Sources of Noise in Government Primary Schools in Finfinnee

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Abstract

Most prior research on noise in educational environments has focused predominantly on high-income countries, leaving limited knowledge about noise sources in learning spaces within low-income contexts such as Ethiopia. This study addresses that gap by surveying noise sources in primary schools in Finfinnee (Addis Ababa), Ethiopia. A total of fifty-six government primary schools were randomly selected, and data were collected from 2,300 children using structured questionnaires. Analysis revealed that both internal and external noise sources significantly contributed to classroom background noise, with internal sources exerting a greater impact. The most frequently reported sources included classroom talk, idle students in school compounds, noise from adjacent classrooms, religious organisations, and road traffic. The prevalence of these noise sources varied across different city locations. The findings suggest that noise in these schools originates from multiple sources, both within and outside school compounds, underscoring the need for targeted interventions to mitigate its impact on learning environments.

Keywords: ***Noise, Pollution, Schools, Electric Vehicle***

1. INTRODUCTION

1.1 Background

Noise, as a form of sound, is an acoustic reality with its own physical and psychological characteristics. It has magnitude, resonance, pitch and intensity, and makes its effect felt on animals around through their auditory systems (Bijsterveld, 2008). For humans, the perception of noise may be selective, subjective and sometimes come with the processing of visual information (Hendy, 2014). Such factors may differentiate it from other environmental pollutants. Noise does not remain for a long time in the atmosphere because it is transient. It, therefore, has finite duration and energy, which depend on the emission of the noise source or on the strength of the source. In addition, it has spatial limits, typically exerting an impact only within a relatively restricted radius (Réfrégier, 2004). It does not possess the same ability to spread as other forms of pollution (Goines and Hagler, 2007). This characteristic makes noise a distinctive pollutant in the context of control considerations, particularly in learning spaces located in big cites like Finfinnee (García, 2017).

Noise has been extensively researched but previous studies have concentrated

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on high-income countries, with low-income countries under-represented as if noise pollution was not an environmental issue in such countries (Haines et al., 2001; Oloruntoba, Ademola, Sridhar and Agbola, 2012). In addition, the studies have focused more on investigating the effects of individual noise sources such as air and road traffic, separately documenting their impacts (Michaud, Keith and McMurchy, 2007). These studies have, however, generally demonstrated that noise is a harmful auditory stimulus reported to cause several health, academic and speech communication problems. Some of the frequently quoted adverse effects of noise include permanent or temporary hearing loss, annoyance, distraction, sleep disturbance, interference with speech communication, reduced memory, cognitive impairments, poor academic achievements and reduced quality of life (Stansfeld and Matheson, 2003; Shield and Dockrell, 2003; vanKempen et al., 2010). Evidently, long-term exposure to high-level noise can have significant negative impacts on the health, behaviours and performances of those who are frequently exposed to it. Identifying the sources of noise is very essential to understanding and dealing with such negative impacts, and the current study sets out to investigate the sources of noise in government primary schools in Finfinnee, which currently serves as a capital city of the Oromia Regional State and Ethiopia.

1.2 Previous studies

Noise does not affect different sections of human population in a similar way; for instance, unlike adults, children lack the experience to effectively deal with harmful stimuli from their environments and their growing nervous system are not mature enough to cope with such environmental stimuli as noise. Consequently, they are more likely to be affected by noise due to a lack of good coping strategies and their immature nervous system (Stansfeld and Matheson, 2003; WHO, 2011). A study conducted on children in primary schools in London indicated that the noise level and the test scores on literacy, mathematics and science were negatively correlated (Stansfeld and Matheson, 2003), which implies that children's school achievements will decrease when the level of noise to which they are exposed increases. The same study suggested that chronic exposure could lead to reduced cognitive activities in mentally demanding tasks. In a noisy learning space, children make an extra cognitive effort to listen as noise occupies their mental resources and this impact of noise can be worsened by a lack of enough proficiency in the language of instruction (Cutler, Lecumberri and Cooke, 2008). A review of international studies on children's reading performance in a noisy environment also revealed that children suffer reduced reading comprehension and other related learning outcomes (Ferguson, Cassells, MacAllister and Evans, 2013). The reduced learning outcomes are attributed to the interference of noise with verbal communication and cognitive processes at a higher level (Shield and Dockrell, 2003).

