SUGGESTIVE MODIFICATION TO REDUCE NOISE POLLUTION AND SOCIO-ECONOMIC ASPECTS OF SHALLOW ENGINE VEHICLES IN KUSHTIA AREA

Omar Ahsan Fahim*[1], Quazi Hamidul Bari[2] and H M Fairooz Adnan[3]

[1] *Graduate in Civil Engineering, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: fahimahsan555@gmail.com*

[2] *Professor, Department of Civil Engineering, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: qhbari@ce.kuet.ac.bd*

[3] *Graduate Student, Department of Civil Engineering, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: adnanauntor336@gmail.com*

***Corresponding Author**

ABSTRACT

Shallow Engine Vehicles (SEV) are designed and manufactured locally in Bangladesh with the intention of carrying agricultural goods on rural roads. These vehicles are cheaper and have a heavy-duty load-carrying capacity with noise generation. The noise is usually generated by different kinds of vehicles moving on the roads mainly buses, trucks, and SEV. In areas like Kushtia, Meherpur, Jessore, Pabna, and nearby regions, Shallow-engine vehicles like Nosimon-Korimon & Troly are commonly used, flouting the "motor vehicle ordinance" on main roads. While these vehicles are banned on main roads, they persist on side roads, mainly in rural areas. Lacking noise and emission reduction systems, these vehicles subject people living near roads to harsh noise. Despite this, their affordability and utility create job opportunities in rural areas, akin to pickup trucks or mini-buses. The study's goal is to gather data on these vehicles, assessing their noise pollution contribution to suggest the reduction approach and socio-economic implications. Detailed investigations regarding the design, fabrication, socio-economic aspect, and noise emission from SEV in Kushtia town from December 2021 to March 2022 were conducted. The noise levels were measured alongside these vehicles, and surveys collected feedback from the local population, considering the socio-economic significance. In Kushtia's residential areas, noise levels exceed the standard, ranging from 58dB to 80dB, posing a significant social problem. The government has already banned these noisy vehicles, but this action may lead to unemployment for thousands of people who rely on them for their livelihoods, as 13% of rural residents in adjacent areas use this technology and 10% are fully dependent on it. Instead of an outright ban, alternative solutions such as implementing noise-reducing technologies like padding, additives, specific engine oils, and noise barriers should be considered to address the noise pollution issue while preserving employment opportunities.

Keywords: *Noise pollution, shallow engine vehicles, socio-economic aspects, economic growth, affordability.*

1. INTRODUCTION

Inhabitants of our planet find themselves unable to escape the intrusive clutches of noise, which is essentially an unwanted and disruptive auditory disturbance that can be quite bothersome to those who experience it. Over the past three decades, the prevalence of noise pollution has surged considerably, particularly in urban areas (Islam & Bari 2008; Sordello et al., 2020). Typically, the standard range for acceptable sound levels falls between 30 decibels (dB) to 60 dB (Chepesiuk, 2005). When the sound level surpasses the 80 dB threshold, it officially qualifies as noise. Shallow engine vehicles, such as the Nosimon-Korimon and Troly, due to their suboptimal design and construction, emit an insufferable cacophony throughout their entire operation. Notwithstanding these unfavourable consequences, these vehicles offer various socio-economic advantages that render them desirable despite their adverse auditory effects.

To provide a precise definition, "Shallow engine vehicles" refer to a category of cost-effective vehicles powered by specialized boring or pumping machines. Typically, these machines are imported from countries like China and India, primarily for purposes related to irrigation and water pumping (Adnan et al., 2023). However, innovative mechanics and skilled workers have harnessed their capabilities to create a unique technological adaptation. They've managed to achieve the same rotational speed, usually around 2200 revolutions per minute (rpm), comparable to pickup trucks imported from more established automotive markets such as India and Japan. Shallow-engine vehicles are versatile and designed to serve various functions depending on their specific configuration (Bari et. al 2011). For passenger transportation, they are equipped with comfortable seating arrangements, often sheltered by a protective canopy to shield occupants from the elements, be it the harsh sun or inclement weather. In cases where cargo transport is the primary objective, these vehicles are equipped with a sturdy deck, capable of supporting substantial loads (Kaewfak et al., 2021).

These vehicles exhibit remarkable utility, enabling the transportation of materials such as sand, bricks, cement, khoya, and similar items, especially in regions where conventional alternatives are impractical. The key distinction lies in their adaptability to navigate rural roads, often characterized by their narrow, poorly constructed nature. These roads pose significant challenges for conventional pickup trucks, making it arduous for them to access and transport materials through such challenging terrain. Shallow-engine vehicles fill a critical niche, facilitating the movement of goods and materials where traditional vehicles cannot, making them indispensable in these remote and challenging environments. Regrettably, Shallow engine vehicles have not yet incorporated effective sound reduction systems or silencers into their machinery. This omission becomes particularly problematic as these machines, initially intended for field use, generate noise in an environment where such noise is relatively inconsequential due to the open terrain and limited human presence. However, a significant concern arises from the fact that these machines are now being deployed on roads and highways, a usage that contravenes established legal norms as they do not adhere to the "motor ordinance law." These vehicles have faced multiple bans as a result of their non-compliance (Islam & Dinar, 2021).

