CHAPTER EIGHT

ECOMUSICOLOGY, MUSIC ACOUSTICS AND BUILDING SUSTAINABILITY PERFORMANCE

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Abstract
This study was aimed at appraising the impacts of music acoustics on the sustainability performance of buildings in our immediate environment. Through the literature survey, the paper established that music acoustics affects the sustainability performance of buildings socially and environmentally. Notwithstanding these effects, the paper revealed that there were very few research interests concerning music acoustics and sustainable building performance. It also revealed that building designs considering music acoustics are absent and suggested integrating acoustics into a sustainable design process as a way of achieving a sustainable building. Finally, the paper identified pre-design site assessment, site and building orientation, building envelope, space planning, and building material selection as some acoustic practices that could aid the sustainable performance of our buildings which would also reduce the consequential effects of music sound in buildings. Practically, this could be achieved through sound control and the prediction of sound behaviour in buildings, interior environments and urban settings.

Keywords: Music acoustics, Building, Ecomusicology and Sustainable performance

Introduction

Scholarly interest in the relationships between music and nature has 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 (Bendrups, Barney and Grant, 2013). Sustainability and ecomusicology have brought up the concept of the soundscape to awaken people to their natural acoustic surroundings in an increasingly noisy world. Music and all sounds are considered in vibration terms as *transferable energy*, which impinges upon our body and our senses (Eidsheim, 2015). Acoustically, music is the 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 (Reybrouck, Podlipniak and Welch, 2019).

Music industry no doubt has potential for economic and cultural sustainability. According to Wolcott (2016), music has a critical role to play in the transition towards a culture of sustainability. Hawkes suggests that cultural vitality which encompasses is as essential to a healthy and sustainable society as social equity, environmental responsibility and economic viability. In terms of cultural ecology, the music embraces a multilevel interconnection with the organism, population, and community (Titon, 2009a). To this end, music becomes an extremely cost-effective and powerful language that all cultures relate with, a direct and potent tool that sustain urban and rural community building as well as the healing process of

individuals and communities (Ogunrinade, 2015). Titon (2009b) sees music as bio cultural a resource that is renewable.

Economically, the music industry in Nigeria, as in most parts of the world holds great economic potentials (Ogunrinade, 2015). Available statistics show that the record sales in Nigeria in 1981 was about 4.5million; in 1986 it was 5.5million; in 1991, 8.5million and 1995, 12 million records were sold nationwide (Gronov and Saunio, cited in Emielu, 2008). Environmentally, music has been used to advance advocacy towards environmental sustainability (Allen, 2012; Publicover, Wright, Baur and Duinker, 2018; Rees, 2016; Silver, 2015; Titus and Titus, 2017).

However, we are currently living amid a global warming crisis, and running against the clock to counter the rapid depletion of natural resources in an increasingly technology-run world (Challe, 2015). 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 towards social and environmental sustainability performance of our buildings. Sound is a sequence of waves of pressure that move, or propagate, through the air or another medium. When sound waves propagate throughout a space, they can be reflected (bounced back), refracted (bent), or attenuated (weakened) by the materials they come into contact with (Wilson, 2017). Environmental noise can be regarded as one of the agents of deterioration in people's quality of life in an urban environment (Silva, 2015). According to Treasure (2012, the acoustics of a space have a disproportionate impact on the well-being and productivity of its occupants. Treasure (2012) further reveals that 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 (2015) also states that high levels of noise interference can cause stress and hearing loss. As for Alves, Silva and Remoaldo (2015), it can cause discomfort.

Although Iyendo (2016) acknowledged that listening to soothing music reduces stress, blood pressure and post-operative trauma when compared to silence, the negative impression of noises within healthcare soundscapes is significant. A more precarious situation is the acoustic quality of the buildings where we spend 90% of our time (Wilson, 2017). While our experience of a space is always influenced by its acoustics, these buildings all too often have poor acoustics, which can disrupt our work, activities, and health.

Undoubtedly, the first step toward sustainability is to care for our society that is full of vibrant ecosystems and that we must work together to preserve (Challe, 2015). However, music sound in emerging cities is becoming more worrisome. The implications of this on the residents are many and varied owing to the makeup and nature of buildings in the cities. Despite this fact, not much study has been done in that respect. It is against this backdrop that this study aimed at appraising the impacts of music acoustics on the sustainability performance of buildings in our immediate environment.