Similarly, teachers can be negatively affected by noise coming from outside and within schools; these effects are well documented by previous studies. Teachers often complained about having to raise their voices and interference with speech communication as well as suffering from tension and fatigue while working in noisy classrooms (Crandell and Smaldino, 2000). In schools with a high level of noise, teachers are forced to raise their voices to be heard and this could result in vocal nodules, loss of voice, vocal fatigue and a dry or sore throat (Roy, Merrill, Thibeault, Gray and Smith, 2004; Simberg, 2004). Unlike other professions, teaching probably requires an excessive use of voice and a classroom with poor acoustics can worsen the situation. Teachers have enough reason to take good care of their voice because if it fails, they cannot do their job. Given this fact, it is not surprising that some teachers have shown the tendency to leave their profession earlier due to persistent voice problems (Roy, Merrill, Thibeault, Gray and Smith, 2004). The studies reviewed above indicate that noise in schools deleteriously affects both students and teachers, reducing their performances. Identifying noise sources is an important step to control noise and reduce its impacts on learning and teaching.

Previous studies have also indicated that there are several noise sources for schools with each source differently contributing to noise in classrooms. The sources of noise in schools are often divided into internal and external sources. External sources include road traffic, air traffic, rail traffic and local construction while internal sources comprise cafeterias, lecture rooms, playgrounds and busy hallways (Crandell and Smaldino, 2000). The internal sources of noise inside of a classroom consist of children talking, sliding of chairs or tables and shuffling of hard-soled shoes on non-carpeted floors. Heating, ventilating and air conditioning systems usually significantly contribute to classroom noise levels (Shield and Dockrell, 2004). However, the most common source of noise for schools in many parts of the world is road traffic followed by rail traffic (Sanzl, Garcial and Garcia, 1993). One study in Nigeria showed that 60% of the participants in a noise survey reported road traffic as the major source of noise and a similar finding was obtained from a study conducted in London (Shield and Dockrell, 2003). The contribution of each noise source may vary but background noise in classrooms is the result of noise generated inside and outside schools' compounds.

1.3 Noise in Finfinnee

There is usually a large concentration of schools in cities where noise pollution is, unfortunately, higher because of the big population size and various economic, social and religious activities. For instance, Finfinnee, the capital and biggest city of Ethiopia and Oromia Regional State, has 728 primary schools (including private and government schools) (MOE, 2011). A city is evidently a setting in which noise has particular significance for its dwellers who consider the effect of the pollutant depending on their perception of what life in city

should look like. Such perception may give rise to the existence of hidden cities within the city as individuals from various backgrounds will differently construe a city life (Millie, 2017). In such context, as indicated by Atkinson (2007), the desire for peace and quiet in an urban place is impacted by the dynamic and elastic nature of city life and by the lack of putting in place an effective noise pollution control mechanisms. This can lead to a conflict between social ecology (Atkinson, 2007) and urbanisation of public space, having an important implication for the rights to the city and the rights in the city. Consequently, lack of balancing these competing rights will impact the rights of individuals to public and private acoustic spaces.

Urbanisation of public spaces without due considerations for soundscape seems a common practice in Finfinnee where different groups or organisations openly abuse public acoustic spaces under the the guise of the activity or responsibility they are socially or legally mandated to carry out. Learning space, where citizens send their children for education, is one of the victims of such urbanisation. Like other African countries (See Olayinka, 2013), Ethiopia does not have acoustic standards that govern the acoustics of classrooms in an urban soundscape. It has general legal frameworks enshrined in the constitution and proclamations to protect noise and other environmental pollutants (EPA, 1997; FDRE,1994). However, schools, parents and dwellers do not seem to be aware of the presence of such legal provisions, which remain on paper due to lack of clear policy and guidelines, governing their actual implementation. As a result, noise pollution remains a serious environmental crisis in city in particular, and the country in general (Kucha, 2014). For example, small surveys conducted in the city showed that religious organisations and music shops were the major causes of noise complaints filed with law enforcement bodies (Aberra, 2011; Dana, 2017). These surveys also revealed that noise pollution was observed in all parts of the city, thereby causing a lot of public complaints. Another noise survey (Kucha, 2014) also indicated that students and teachers in Finfinnee complained about the negative impacts of noise on their activities and health, and generally reported road traffic as the main source of the noise. The current study predicts that there may be several sources of school noise in Finfinnee because the city has relatively many vehicles and is the centre of economic, social, and religious activities.

The two surveys cited above are the only studies to investigate noise sources and also limited in scope. The first survey was a preliminary attempt to identify noise sources and public noise complaints across Finfinnee; and it did not address the sources of noise in primary schools in the city (Aberra, 2011; Dana 2017). The second survey was an MA thesis which aimed at assessing extremal noise sources, noise levels and their impacts in eight purposively selected schools (Kucha, 2014). Therefore, the current study was conducted to identify the major external and internal sources of noise for primary schools in Finfinnee. It also investigated whether or not noise sources significantly vary

across the city. Primary schools were selected as children are more likely to be affected by noise than those in secondary schools. This study is significant in terms of paving the way for future studies which need to assess the level of noise and its associated negative effects on behaviours and academic performances of children in primary schools.