One of the primary factors contributing to the pronounced noise emanating from these engines during the combustion process is the fundamental dissimilarity between diesel and petrol molecules. Diesel molecules are notably larger, and these engines operate under high compression conditions. Additionally, diesel engines lack spark ignition, further accentuating their noisiness (Rodríguez-Fernández et al., 2020). The presence of "sweeping" turbo vanes, which occasionally change position, especially at idle, contributes to the distinct "jet" noise. Comparatively, diesel engines tend to be even noisier than their petrol counterparts. Both diesel and petrol engines function as internal combustion engines, converting fuel energy into mechanical energy (Wallington et al., 2006). The pivotal disparity arises in the compression process. Diesel engines inject fuel into air that is already highly compressed within the cylinder, intensifying the noise output. These engines incorporate numerous intricate components, including metal caps, small valves, and oil conduits, which collectively contribute to the overall noise level. Furthermore, diesel fuel undergoes less rigorous filtration

compared to petrol, resulting in a higher presence of particulates that contribute to its amplified noise when ignited (Rounce, 2011). Therefore, it is critical to heed unusual noises emanating from diesel engines, as they often serve as early indicators of potential mechanical issues.
Presently, noise pollution stands as a formidable issue not only in Bangladesh but globally. The human ear, a marvellously delicate and intricate anatomical structure, is nonetheless a robust force to reckon with (Jariwala et al., 2017). It reacts swiftly to stimuli, although not always in a manner one would desire, as exemplified when the ear captures the sudden blast of a gunshot. Such unanticipated sonic assaults can inflict significant damage due to the ear's unpreparedness. Noise pollution, however, extends beyond mere annoyance; it constitutes a substantial health hazard. It has the potential to elevate stress levels, raise blood pressure, disrupt sleep, hinder concentration, and trigger irritability and tension (Singh & Davar, 2004).

It is rather remarkable that, despite perpetually emanating harsh and intolerable noise, these vehicles remain popular. Therefore, it is imperative to conduct a socio-economic study to ascertain the motivating factors behind the support for these vehicles. Their appeal lies in their affordability, costing roughly one-fourth of the price of equivalent vehicles. Lack of a sheltered enclosure is a non-issue for rural communities; what holds paramount importance to them is cost-effectiveness. These vehicles are ideally suited to cater to the needs of rural areas. In terms of load-carrying capacity, they rival trucks and can transport construction materials with ease. Astonishingly, they can handle loads ranging from 5 to 10 tons. Their narrow design allows them to navigate through the tight, poorly designed-roads of rural and recently-developed towns. In these areas, no better alternative to these vehicles exists. They hold a predominant status in these regions and are indispensable for construction purposes. Therefore, the specific aims of this study include measuring noise levels at selected locations along specified roads in the chosen area, investigating the potential impact of noise in these areas, assessing the socio-economic benefits of using these specialized vehicles, and conducting a brief examination of Shallow Engine (pump) Vehicles as part of the research.

Figure 1: Three-wheeler and four-wheeler SEV for carrying comparatively lightweight and heavy weight load

2. DIFFERENT PARTS OF SEV

The main head engine of these vehicles is pivotal, serving as the powerhouse that drives their efficiency. Primarily sourced from China, these engines, such as EMEI 190-AN, SIFANG, and CHANGCHAI T-35, power vehicles capable of carrying 5 to 10 tons, rivaling imports from countries like India but at significantly lower costs ranging from 1.22 to 6.5 lakhs, a mere fraction of the usual 17 lakh price tag.
The EMEI 190-AN engines, popular due to their affordability and availability, range from 6 to 15 HP, boasting a mileage of about 15 km per liter of diesel and costing between 25k to 36k Tk. SIFANG engines, renowned for long-term performance and low maintenance, offer 14 to 25 HP, with a mileage of 20 to 25 km per liter, priced from 30k to 45k Tk. CHANGCHAI T-35, the most powerful and expensive among them, offers 20 to 35 HP, with a mileage of 17-20 km per liter, priced between 40k to 55k Tk, featuring a self-starting system.

The vehicles' structure includes a cabin shell, roof panel, chassis, and flatbed deck, with customizable designs. The chassis serves as the vehicle's structural foundation, while the flatbed deck provides space for cargo, either enclosed or open, based on transportation needs.

Tires vary in size and section based on terrain and usage. For smooth surfaces, smaller section tires suffice, while rough terrains demand larger rear wheels for increased friction. In extreme conditions like soft soil or mud, truck tires or double-axle wheels are used for better traction.

(a) (b) (c) (d)

Figure 2: Different parts of an SEV such as (a) Emei 190-AN main head engine, (b) Cabin shell (c) Chassis(Underpart), and (d) Hydraulic systems.

Hydraulic systems, akin to dump trucks, expedite unloading, reducing time and labor. Imported from India or China, these systems offer two setups: mid-deck or corner placement, each with its advantages in power consumption and speed.

Additional components like ladders, LED headlamp systems, and mudguards contribute to the vehicle's functionality and safety, completing these cost-effective yet robust vehicles designed for diverse transportation needs.

