSI of 3.93, and lastly environmental sustainability with MSI of 3.80 respectively. The high average means scores for these major sustainability criteria implies that loud music sounds have high severe impact on the overall sustainability performance of buildings in Nnewi city like in other major cities in the Anambra State. This is also attested by the values of severity index percent computed across all variables.

Table 4. Analysis of the impact of loud music sounds on the sustainability performance of building (Responses from Onitsha)

SN	Variable	1	2	3	4	5	Mean Score Index	Severity Index (%)	Group mean/ Std D.
Environmental Sustainability									
1	Increase energy consumption in building		18	42	46	35	3.89	77.87	3.95 1.07
2	Release volatile organic compounds (VOC)	15	38	56	22	10	2.86	56.31	
3	Release toxic air contaminants			30	43	68	4.27	85.39	
4	Decrease indoor environmental quality				28	113	4.80	96.03	
5	Release environmental pollution			4	35	102	4.70	93.90	
6	Disrupt biodiversity and natural habitats		14	73	34	20	3.43	68.51	
Social Sustainability									
1	Threat to security of building	3	22	20	80	16	3.60	71.91	4.39 0.71
2	Threat to health and wellbeing of users and occupants				13	128	4.91	98.16	
3	Increase workplace accidents and injuries		7	76	43	15	3.47	69.36	
4	Decrease users' comfort and satisfaction				25	116	4.82	96.45	
5	Sleep disturbance			6	35	100	4.67	93.33	
6	Create tension or anxiety within the building			11	81	49	4.27	85.39	
7	Psychological damage to users/occupants				56	85	4.60	92.06	
8	Increase annoyance, anger and frustration in users/occupants			14	27	110	4.96	99.29	
9	Increase blood pressure or stress levels in users/occupants			18	63	60	4.30	85.96	
10	Increase rate of sickness or absenteeism in users/occupants			64	30	47	3.88	77.59	
11	Decrease performance and productivity of users/occupants			24	43	74	4.35	87.09	
12	Increase Eardrum damage or hearing difficulties			9	34	98	4.63	92.62	
13	Speech interference			18	48	75	4.40	88.09	
14	Reduce quality of life				61	80	4.57	91.35	
Economic Sustainability									
1	Decrease housing price and value			4	55	82	4.55	91.06	4.09 0.88
2	Increase maintenance cost of building		20	34	45	42	3.77	75.46	
3	Increase medical cost to users/occupants			39	60	42	4.02	80.43	
4	Increase insurance premium		11	24	61	45	3.99	79.86	
Technical Sustainability									
1	Deteriorate building fabrics		10	33	51	47	3.96	79.15	3.73 0.97
2	Increase sound induced Vibrations in building				40	101	4.72	94.33	
3	Decrease structural stability and durability of building		21	68	37	15	3.33	66.52	
4	Reduce functionality and serviceability of building		32	57	44	8	3.20	63.97	
5	Induce reverberation and reflection		12	70	39	20	3.48	69.50	

Table 4 showed the result of the impact of loud music sounds on the sustainability performance of building from Onitsha City. The results showed that decrease in indoor environmental quality (MSI = 4.80; SI% = 96.03) and release of environmental pollution (MSI = 4.70; SI% = 93.90) were the top two environmental impact of loud music sounds on buildings, similar to the result in Table 3. Similarly, increase annoyance, anger and frustration in users/occupants (MSI = 4.96; SI% = 99.29), and Threat to health and wellbeing of users and occupants (MSI = 4.91; SI% = 98.16) were the two top social impact of loud music sounds on buildings.

For economic sustainability, decrease housing price and value (MSI = 4.55; SI% = 91.06) and increase medical cost to users/occupants (MSI = 4.02; SI% = 80.43) were the two most severe impacts of loud music sounds on buildings. In the same vein, increase sound induced vibrations in building (MSI = 4.72; SI% = 94.33) and deteriorate building fabrics (MSI = 3.96; SI% = 79.15) were the two most severe technical impacts of loud music sounds on buildings.

The results further showed that social sustainability performance of building was mostly affected by the loud music sounds with average means score index of 4.39, followed by the economic sustainability (4.09), environmental sustainability (3.95), and lastly technical sustainability (3.73) respectively. The high average means scores also imply that loud music sounds severely impact the overall sustainability performance of buildings in Onitsha city.

Test of Hypothesis

To further give credence to the results of this study, significance of the severity of impacts of loud music

sounds on the sustainability performance of buildings were analysed. The following hypothesis is stated to give direction to the study. The results the analyses are presented in Tables 5 - 8.

H₀: There is no significance difference in the severity of the impacts of loud music sounds on the sustainability performance of buildings across the three cities of Anambra State.

The result of Table 5 showed that the value of F-ratio (2.794) is less than F-critical (3.021) and *P-value* (0.067) is greater than the Alpha (0.05). In this case, the null hypothesis is accepted. It then implies that there is no significance difference in the severity of impacts of loud music sounds on environmental sustainability performance of buildings across the three cities of Anambra State. This shows that loud music sounds are being perceived to have almost the same environmental impacts on buildings across the three cities of Anambra State as can be seen in the averages means scores for environmental sustainability in Tables 2, 3 and 4.

Although the results of averages mean scores in Tables 2, 3 and 4 showed that social sustainability performance of buildings was mostly affected by the impact of loud music sounds across the three cities of Anambra State with greatest values, Table 6 revealed that the value of F-ratio (4.275) is greater than F-critical (3.021) and *P-value* (0.017) is less than the Alpha (0.05). In this case, the null hypothesis is rejected and it concludes that there is significance difference in the severity of impacts of loud music sounds on social sustainability performance of buildings across the three cities of Anambra State. This scenario could be attributed to the differences in the social status of the three cities; whereas Awka is the administrative capital of Anambra State, Nnewi is an industrial city while Onitsha is a commercial city.