2. METHODOLOGY

2.1 Participants and selection procedures

There are generally two types of schools in Finfinnee: private and government schools, with each welcoming children based on not their quality but on the socio-economic backgrounds of their parents. In other words, the type of school to which children of the city go is mainly determined by the economic status of their parents and an academic background matters a little. Children whose parents can afford the steadily increasing school fees are typically enrolled in private schools, where they arrive with fully prepared lunch boxes neatly packed in their bags. In contrast, children from low-income parents go to government schools, which have a larger class size, low-paid and unmotivated teachers, and poorly built and furnished buildings (Kucha, 2014; Tadesse and Maeregu, 2014).

At the time of the current study, a primary school had first and second cycles, which respectively consisted of grades one to four and grades five to eight. In the primary schools found in the capital city, there were 192 primary schools with the second cycle. These schools were owned by the government and attended by 115,002 students. The number of students in such schools was 41,704 and 10880 of them were in grade eight. Participants of the study were 2300 students drawn from grades seven and eight in schools owned by the government. It was thought that students in government schools could be more affected by noise pollution due to larger class sizes and poorer physical facilities. Students in grades seven and eight were selected because such students could relatively read, understand and fill in a questionnaire written in Amharic. The consent of school administrations was obtained before the children took part in the study.

Table 1. Statistical information about participants and the survey questionnaire.

District	Age (mean)	SD	No of questionnaire distributed	No of questionnaire properly filled in and returned	Return rate (%)
Addis Ketema	14.79	1.36	387	381	100
Akaki Kality	14.84	1.25	230	226	100
Arada	14.72	1.22	172	169	100
Bole	14.77	1.28	183	181	100
Gullele	14.78	1.16	203	200	100
Kirkos	14.67	1.32	106	104	100
Kolfe keranio	14.84	1.22	341	336	100
Lideta	14.94	1.18	187	184	100
Nefas Silk Lafto	14.82	1.16	251	247	100
Yeka	14.74	1.26	240	237	100

When the survey was conducted, Finfinnee had ten districts namely, Addis Ketema, Arada, Akaki Kality, Bole, Gullele, Kirkos, Kolfe Keranio, Lideta, Nefas Silk Lafto and Yeka (Table 1). Multi-stage sampling was used to select participants for the study (Gray, 2004) and the sampling was conducted on the schools' data obtained from the Education Bureau of the City Government of Finfinnee. First, government primary schools which have grades seven and eight were identified in each district. From these schools, 56 schools were chosen using systematic simple random sampling. From each district, five to six schools were drawn depending on the number of schools. Finally, inclusion criteria were set to choose students who could participate in the study. Age (14-18 years) and

length of duration of stay at a school (at least two years to identify sources of noise at their schools), and hearing status (normal to distinctly identify noise sources) were used as criteria to select 21 % of students (with an equal percentage of female male) in grade eight in each school.

It was thought that this proportion of students would be enough based on a previous study (van Kempen et al., 2009). Self-report oral hearing questions were to determine hearing status, (e.g., *Do you feel you have a hearing loss in ears*?) because an audiometric screening was not feasible given the large sample size (Weiss et al., 2017). The data collectors were advised to strictly apply the inclusion criteria during the administration of the survey questionnaire. The average and standard deviation of the age of the children were around 15 years and 1.25 respectively (See Table 1). The children did not report any history of hearing loss that could interfere with their participation in the research.

2.2 Data collection procedures

The survey was conducted by using a questionnaire which was written in English and then translated to Amharic (a language used as a medium of instruction for primary schools in the city). The following question was used in the questionnaire: Have you repeatedly heard noise from _ [*road traffic]* in your school over the past month? The children were asked to indicate their answers on two-incidence scales (No, Yes). 'No' means no occurrence at all or seldom while 'Yes' means noise from a given source is often heard. The participants filled in the questionnaire while in school and could ask the research assistants questions if they had issues with the questionnaire. Since the survey was conducted during class time, the return rate was very high (100%). However, thirty-five questionnaires were excluded from the analysis because of being incomplete (Table 1). To check the reliability of the questionnaire, a reliability test was conducted. The Cronbach Alfa Coefficient obtained was 0.76, which showed that the data-collection tool had a good internal consistency (Zocoli, Catalani and Marques, 2009).