In essence, these vehicles are a testament to efficient engineering, leveraging affordable yet powerful engines, customizable structures, and adaptable features to cater to various terrains and cargo requirements, all at a fraction of the usual cost.

3. METHODOLOGY

3.1 Site Selection

Due to the prevalence and accessibility of these shallow vehicles, the initial focus of the study was directed toward Kushtia town. Situated within the Khulna division (Figure 3), Kushtia district boasts geographical coordinates at a latitude of 23.9028 and a longitude of 89.11943. Kushtia holds significance as the spot of the invention of these shallow-engine vehicles, and consequently, numerous stations can be found scattered throughout the area.

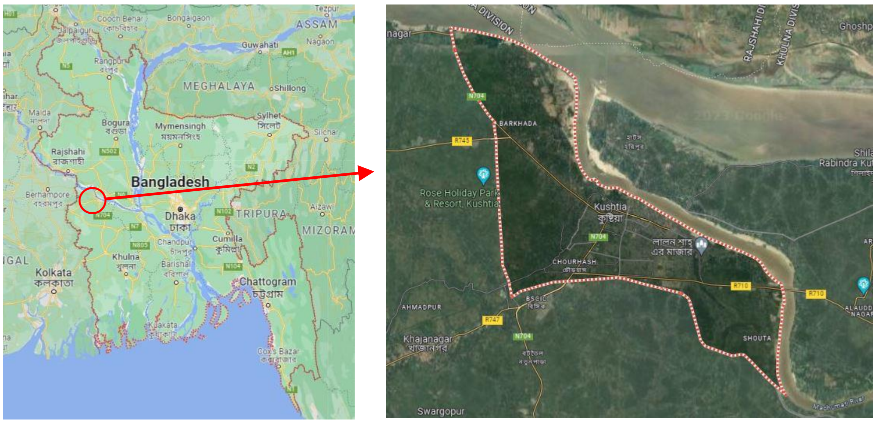


Figure 3: Location of Kushtia area

To account for the high demand and widespread use, five specific stations were strategically chosen for this study which are shown in Figure 4. These stations are renowned for their extensive utilization in transporting goods, materials, and passengers. The selected sites that best met these criteria include Trimohoni, Vadalia, Horipur Bridge, Battail, and Borobajar. While some data were also collected from other locations such as Mirpur and Fulbari, it was not as comprehensive as the information gathered from these primary stations.

Location	Latitude	Longitude
Trimohoni	23°55'55.0"N	89°05'21.5"E
Vadalia	23°50'45.5"N	89°05'49.7"E
Horipur bridge	23°54'49.5"N	89°07'42.2"E
Battail	23°52'48.0"N	89°05'31.5"E
Borobajar	23°54'06.6"N	89°08'48.7"E

Figure 4: Sampling Location

3.2 Identification of Noise Problems in Workplace

The initial phase in addressing the issue of workplace noise is the crucial task of ascertaining whether it poses a potential problem (Abo-Qudais & Abu-Qdais, 2005). One effective method to make this determination is by conducting a comprehensive walk-through survey. During this survey, various indicators indicative of potentially hazardous noise levels are carefully examined. This can encompass a range of factors, such as the volume and frequency of noise sources, the proximity of employees to these sources, and the duration of exposure. By systematically assessing these indicators, employers and safety professionals can gain valuable insights into the presence and severity of noise-related risks in the workplace, ultimately guiding the development of appropriate mitigation strategies and safeguards to protect the well-being of employees and ensure a safer and more productive work environment.

3.3 Noise Measurement

A standard sound level meter comprises a microphone, electronic circuits, and a display to convert sound into electrical signals and present it in decibels. During noise measurement one should take care about the heterogeneous Traffic near Urban Roadways (Emran et. al. 2020). On another note, for Shallow Engine Vehicles lacking front speed panel displays, a popular Android application called GPS Speedometer-Odometer was utilized to determine vehicle speed. Developed by "Trusted Android Apps-Pdf reader & Documents apps," this app employs a smartphone's GPS sensor to act as a speedometer with a 98% accuracy rate. It functions both online and offline, with online mode offering better precision, making it a convenient tool for collecting speed data. The data collection process involved the utilization of a Digital Sound Level Meter (SLM) at various preselected locations within Kushtia City (Nast et al., 2014). Prior to measuring sound levels, the noise meter was meticulously calibrated to ensure accuracy, and precautions were taken to ensure safety from traffic disruptions during data collection. To conduct the measurements, the SLM was held at arm's length, positioned at ear height relative to individuals exposed to the noise. The microphone's exact orientation toward the noise source was typically non-critical for most SLM models, as outlined in the instrument's instruction manual (Jamrah et al., 2006). Calibration, both before and after each use, was a crucial step, with calibration procedures detailed in the manual. The ultimate noise level value was determined as the average of three consecutive readings at a specific moment. In parallel, to assess the speed of the vehicles during noise determination, the GPS Speedometer-Odometer App, downloaded from the Play Store and utilized online through GPS, was employed. The values were recorded at three distinct distances from the noise source of the engine, specifically at 0 meters from the driver's perspective, 5 meters from the engine, and 10 meters from the engine (Katorani, 2019).