Sustainable Building and Music Acoustics

For about 4 decades, discussion on issues concerning sustainable building has been on and diverse. The central theme was to provide a building that meets various environmental, economic and social performances now and for the future generation. Environmental issues cover natural source use, energy use, climate change, pollution of land, sea and air, protection of biodiversity, natural habitats etc. Social issues cover public health, education, peace, security, social justice, poverty, people relations with nature, occupational and customer safety etc. Economic issues cover employment, business formation, income, economic opportunity, nature as an economic externality etc. These three concerns have to be considered in all fields that sustainability is subjected (Avgin, 2014), including the music industry. In this case, a sustainable building focuses on increasing the efficiency of resource use (energy, water, and materials) while reducing building impacts on human health and the environment during the building's lifecycle, through better siting, design, construction, operation, maintenance, and removal (Srinivas, 2015).

Sustainability of the technology used toward music-making, awakening people to their natural acoustic surroundings, community-based music to keep endangered indigenous cultures alive, and presenting artists' works that convey climate change through music are innovative ways forward that contribute to our holistic understanding of the interplay of environment and people in times of acute climate change (Challe, 2015). However, as an emerging area of discipline, ecomusicology or ecocritical musicology considers the interconnections between music, nature, and culture, including between non-human sound worlds and human sound worlds (Garett, 2013), or the overlap of the physical and cultural environments as mediated through sound (Allen, Titon, and Glahn, 2014). In this regard, Taylor and Hurley (2015) found acoustic ecology and ecomusicology as one of the five contemporary and emerging fields of interest that connect music and environment. Taylor and Hurley acknowledged the increase of the studies on the Intersections of the two concepts, particularly as composers, performers, and musicologists attempt to respond to matters of climate change, sustainability, and environmental collapse in the novel and meaningful ways.

It is however expected that design for sustainable buildings should consider acoustical concerns from standpoints of efficiency, productivity, functionality, health, comfort and environmental impact (Caliskan and Arslan, 2005). The soundscape shapes the aural dimension of the landscape; it is the aural 'space' shared by humans, human technologies, and the natural world (Rothenberg 2011; Titon 2009; Truax 2012). Meanwhile, different nations have developed energy efficiency certification systems to encourage the building industry to design and construct buildings that are healthy, comfortable and have less energy consumption. However, the acoustical performance criterion is included but not deeply examined in the sustainable design practices (Field, 2008). Whereas, the precautions for sustainable building design considerations if applied without regarding the acoustical requirements cause to design of worse spaces than non-sustainable buildings in terms of acoustical comfort (Field, 2008; Muehleisen, 2010).

Music performances go beyond the frontiers of mere entertainment activity but are geared more towards socio-cultural dimensions due to its ability to socialise, consolidate values and other utilitarian exigencies (Ojukwu, Obielozie and Esimone, 2016). Titon (2013) opines that studies about 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. 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 (Challe, 2015).

Impact of Music Sound on Sustainable Building Performance

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 (Hodgson, 2006). The acoustic performance of a building is one of the crucial factors which contribute to its quality (Nurzynski, 2005). Acoustic quality is also important in ensuring a healthy and workable working environment (Jalil, Din and Daud, 2013). A healthy environment is one that does not cause disease, promotes well-being and, in the case of places for work and learning (i.e. schools), promotes productivity (Hodgson, 2006). Therefore, considering the importance of health and wellbeing of persons inhabiting or working in a building, sound protection became an important indicator of social sustainability aspects of buildings (Dolezal, and Spitzbart-Glasl, 2017).

Since the characterisation of sound as noise is often subjective and it can vary across individuals (*Murphy and King, 2014*), many studies have demonstrated how sound environment can influence the peoples' behaviours positively and negatively (Aletta *et al.,* 2016; Franˇek, van Noorden and Režný, 2014; Meng and Kang, 2013; Miedema, 2004; Ren and Kang, 2015). According to Meng, Zhao and Kang (2018), the sound environment can affect human perception, and human perception can influence individual and crowd behaviour in both indoor and outdoor spaces. Literature survey also 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 (Basner *et al.,* 2014). Ironically, music other than other factors has been found to have been causing acoustic pollution even in the civilised cities of the world (Martí, 1997). Although the physical effects can be subjective to individuals depending on their personal and physical bearing (Emenike and Sampson, 2017; Nyoni, 2015), Association of Australian Acoustical Consultants (ACCC, 2013) showed that sound had a knock-out effect on health and psychological bearing leading decreased productivity. The list of detrimental effects of exposure to sound is very long (WHO, 2011, 2018).