2.3 Data Analysis

I employed mixed- effects logistic regression models to estimate the probability that respondents reported each noise source as persisting in generating noise (Winter, 2020). Location (ten subcites), source (twelve categories), and noise type (internal vs. external) were treated as fixed effects to allow direct comparisons among these specific categories. Respondent identity was included as a random intercept to account for repeated measures, and subcity was modeled as an additional clustering factor to capture contextual variation. To complement the regression analyses and provide a natural classification of severity, a hierarchical cluster analysis was performed. Using the predicted probabilities derived from the initial model, a Euclidean distance matrix was computed, and Ward's method was applied to agglomerate sources into distinct groups based on

the similarity of their perceived severity. The resulting dendrogram was cut at a dissimilarity threshold to identify four primary severity clusters, which were subsequently characterised by their mean probability ranges.

I adopted a stepwise modelling strategy, beginning with main effects and progressively introducing two- way and three- way interactions (e.g., location × source) to test whether noise prevalence varied across combinations of predictors. Competing models were compared using likelihood ratio tests and information criteria (AIC/BIC) to identify the most parsimonious specification. The final model provided odds ratios and predicted probabilities that were used to classify the severity of noise prevalence across locations, yielding a natural, data- driven categorisation of mild, moderate, severe, and extreme disturbances.

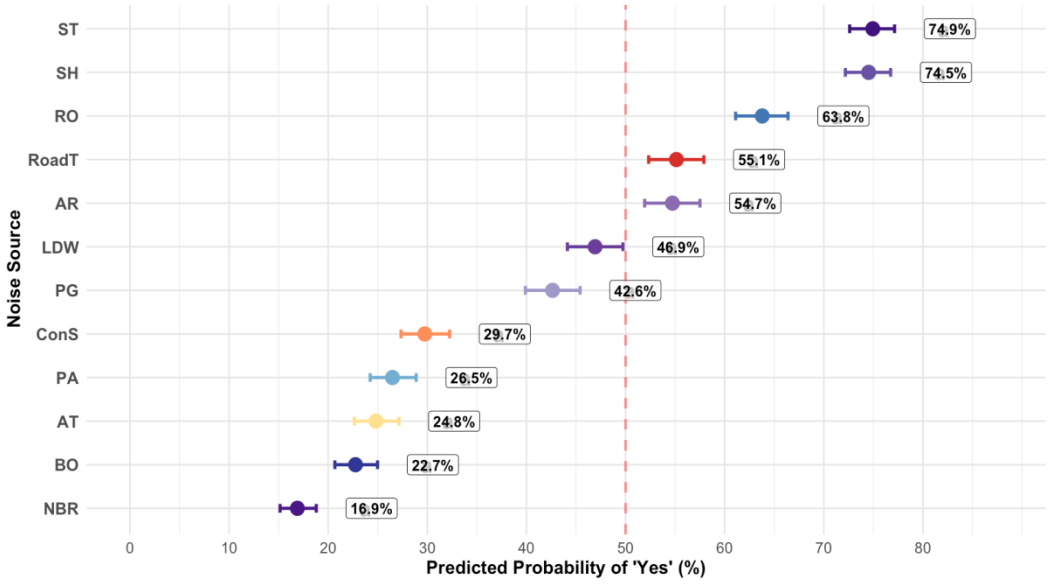
3. RESULTS AND DISCUSSION

3.1 RESULTS

Individual Noise Sources

One of the objectives of the survey is to determine if noise variables are considered as noise sources for government primary schools in the city. Figure 1 displays the predicted probabilities that each of the 12 noise sources would be reported as a prevalent in primary schools, based on mixed-effects logistic regression models accounting for clustering by subject and subcity. Sources are ordered from highest to lowest probability, with error bars representing 95% confidence intervals. The horizontal dashed red line at 50% indicates the threshold where a source is more likely than not to be reported as a problem; five sources exceeded this threshold.

The result indicates that the most prevalent noise sources are students' on-task noise (ST) which showed the highest predicted probability at 74.9% (95% CI [72.6%, 77.1%]), followed closely by noise of students hanging around (SH) at 74.5% (95% CI [72.2%, 76.7%]) . The third-ranked source is religious organisation (RO) at 63.8% (95% CI [61.1%, 66.4%]). Mid-range sources included road traffic (RoadT) at 55.1% (95% CI [52.3%, 57.9%]), adjacent classrooms (AR) at 54.7% (95% CI [51.9%, 57.5%]), moving doors and windows (LDW) at 46.9% (95% CI [44.1%, 49.7%]), and playground (PG) at 42.6% (95% CI [39.9%, 45.4%]). Lower-probability sources included construction sites (ConS) at 29.7% (95% CI [27.3%, 32.2%]), public announcement (PA) at 26.5% (95% CI [24.2%, 28.9%]), air traffic (AT) at 24.8% (95% CI [22.6%, 27.1%]) , and business organisation (BO) at 22.7% (95% CI [20.7%, 25.0%]) . Neighbourhood noise (NBR) was perceived as the least problematic, with a



predicted probability of only 16.9% (95% CI [15.1%, 18.8%])

Figure 1: Ranking of noise sources for government primary schools in the capital city.