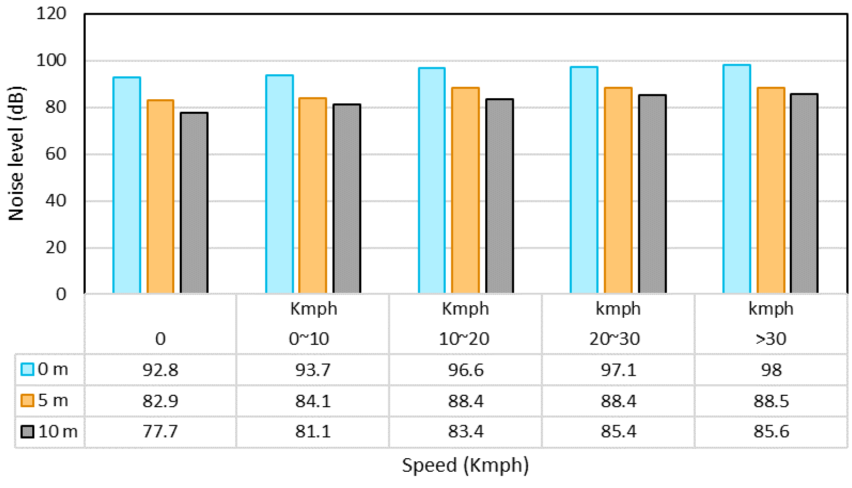
3.4 Conduct Study and Questionnaire

A comprehensive research endeavor was undertaken to acquire detailed specifications of the Shallow Engine Vehicles prevalent in Kushtia, a city renowned as their place of origin and where their inventor, Mithu Vai, played a significant role. This study delved deeply into the intricacies of these vehicles, encompassing their various types, specifications, practical utility, and efficiency. Moreover, the investigation extended to include the formulation of a comprehensive questionnaire that covered a broad spectrum of socio-economic factors. It also solicited feedback related to noise disturbance, addressing the multifaceted aspects of these vehicles and their impact on the local community, thereby providing a holistic understanding of this unique vehicular landscape.

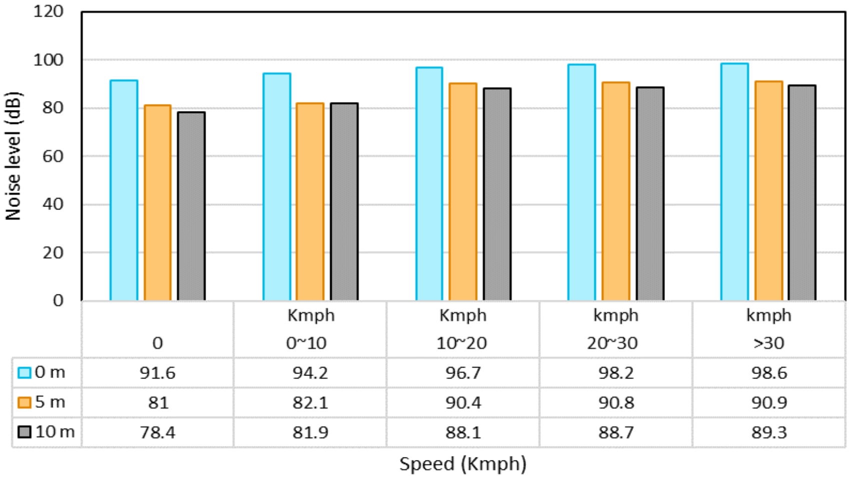
4. RESULTS AND DISCUSSIONS

4.1 Noise Levels of Different Locations

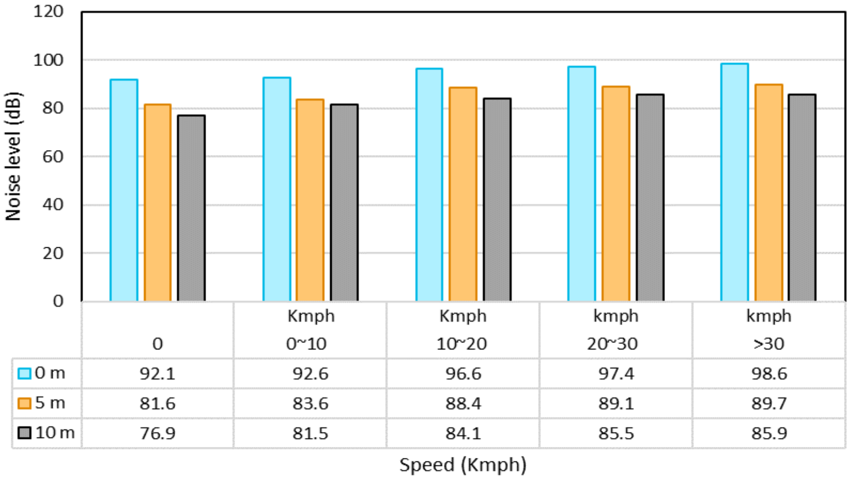
A comprehensive evaluation of noise levels associated with shallow engines at various stations, including Trimohoni, Vadalia, Battail, Borobazar, and Horipur-bridge, has revealed concerning results. The minimum noise level recorded at these stations exceeds the tolerable range of 80 decibels (dB). It is important to note that these measurements consider the potential influence of external factors such as road conditions, other vehicles, crowds, and air flows. Notably, even in the relatively tranquil setting of the Horipur-bridge station, where external interference is minimal due to its location near a river, noise levels still surpass the acceptable threshold. Figure 5 graphically illustrates the relationship between noise levels and distance at different stations, with these lines demonstrating an inversely proportional correlation.