From the available literature, the following effects could be attributed to the increased and irregular sounds of music as it relates to the sustainable performance of buildings. relaxation disturbance, impair task performance, difficulty in focusing attention, irritation, interfere with speech comprehension, disruption of sleep or falling asleep difficulty, deregulation the physiological system, generating permanent release of stress hormones, adrenaline and

cortisol, an increase of cholesterol and triglycerides level in the blood, which subsequently leads to a higher risk of heart attack, cardiovascular disease, cognitive impairment, sleep disturbance, tinnitus, annoyance, stress, attitude (negative emotion) and anxiety, annoyance and nuisance, prolonged reaction time and lack of concentration, distraction and slowness of mental processing, increase in risk-taking, an increase of errors, and decrease in volume, speed and quantity (Alves *et al.,* 2015; Challe, 2015; Emenike and Sampson, 2017; Hodgson, 2006; *Murphy and King, 2014;* Nurzyński, 2005; Nyoni, 2015; Oloruntoba *et al*., 2012; Silva, 2015; The Department of Health, 2018; Treasure; 2012; WHO, 2011, 2018). These impacts are mainly concerned with the social and environmental performance of buildings.

Although a lot of research has shown that poor acoustic performance can have a negative impact on health, behaviour, and cognitive function, acoustics has been neglected in design and construction practice. Wilson (2017) 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 (Park, Lee and Lee, 2017), unlike in the advanced countries (Zalejska-Jonsson, 2019). Therefore integrating acoustics into an established sustainable design process is a balancing act to achieving a sustainable building.

Acoustic Practices for Sustainable Buildings Performance

In recent times, there has been a paradigm shift towards designing sustainable building environments (Boglev, 2008). The main goal of soundscape design and acoustic comfort improvement is not only to reduce relatively unpleasant sounds (such as noise) but also to design and enable a relatively pleasant sound environment (Taghipour, Sievers and Eggenschwiler, 2019). A good acoustic environment is absolutely essential to maintaining a high level of satisfaction and moral health among residents (Zhisheng, 2007). However, different studies have suggested different ways of insulating buildings from sound interference for optimum sustainable performance (Schiavi, Prato and Vallée, 2017). According to Wilson (2017), building acoustic performance is refers as the effectiveness of a building's acoustic design to protect and promote occupants' comfort, well- being, productivity, and ability to communicate. It describes the capacity of space to provide an acoustic environment appropriate to its intended use.

Although acoustic performance seems like a technical quality, it is part of the social sustainability aspects of a building (Dolezal, and Spitzbart-Glasl, 2017). Wilson (2017) suggested the use of a holistic design approach in evaluating and tracking how various sustainable design decisions either conflict or harmonise with an acoustic performance. Idyllically, this process would start at the very outset of the building project when the existing conditions are being examined. In this regard, acoustical and noise control criteria

are incorporated into new standards and criteria for sustainable and high performing buildings as Environmental Quality (EQ) (Evans, 2010), however, Hayne, Brazukas and Marklund (2016) found that none of the green rating schemes addresses all potential acoustic design requirements associated with sustainable buildings.

While certain acoustic practices have been identified as aiding sustainability performance of our buildings which in return reduces the consequential effects of musical sounds in our buildings, the practical application of acoustics includes noise control and the prediction of sound behaviour in buildings, interior environments and urban settings, among other designed places. From the manufacturing of building materials and systems to the design of every kind of occupied space and the surfaces and furnishings inside, there is a high degree of reliance on the principles of acoustics.

Pre-design site assessment

Before the design of any building could start, it is important to understand all the factors that may have an impact on the project's acoustic performance. In assessing the site and context of a building, Wilson (2017) suggested that designers should consider everything in the environment that produces noise or vibration to determine whether it could affect what will be happening inside the building. This assessment should also be done concerning the client's (end-users, owners, tenants) total building performance expectation since clients are increasingly becoming interested in the functional requirements on fitness for purpose, quality and flexibility of the workplace over time, healthy and productive indoor-environments, and added value of the facility for the business process (Ang, Wyatt and Hermans, 2001).

The site and building orientation

How a building is situated on its site can have significant impacts on acoustic performance. A building might be sited or oriented to optimise its relationship to sun and wind for solar energy generation, day lighting, and natural ventilation but designers should also analyze impacts on acoustics. Setyowati and Trilistyo (2016) established a correlation between housing orientation and source of sounds. Therefore, building orientation without considering environmental acoustics causes a high level of sound received and it could disturb human life (Ministry of Environment cited in Setyowati, Budihardjo and Putri, 2019). This is because room acoustic parameters are dependent on the location of both the sound source(s) and the receiver in a room (Reinten *et al.,* 2017).