A mixed-effects logistic regression revealed significant overall differences among the twelve noise sources, $\chi^2(11) = 3338.49$, $p < .001$, indicating that not all sources are similarly perceived as prevalent. However, despite the wide range of probabilities (from 16.9% to 74.9%), post-hoc pairwise comparisons with Tukey adjustment did not identify any specific pairs of sources that differed significantly at $p< 0.05$. This suggests that while there is an overall pattern of differences among sources, the specific contrasts between individual source pairs were not large enough to reach statistical significance after correction for multiple comparisons.

Location

The analysis revealed a significant main effect of location (Subcity: $\chi^2(9) = 20.49$, $p = 0.015$), indicating that the overall probability of reporting noise as a problem differs across subcities. More importantly, a highly significant Source × Subcity interaction was observed ($\chi^2(27) = 152.32$, $p < 0.001$), demonstrating that the relative ranking of noise sources is not consistent across locations but rather depends systematically on where the school is situated.

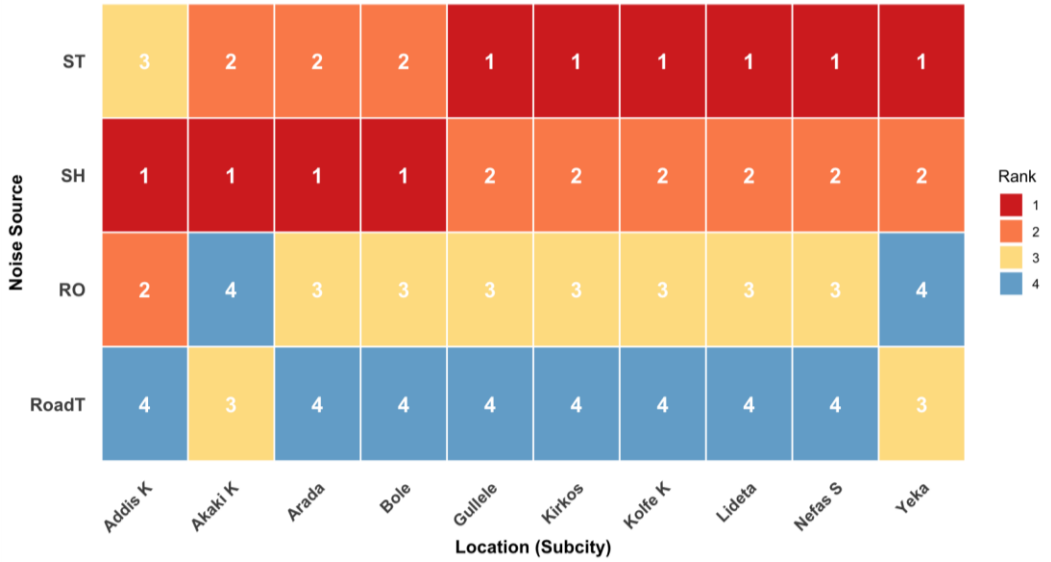


Figure 2: Ranking of the four top noise sources across different locations in the city. The numbers indicate ranks, with a rank of 1 denotes the most problematic source.

The heatmap in Figure 2 presents the ranking of the four principal noise sources—students on-task (ST), students lingering around classrooms (SH), religious organizations (RO), and road traffic (RoadT)—across ten sub-cities of Addis Ababa. Idle students around classrooms were identified as the dominant contributor, ranked first in seven of the ten sub-cities, including Akki Kality., Arada, and Bole. In Addis Ketema and Gullele, students on-task were reported as the primary source, while religious organisations most frequently occupied the second rank across multiple locations. Road traffic consistently appeared as the least problematic among the top four sources. These results demonstrate that noise prevalence is strongly influenced by location in two respects: the overall burden varies across sub-cities, and the relative ranking of sources is contingent on geographic context. The findings indicate that effective noise mitigation strategies for schools in the city must be adapted to local conditions rather than applied uniformly across the city.