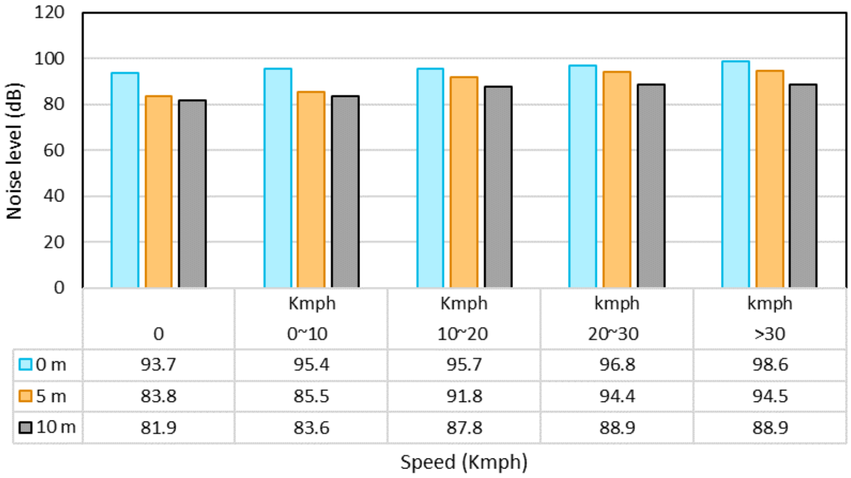
(a)



(b)



(c)



(d)

Figure 5: Noise level associated with Shallow-Engine Vehicles of (a) Trimohoni, (b) Vadalia, (c) Battail, and (d) Borobazar with corresponding distance and vehicle speed.

Typically, people should perceive sound from these vehicles at a distance of 5 to 10 meters when standing alongside the road. Alarmingly, peak noise levels are observed, with Trimohoni station registering 98 dB, Vadalia station at 98.6 dB, Battail at 98.6 dB, Borobazar at 98.5 dB, and Horipur-bridge at 96.7 dB. These levels indicate a hazardous impact that could potentially result in hearing impairment and require immediate attention.

Additionally, Figure 5 depicts the connection between sound levels (dB) and vehicle speed at various stations. Given that these vehicles generate substantial vibrations during operation, a discernible relationship between engine vibration and speed is evident. The data indicates that the engine produces a pronounced vibration at the outset, typically ranging from 77 to 93 dB when stationary at 0 kmph. Subsequently, the vibration intensifies for a certain range of speeds, roughly between 1 to 30 kmph. Behzad et al. (2007) also reported that increasing vehicle speed will increase the emitted noise level. Beyond this range, there is a vibration reduction, typically occurring after crossing 30 kmph, followed by irregular fluctuations that do not adhere to a consistent pattern.

Comparing the five stations, it becomes apparent that noise levels are highest at Trimohoni and lowest at Horipur-bridge station. This variation is primarily attributed to the presence of crowds and the intensity of vehicular activity in market areas. Trimohoni, being a bustling hub of commerce among these locations, registers the highest noise levels. Conversely, Horipur-bridge, situated beside the serene Gorai River, experiences minimal external interference and crowd presence, resulting in the lowest noise levels.

4.2 Analysis of Socio-Economic Aspects

A meticulously conducted and comprehensive questionnaire survey was undertaken, aiming to gather in-depth and detailed insights. This survey involved the systematic collection of data through an extensive set of questions designed to probe deeply into the subject matter and acquire a thorough understanding of the various aspects under investigation. The questionnaire was thoughtfully crafted to cover a wide spectrum of relevant topics, ensuring that no pertinent aspect was left unexamined. Through this diligent and exhaustive questionnaire survey, a wealth of information and nuanced perspectives was obtained, providing a robust foundation for subsequent analysis and decision-making. Findings from the questionnaire survey reveal a compelling trend: approximately 80% of respondents express their support for these vehicles, even in the face of the inconvenience posed by noise disturbances. This survey further uncovers that nearly 20% of rural residents in the neighbouring regions have embraced this technology, with a notable 12% relying on these vehicles as their primary source of livelihood. Remarkably, a significant majority of these individuals, as indicated by our study (85%), stand in opposition to any outright ban on these vehicles. Instead, they advocate for innovative solutions or alternative technologies to mitigate the noise and associated issues stemming from these vehicles.