Building Envelope

The design of the building enclosure can greatly impact energy performance, but it can also significantly affect acoustic performance (Wilson, 2017). Therefore, the acoustic quality of a building should be assessed taking into consideration it's surrounding. Not only the building's interior but also associated infrastructure, balconies, loggias etc. creates an environment of living. In practice, the protection of rooms against noise penetrating from outside is often limited to applying windows with adequate sound insulation (Nurzyński,

2005). Oral, Yener and Bayazit (2004) acknowledged building envelope as one of the most important factors in the control of physical environmental factors such as heat, light and sound to realise defined comfort conditions for the building users.

Space Planning

The sound should also be a key consideration when organising a building's interior spaces. It is noted that when it comes to preventing acoustical issues that are difficult and costly to fix, space planning is incredibly important (Wilson, 2017). Considering sounds when designing and organising the building spaces and space types is both basic and effective. Thus, during the planning process, noise-producing spaces should be isolated from sound- critical spaces using noise-neutral buffer spaces. Additionally, proper compartmentalisation of spaces can reduce flanking (the transmission of sound from space to space along with building elements like floor-to-floor penetrations) while also contributing to air tightness and other acoustical controls.

Building Material Selection

Materials that absorb sound and reduce reverberation time will generally contribute to acoustic comfort. Therefore, in addition to the usual sustainability criteria for material selection, such as minimal embodied carbon and low chemical emissions, design teams should also consider how certain materials or products would affect the acoustics of a space. That can sometimes mean a conflict.

Hard surfaces like concrete are popular in green building for reducing the use of finishes that emit *Volatile organic compounds* (VOCs), but softer surfaces are better for acoustics. Carpeting, cork, or resilient textile flooring are all softer acoustically but require more frequent replacement. In this regard, Nurzyński (20050 posited that the possibility to achieve the proper acoustic quality of a building depends on applied materials and products, on the building's structural details, technical equipment, installations, supporting elements etc..

Generally, solutions to acoustical issues in buildings fall into three categories: absorption, blocking and covering (Barclay, Kang and Sharples, 2012; De Salis, Oldham and Sharples, 2002; Hao, 2014; Jalil *et al.,* 2013). Absorption is used to address the intelligibility and understanding of sounds that occur within a room by controlling reverberation time and echo. Reverberation time is the period it takes for a sound event to become no longer audible. The primary method of controlling reverberation times is through the introduction of absorptive and reflective surfaces and materials into space. The more absorptive materials space contains, the lower space's reverberation time will be.

Blocking is a strategy used to combat the sound transfer between spaces. There are two primary metrics or ratings for an assembly's ability to block sound transmission. Sound transmission class (STC) is a measure of how well an assembly blocks airborne sound. STC must be established for the entire building assembly, not for individual components and then added together. STC is typically established through laboratory tests that document the

decibel loss of a sound that is emitted in one space as it passes through the proposed assembly to the adjacent space. The other measure of sound blocking is Impact Insulation Class (IIC). As its name suggests, IIC is focused on an assembly's ability to attenuate impact sounds such as walking or moving furniture and is especially important in multiple-story buildings.

Covering is the final strategy of the acoustical control, and it is also often called sound masking. Sound masking raises the background sound level of a space to mask or cover unwanted sounds like a neighbour's conversation in an open office. Sound masking can often be cheaply provided in space through the sound produced by a constant airflow HVAC system. A more advanced and targeted way to provide sound masking is through a specially design sound masking system that uses small speakers to admit "white noise" through space. White noise is a random sound signal emitted at a wide range of sound frequencies. These strategies can be used separately or in conjunction to address the primary acoustical concerns of a space which often vary by space type.

Conclusion

Music, though not as important as building plays a crucial role in the socio-cultural life of every human; but when the sounds of music are loud, uncoordinated and uncontrolled they become detrimental to human lives. The fact that music sounds are increasingly becoming worrisome in our today's society arouses the need for this review. Therefore, this paper has established a link between music acoustics and sustainable building. It revealed that music though beneficial to the social and economic life of people, its effect when the sound is loud and uncontrolled becomes injurious to health thereby impinges on the sustainability performance of buildings in terms of social, economic and environmental performance. This calls for the need for sustainable design process towards achieving a sustainable building through Pre-design site assessment, Site and building orientation, Building envelope, Space Planning, and Building material selection. However, the general sustainability strategies for improving acoustics performance of buildings include absorption, blocking and covering.

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