Noise Type

To test whether internal and external noise sources significantly differ in their prevalences, a mixed-effects logistic regression was fitted with Source Type (internal vs. external) as a fixed effect and random intercepts for subjects and subcities. The result revealed a highly significant difference between the two source categories ($\chi^2(1) = 516.11$, $p < 0.0001$), with internal sources demonstrating a higher predicted probability of being reported as prevalent (52.0%) compared to external sources (38.0%). This 14 percentage-point gap confirms that the internal-external dichotomy is a meaningful distinction in understanding noise sources of noise in the city (Figure 3). Contrary to expectations, noise originating within the school environment is consistently more counted as noise source than the noise originating from outside school compounds, suggesting that interventions targeting internal sources may yield greater immediate benefits for noise reduction within the school's administrative control. The result shows that source type significantly influences noise distribution, with the internal sources reported as being significantly more prevalent.

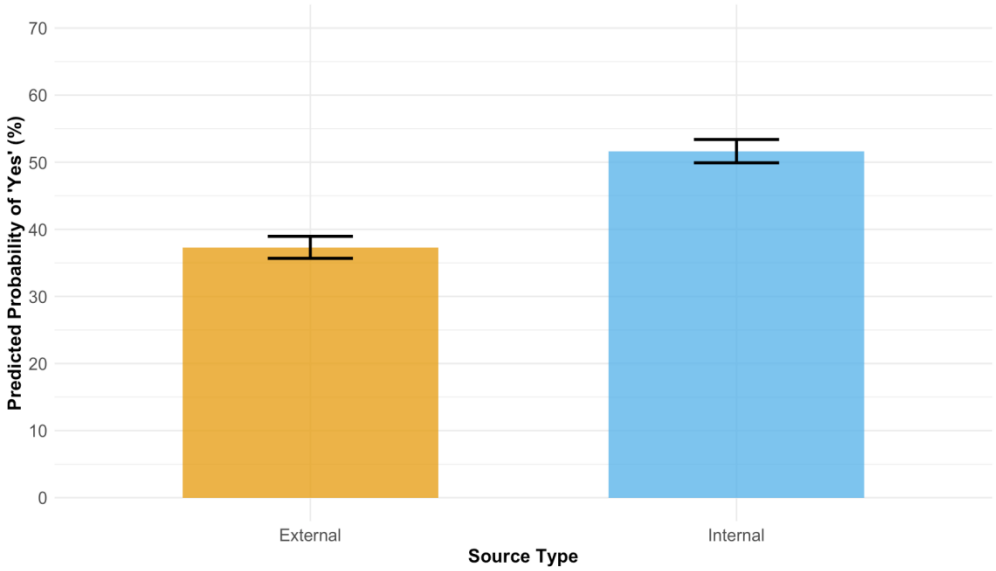
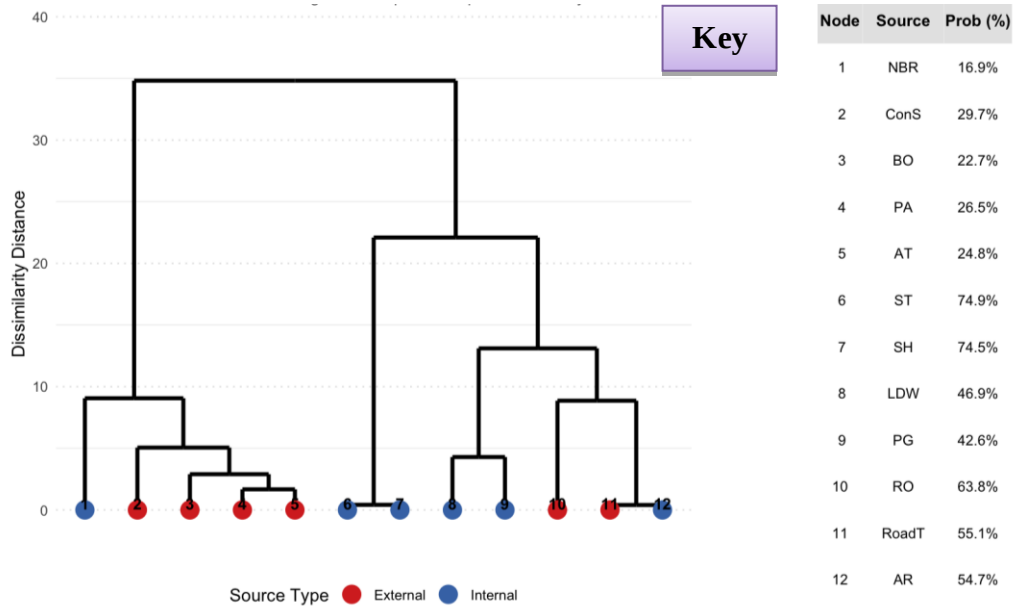


Figure 3: The predicting probability of 'yes' of noise type (internal and external noise sources) as reported by the participants.