It is clear that, like many innovations, these vehicles are not without their drawbacks. Despite the aforementioned adverse effects, they have gained dominance and popularity across Kushtia, Jessore, Pabna, Veramara, and their adjacent regions. The seemingly intolerable noise levels notwithstanding, people remain enthusiastic about utilizing these vehicles. This resilience can be attributed to the vital socio-economic role these vehicles play in the lives of the residents in our study areas. The significance of these roles is underscored by several key factors:

4.2.1 In terms of costs

In contrast to high-end vehicles such as small trailers or passenger vans, these shallow-engine vehicles employ more modest engines, designed for lightweight tasks such as powering irrigation boring machines like Sifang, Changchai, or EMEI 190-AN, originally intended for agricultural use. Surprisingly, despite their cost-effective design, these vehicles are remarkably affordable, with prices ranging from 1.3 lakh to 7 lakh Bangladeshi Taka(Shaoxing Nosimon Machinery's- Volza, 2023), well within the financial means of their intended users. What makes these vehicles truly remarkable is their ability to offer utility and functionality on par with, if not exceeding, that of more expensive pickup trucks, which typically command prices between 15 lakh to 30 lakh Taka. As a result, these vehicles emerge as not only cost-effective alternatives but also as vital lifelines and invaluable career opportunities for the rural working-class population, reinforcing their significance in the socio-economic landscape.

4.2.2 In terms of usage

The application spectrum of these vehicles encompasses a wide array of utility, making them indispensable to rural communities. Rural residents harness the versatility of these vehicles for various purposes, including the efficient transportation of construction materials such as sand, bricks, aggregates, cement bags etc. Furthermore, they serve as an irreplaceable means of carrying livestock from remote rural areas to the market, especially as rural roads often entail narrow, challenging passages. Additionally, these vehicles are adept at conveying diverse products, furniture, and other commodities. As a result, these vehicles have become a linchpin in the daily lives of rural inhabitants, not only facilitating their immediate needs but also nurturing their livelihoods, thereby earning deep-seated satisfaction among the rural populace.

4.2.3 In terms of passenger vehicle

Despite lacking designated seating arrangements and protective sheds, these vehicles have garnered remarkable popularity among the general populace in their respective regions. This popularity has been gained primarily due to their affordability and cost-effective services, as other public transport may be costly and not suitable for all types of roads (M. M. Rahman et al., 2020). With the capacity to comfortably accommodate up to 10 passengers, there are even instances of these vehicles transporting as many as 20 individuals. This flexibility extends their utility beyond the realms of material transportation, as they serve as a convenient mode of collective transportation for the local residents. In essence, these vehicles have evolved into an additional avenue for livelihood, further endearing them to their users and solidifying their standing as indispensable assets in the socio-economic landscape.

4.2.4 In terms of facing adverse condition

The versatility of these vehicles extends to their adaptability across a wide spectrum of conditions. Moreover, other public transportations often get into accidents due to inclement weather on rural roads (S. Rahman, 2017). The SEV effortlessly navigate rural roads, often characterized by their rugged and unpaved nature, as well as the intricate network of narrow and under-designed town roads. What sets them apart is their remarkable ability to transition seamlessly onto highways, making them a valuable mode of transportation across different terrains. Moreover, their exceptional performance shines in challenging environments such as muddy, recently dredged ponds, and irrigated fields, where traditional vehicles would falter. Equipped with robust engines and an open structure with sturdy truck tires, these vehicles demonstrate their prowess in areas where others cannot operate, further exemplifying their distinct advantage and adaptability in diverse and demanding scenarios.

4.2.5 In terms of power

An astonishing feat is achieved by these machines, as they are capable of delivering an impressive 2200 revolutions per minute (rpm) and possess the same carrying capacity as conventional trucks. What truly boggles the mind is that this remarkable performance is accompanied by a price tag that is almost inconceivably lower, amounting to approximately one-fourth of the cost of a typical pickup truck (Tata Ace EX2, 2023). This discrepancy between their exceptional capabilities and their remarkably cost-effective pricing stands as a monumental advantage in the realm of socio-economics. It opens up opportunities and levels the playing field for rural communities, offering them access to powerful and versatile vehicles that were previously considered beyond their reach, thereby fostering socio-economic growth and empowerment.

5. SUGGESTIVE MODIFICATION

Reducing diesel engine noise by 10 to 15 decibels involves a blend of meticulous enhancements and strategic additions to the vehicle.

5.1 Upgraded Engine Oil

Conventional mineral oil should be swapped for high-quality synthetic engine oil. While slightly pricier, synthetic oils offer unparalleled lubrication, leveraging compounds like PTFE (commonly known as Teflon) that coat moving parts, curbing friction, and consequently, minimizing engine noise (Tripathi & Vinu, 2015).

5.2 Additives for Friction Reduction

If synthetic oil seems cost-prohibitive, It should be considered specific additives like STP or Nulon. These additives create a smooth layer on moving components, diminishing friction and noise (Vipper et al., 2001). While they aren't as comprehensive as synthetic oil, they serve as a more affordable alternative.