Table 5. ANOVA table and F – statistic for differences in the severity of impacts on environmental sustainability of buildings

Sources	Sum of squares	Degree of freedom	Mean squares	F-Ratio	F-critical	<i>P-value</i>	Decision
Between	6.141	2	3.070	2.794	3.021	0.067	Accept H ₀
Within	390.153	355	1.099				
Total	396.294	357					

Table 6. ANOVA table and F – statistic for differences in the severity of impacts on social sustainability of buildings

Sources	Sum of squares	Degree of freedom	Mean squares	F-Ratio	F critical	<i>P-value</i>	Decision
Between	3.406	2	1.703	4.275	3.021	0.017	Reject H ₀
Within	141.382	355	0.398				
Total	144.788	357					

Table 7. ANOVA table and F – statistic for differences in the severity of impacts on economic sustainability of buildings

Sources	Sum of squares	Degree of freedom	Mean squares	F-Ratio	F critical	<i>P-value</i>	Decision
Between	2.108	2	1.054	1.252	3.021	0.296	Accept H ₀
Within	298.981	355	0.842				
Total	301.089	357					

Table 8. ANOVA table and F – statistic for differences in the severity of impacts on technical sustainability of buildings

Sources	Sum of squares	Degree of freedom	Mean squares	F-Ratio	F critical	p-value	Decision
Between	2.859	2	1.430	1.405	3.021	0.247	Accept H_0
Within	361.538	355	1.018				
Total	364.397	357					

The result of Table 7 showed that the value of F-ratio (1.252) is less than F-critical (3.021) and *P-value* (0.296) is greater than the Alpha (0.05). In this case, the null hypothesis is accepted and it implies that there is no significance difference in the severity of impacts of loud music sounds on economic sustainability performance of buildings across the three cities of Anambra State. It further implies that loud music sounds are being perceived to have almost the same economic impacts on buildings across the three cities of Anambra State as it can also be seen in the averages means scores for economic sustainability in Tables 2, 3 and 4.

The result of Table 8 revealed that the value of F-ratio (1.405) is less than F-critical (3.021) and *P-value* (0.247) is greater than the Alpha (0.05). This means that the null hypothesis is accepted. It then implies that there is no significance difference in the severity of impacts of loud music sounds on technical sustainability performance of buildings across the three cities of Anambra State. It further implies that loud music sounds are being perceived to have almost the same technical impacts on buildings across the three cities of Anambra State. This can equally be attested by the averages means score values for technical sustainability in Tables 2, 3 and 4.

From the results of this study, it was shown that the impact of loud music sound on the sustainability performance of buildings in Anambra State is obvious. The general consensus was that loud music sounds affect environmental, social, economic and technical sustainability performance buildings, but the greatest effect was found on social sustainability performance, followed by economic performance, environmental and technical respectively. However, while there was significant agreement about the severity of the impact of loud music sounds on environmental, economic and technical sustainability performance buildings; there was significant disagreement among the users/occupies of buildings in the three cities of Anambra State about the level of severity of the impact of loud music sounds on social sustainability performance buildings. This could be as a result of differences in the social status of the cities. Whereas Awka is an administrative capital of Anambra State, Nnewi is a known industrial city and Onitsha is a globally recognised commercial city.

The result of this study therefore is in line with that of Dolezal and Spitzbart-Glasl [38] who found that acoustic quality of building components can have impact on the ecological performance of the whole building and counterbalance advantages already gained in the

sustainability rating. This study is also supported by Schiavi and Rossi and Jablonska et al. [65,66].

5. Conclusions

Although music is not as important as building in the human priority needs, it plays a crucial role in the socio-cultural life of every human being. However, when the sounds of music become loud, uncoordinated and uncontrolled they are detrimental to human lives and the building in which we live. The fact that music sounds is increasingly becoming worrisome in our today's society arouse the need for this study. Thus, this study has found that loud music sounds principally affect the sustainability performance of buildings in four different dimensions. They are environmental, social economic and technical dimensions. Among these dimensions, the study found that social sustainability performance of buildings was mostly affected. The study further established that there were high severity impacts of loud music sounds on buildings based on the four sustainability criteria across the three cities of Anambra State. However, there were significance differences in the severity of impacts of loud music sounds on social sustainability performance of buildings across the three cities of Anambra State due to differences in the social status of the cities.

Undoubtedly, this study has highlighted the need to reconsider certain aspects of building design and construction to incorporate this trend having seen the severity of the impacts of loud music sounds on buildings. The study craves for a rethink in the underlying principles behind ecomusicology and sustainable building and their interrelationships. It would therefore, awaken the conscience of the Anambra State Government towards putting in place an enabling law that would curtail the effect of this phenomenon.

On this premise, the study further hankers for change in the design and construction of buildings that will incorporate the provisions of National Building Code as regards the sound control in buildings. Technically, the general sustainability strategies for improving acoustics performance of buildings such as absorption, mechanical decoupling, mechanical damping, blocking, covering, etc., should be adopted and promotion of acoustic practices that would improve sustainable performance of our buildings and reduce the consequential effects of music sounds in buildings. Furthermore, there is need to activate and review the existing zoning laws and policies in the State, and to

borrow a leaf from Lagos State Government in enacting a law against noise pollution. Finally, there is a need for the Anambra State Government to revisit the structural plans for the three cities prepared by the UN-HABITAT in collaboration with Anambra State Government.

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