Perceived Noise Prevalence Severity

Perceived noise prevalence severity was quantified as the model-predicted probability (percentage) of a noise source being reported as problematic, estimated from mixed-effects logistic regression analyses that controlled for

clustering at the subject and sub-city levels. This metric serves to prioritise noise sources for intervention, with higher probabilities indicating a more urgent need for remedial action.



Node	Source	Prob (%)
1	NBR	16.9%
2	ConS	29.7%
3	BO	22.7%
4	PA	26.5%
5	AT	24.8%
6	ST	74.9%
7	SH	74.5%
8	LDW	46.9%
9	PG	42.6%
10	RO	63.8%
11	RoadT	55.1%
12	AR	54.7%

Figure 4: Dendrogram from hierarchical cluster analysis of 12 noise sources based on predicted problem severity. Sources that branch together at lower heights demonstrate greater similarity in their probability of being reported as problematic by participants.

Figure 4 displays a dendrogram from hierarchical cluster analysis of the 12 noise sources based on the predicted probabilities. The analysis reveals four distinct clusters at a dissimilarity distance of approximately 10: a severe cluster comprising ST (74.9%) and SH (74.5%); a moderate-severe cluster containing RO (63.8%), RoadT (55.1%), and AR (54.7%); a moderate cluster with LDW (46.9%) and PG (42.6%); and a mild cluster encompassing the five least problematic sources (ConS, PA, AT, BO, NBR), with probabilities ranging from 16.9% to 29.7%. The branching pattern confirms that perceived noise severity follows a natural hierarchical ordering, with sources clustering by probability level rather than by source type. Noise sources cluster into four clear severity tiers based on their predicted problem probabilities, with noise coming from students on-task (ST) and from students hanging around (SH) emerging as the most severe concerns. This result may provide an empirical basis for targeting interventions toward the highest-probability sources while acknowledging the hierarchical structure of noise prevalence.

3.2. DISCUSSION

This survey was conducted to identify the sources of noise inside and outside government primary schools in Finfinnee. Religious organisations were reported to be a source of noise for the majority of the primary schools in the city. This report is consistent with the result of a previous study, where religious organisations were found to be the major sources of noise complaints presented to subdistrict 'law enforcement in Finfinnee (Aberra, 2011; Dana, 2017). Similarly, a survey of noise sources in the Indian city of Delhi showed that religious organisations were the major sources of noise in the city where schools are found (Singh and Davar, 2004). The religious organisations in Ethiopia include Orthodox (43.5%), Islam (33.9%), Evangelical churches (8.6%), indigenous (often called traditional) religions (2.6%), and Catholic (0.7%) (Karbo, 2013). There could be other religious organisations such as different sects of Christianity. Due to a lack of data, the exact number and distribution of places of worship (churches, mosques and others) in the city are unknown but the places are generally located within a short walking distance throughout the city. It is little wonder that the frequent incidence of noise from these centres reported by the participants may be due to their large number and use of powerful loudspeakers mounted on their buildings.

Road traffic was also reported as a frequent source of noise for primary schools in the city. Similarly, in high-income countries, where there are noise control laws and acoustic standards, road traffic has remained a major source of noise pollution for schools (Bradley and Sato, 2008). Noise levels were surveyed in 142 schools in London and the result indicated that the main noise source (86%) was road traffic (Shield and Dockrell, 2004). In Europe, noise from road traffic is the major cause of noise pollution affecting 50% of the urban population (WHO, 2011). In Ethiopia, the number and ratio of vehicles are very low compared to other African countries. In 2009, the ratio of vehicles was 4 per 1,000 people while the ratio was 162 per 1,000 people in South Africa. The total number of vehicles in Ethiopia was estimated at 250,000 in 2008 (UN, 2009) and it increases at 7% per annum; most of the imported vehicles are old and used elsewhere (Tulu, Washington and King, 2013). As the number of vehicles increases and as the vehicles get older, the amount of noise they generate will rise, more significantly contributing to noise pollution in schools. The lack of detailed noise control laws and acoustic standards for building schools in the country may worsen the situation.

However, the advent of electric and hybrid vehicles offers a significant opportunity to address noise pollution by road traffic, primarily at low speeds where the absence of internal combustion engine and exhaust noise can reduce acoustic emissions by up to 20 dB (Arenas, 2025). At low urban speeds, the dominant noise sources in electric vehicles are its electric motors, which operate far more quietly than internal combustion engines. Regulatory requirements for

pedestrian safety, such as Acoustic Vehicle Alerting Systems (AVAS) are being introduced as the vehicles will be quieter when their running speeds are reduced (Doleschal & Verhey, 2022; National Highway Traffic Safety Administration, 2022). However, once speed exceeds approximately 50 km/h, the primary source shifts to tire and road interaction noise, rendering the acoustic performance of electric vehicles similar to that of a conventional car at these medium to high speeds. At very high speeds above 120 km/h, aerodynamic noise from airflow over the vehicle body becomes a significant additional contributor to the overall noise generated. Consequently, addressing long-term noise reduction will likely need complementary measures beyond vehicle electrification.