5.3 Strategic Padding

Strategically placing sound-dampening materials in crucial spots throughout the vehicle passively reduces engine noise (Siano et al., 2016). Premium options like Dynamat are highly effective but come at a higher cost. Alternatively, using polyurethane yoga mats can be a more budget-friendly choice, albeit with slightly less efficacy. These materials can be affixed underneath the bonnet, on engine bay sidewalls, and the firewall between the engine bay and passenger compartment. Additional application within door pads and on the vehicle's floor, further diminishes noise, enhancing cabin tranquillity.

5.4 Engine Cover Enhancement

It should be considered to install an engine cover or shield, preferably crafted from lightweight aluminum which significantly reduce the noise of engine (Siano et al., 2016). Outfit the underside with sound-absorbing material and a reflective sheet to mitigate heat accumulation. Enhancing an existing shield by adding a layer of padding can further reduce engine noise.

Figure 5: Engine cover and underbody coating for noise reduction of Shallow Engine

5.5 Underbody Coating

While somewhat less impactful, applying a robust underbody coating—ranging from 100-150 microns—offers multiple benefits. Not only does it shield the vehicle's underbelly from corrosion and debris impact, but it also minimizes road and engine noise permeating the cabin (Kitahara et al., 1984). Opting for reputable brands like 3M for this underbody coating typically ranges between Tk. 3,500 and Tk. 5,500, varying based on the vehicle model.

5.6 Potential of Bio-oil

Bio oils derived from renewable sources like plants or animal fats may boast unique traits beneficial for Shallow engines. They excel in providing enhanced lubrication, minimizing friction between moving parts and potentially reducing overall engine noise(Panchasara & Ashwath, 2021; Ghaderi et al., 2019). Some variants exhibit superior viscosity stability across temperatures, aiding in quieter engine operation. Additionally, certain bio-oils possess properties that dampen mechanical vibrations and sound waves within engine components, contributing to noise reduction. Their potential for promoting cleaner combustion can also lead to smoother engine operation and decreased noise levels. However, the extent of noise reduction varies based on their composition, quality, and compatibility with specific engines, suggesting that while bio-oils offer noise-reduction benefits, their impact might not surpass other targeted measures for significant noise reduction.

6. CONCLUSIONS

Noise levels in residential areas in Kushtia vary between 58 and 80 dB, which is much higher than the standard 50 dB guideline. Similarly, commercial zones exhibit noise levels between 70dB and 100dB, further exceeding acceptable thresholds. The noise generated by the Shallow-Engine vehicles ranges from 80.3dB to 105dB, well above the critical 100dB peak point, posing a severe hazard and emerging as a pressing social concern that demands immediate attention. While the government has enforced a ban under the "motor ordinance law," this approach could exacerbate unemployment issues, as approximately 12% of rural residents rely on these vehicles for their livelihoods. A more balanced solution includes implementing noise-reducing measures like padding, additives, specific engine oils, underbody coating, engine covers, and noise barriers, addressing the broader issue of noise pollution efficiently. To mitigate these diesel engine noises cost-effectively, synthetic engine oil can be considered used for improved lubrication and reduced friction, even though it's pricier than conventional oil. Alternatively, noise-reducing additives like STP or Nulon can create a smooth layer within the engine to diminish noise. Another practical approach involves placing dampening materials strategically in the vehicle. While Dynamat is effective but costly, polyurethane yoga mats are a more budget-friendly option, which can be affixed to various areas like the engine bay, firewall, door pads, and the vehicle's floor, thus reducing interior cabin noise. Adding an engine cover or shield with sound-dampening properties can further dampen noise. Finally, underbody coating offers corrosion protection and minimizes both road and engine noise inside the cabin. These strategies collectively contribute to a quieter and more comfortable driving experience.

ACKNOWLEDGEMENTS

We extend our appreciation to the Department of Civil Engineering of Khulna University of Engineering and Technology for their generous financial backing and instrumental assistance in facilitating this research work.

REFERENCES

Abo-Qudais, S., & Abu-Qdais, H. (2005). Perceptions and attitudes of individuals exposed to traffic noise in working places. Building and Environment, 40(6), 778–787. https://doi.org/10.1016/j.buildenv.2004.08.013

Adnan, H. M. F., Hassan, K. M., & Tabassum, S. N. (2023). Irrigation water quality & soil nutrients near Shyampur sugar mill area in Bangladesh. AIP Conference Proceedings, 2713(1), 060007. https://doi.org/10.1063/5.0129844

Bari Q. H., K. W. Haque and M. B. Ahmed (2011) Is it an Issue to Think about the Spreading of Shallow Engine Vehicles? A Case Study in and Around Khulna City. In Proc. Int. Conf. on Env. Tech. and Const. Eng. for Sust. Dev., SUST, Sylhet, pp. 900-906.