Other external noise sources such as business organisations, air traffic, construction sites, and public announcements were not reported as sources of noise for many primary schools in the city. First, the sample schools could be located away from these noise sources. Second, the sources may be so limited that primary schools are less likely to be in their vicinity and this is particularly true for air traffic. Third, regardless of their number and proximity, these sources may not be generating noise loud enough to be of great concern to the respondents. However, the chance is high for some noise sources to continue to increase. For instance, air traffic was found to be a source of noise for half of the primary schools in Bole District (50 %), where the Bole International Airport is located, and the noise may increase as the aviation industry expands. Air traffic is a dominant source of noise in high-income countries where there is a lot of air traffic. In England, prolonged exposure to air traffic noise is linked to increased noise annoyance and to cognitive impairments in demanding activities in children (Haines et al., 2001). In the USA, children who were exposed to air traffic noise poorly did demanding activities such as solving puzzles and could not adapt to the noise after a year (Cohen, Krantz, Gary, Stokols and Kelly, 1981). The decision to expand an aviation industry either through renovation or building new ones should not ignore real public concerns but needs to consider the environmental impacts such economic activities can have on the acoustic landscape of learning spaces.

The survey further showed that students talking within their classrooms and idle students hanging around classrooms during lessons and adjacent rooms were reported to be sources of noise for most of the surveyed schools. Similar findings were reported by previous studies carried out in Europe and other regions. In Iran and Saudi Arabia, the highest level of noise was recorded inside classrooms which meant that students talking is a major source of noise for schools (Golmohammadi, Ghorbani, Mahjub and Daneshmehr, 2010; Dockrell and Shield, 2006). Similarly, in Europe, noise generated in school including students talking in classrooms is a dominant source of complaints (Woolner and Hall, 2010). Speech communication in classrooms can be adversely affected by background noise consisting of speech since such noise is an effective masker,

making communication very difficult (Srinivasan and Wang, 2008). The contribution of external noise to background noise within classrooms will be reduced when widows and/or doors are closed (Mohan and Rajagopal, 2010). Yet, teaching in a classroom full of students with the doors closed without air conditioners is difficult as it denies a circulation of fresh air, causing discomfort, which can interfere with learning and teaching. A good architectural design and careful planning which involve a team of experts from different professions are needed to strike the delicate balance between classroom ventilation and acoustic performance (Behar, Marshall and Cheesman, 2010).

The current study is a preliminary attempt to identify sources of noise that contribute to the background noise in classrooms in primary schools in Finfinnee. Therefore, the results of the study should be interpreted cautiously for different reasons. A questionnaire was used to collect data for the survey and thus the respondents had to rely on their memory (as is usually the case) to identify the incidence of noise from different sources. Moreover, the respondents might have gotten used to noise when it occurred continuously and failed to notice it. Finally, there was no way to cross-check the quality of the data as they were collected from students only. Despite these limitations, the current study is very useful in producing good empirical evidence about the sources of noise in primary schools in the city. It is hoped that future studies will produce better empirical data by involving teachers and students, and a measurement of noise levels.

4. CONCLUSIONS

The study demonstrates that both internal and external noise sources significantly contribute to the background noise in classrooms of the surveyed schools. Religious organisations, road traffic, students talking, idle students hanging around and adjacent classrooms were reported to be the major sources of noise. Internal noise sources more significantly contribute to noise pollution in government primary schools in the capital city. The incidence of noise from these sources significantly varied across different locations in the city. It is concluded that background noise in government primary schools in Finfinnee has multiple sources. The government of Ethiopia and other responsible stakeholders need to consider these noise sources if they want to improve the acoustic environment of learning spaces in primary schools found in the city. Acoustic standards and enforcement laws are needed for building new schools and improving the performances of old ones so as to reduce the sources of noise polluting the primary schools. The negative impacts of noise pollution on children's health and academic performance are so significant that neither responsible parents nor government officials can afford to ignore or dismiss them as a simple environmental issue.

ACKNOWLEDGEMENTS

The author thanks Addis Ababa University for its financial support. He also thanks the primary schools and their children, and data-collectors for actively collaborating with him to gather data for the noise survey.

CONFLICT OF INTEREST

The author does not have any conflict of interest to declare.

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