Behzad, M., Hodaei, M., & Alimohammadi, I. (2007). Experimental and numerical investigation of the effect of a speed bump on car noise emission level. Applied Acoustics, 68(11), 1346–1356. https://doi.org/10.1016/j.apacoust.2006.07.003

Chepesiuk, R. (2005). Decibel Hell: The Effects of Living in a Noisy World. Environmental Health Perspectives, 113(1), A34–A41. https://doi.org/10.1289/ehp.113-a34

Emran M., Saju Z. A. and Q. H. Bari (2020) Particulate Matter Concentration Emitted from Heterogenous Traffic Near Urban Roadways in Khulna City. In the Proceedings of the 5th ICCESD 2022, Feb. 7-9, Dept. of CE, KUET, Khulna, (ISBN-978-984-34-764-3)

Ghaderi, M., Javadikia, H., Naderloo, L., Mostafaei, M., & Rabbani, H. (2019). Analysis of noise pollution emitted by stationary MF285 tractor using different mixtures of biodiesel, bioethanol, and diesel through artificial intelligence. Environmental Science and Pollution Research, 26(21), 21682–21692. https://doi.org/10.1007/s11356-019-05523-1

Islam, M. A., & Dinar, Y. (2021). Evaluation and Spatial Analysis of Road Accidents in Bangladesh: An Emerging and Alarming Issue. Transportation in Developing Economies, 7(1), 10. https://doi.org/10.1007/s40890-021-00118-3

Islam, M. S. & Bari, Q. H. (2008) Noise Level at Selected Intersections in Khulna City. In Proc. of the Int. Conf. on Sust. Transport for Dev. Countries. BUET, Dhaka, Bangladesh, pp 141-146.

Jamrah, A., Al-Omari, A., & Sharabi, R. (2006). Evaluation of Traffic Noise Pollution in Amman, Jordan. Environmental Monitoring and Assessment, 120(1), 499–525. https://doi.org/10.1007/s10661-005-9077-5

Jariwala, H., Syed, H., Pandya, M., & Gajera, Y. (2017). Noise Pollution & Human Health: A Review . Noise and Air Pollutions: Challenges and Opportunities, Ahmedabad: LD College of Eng. https://www.researchgate.net/profile/Hiral-Jariwala/publication/319329633_

Kaewfak, K., Ammarapala, V., & Huynh, V.-N. (2021). Multi-objective Optimization of Freight Route Choices in Multimodal Transportation. International Journal of Computational Intelligence Systems, 14(1), 794–807. https://doi.org/10.2991/ijcis.d.210126.001

Katorani, S. (2019). Evaluation of the noise pollution caused by urban traffic and its effect on the level of anxiety of citizens in the city of Sanandaj. Motaleate Shahri, 8(32), 117–127. https://doi.org/10.34785/J011.2019.756

Kitahara, T., Terada, I., & Watanabe, T. (1984). Study on effective application of soundproofing materials through low noise prototype car development. International Journal of Vehicle Design, 5(4), 490–504. https://doi.org/10.1504/IJVD.1984.061108

Nast, D. R., Speer, W. S., & Prell, C. G. L. (2014). Sound level measurements using smartphone “apps”: Useful or inaccurate? Noise and Health, 16(72), 251. https://doi.org/10.4103/1463-1741.140495

Panchasara, H., & Ashwath, N. (2021). Effects of Pyrolysis Bio-Oils on Fuel Atomisation—A Review. Energies, 14(4), Article 4. https://doi.org/10.3390/en14040794

Rahman, M. M., Jahan, J., & Zhou, Y. (2020). Alleviating Traffic Congestion by the Strategy of Modal Shift from Private Cars to Public Transports: A Case of Dhaka City, Bangladesh.. Springer International Publishing. https://doi.org/10.1007/978-3-030-35902-7_7

Rahman, S. (2017). An Analysis of Passenger Vessel Accidents in Bangladesh. Procedia Engineering, 194, 284–290. https://doi.org/10.1016/j.proeng.2017.08.147

Rodríguez-Fernández, J., Ramos, Á., Barba, J., Cárdenas, D., & Delgado, J. (2020). Improving Fuel Economy and Engine Performance through Gasoline Fuel Octane Rating. Energies, 13(13), Article 13. https://doi.org/10.3390/en13133499

Rounce, P. L. (2011). Engine performance and particulate matter speciation for compression ignition engines powered by a range of fossil and biofuels [D_ph, University of Birmingham]. https://etheses.bham.ac.uk/id/eprint/2812/

Shaoxing Nosimon Machinery’s—Buyer, Suppliers, full Export Import details—Volza. (2023). https://www.volza.com/company-profile/shaoxing-nosimon-machinery-16790700/

Siano, D., Viscardi, M., & Panza, M. A. (2016). Automotive Materials: An Experimental Investigation of an Engine Bay Acoustic Performances. Energy Procedia, 101, 598–605. https://doi.org/10.1016/j.egypro.2016.11.076

Singh, N., & Davar, S. C. (2004). Noise Pollution-Sources, Effects and Control. Journal of Human Ecology, 16(3), 181–187. https://doi.org/10.1080/09709274.2004.11905735

Sordello, R., Ratel, O., Flamerie De Lachapelle, F., Leger, C., Dambry, A., & Vanpeene, S. (2020). Evidence of the impact of noise pollution on biodiversity: A systematic map. Environmental Evidence, 9(1), 20. https://doi.org/10.1186/s13750-020-00202-y

Tata Ace EX2 Price in BD (2023). https://www.autosbangla.com/tata-ace-ex2.html

Tripathi, A. K., & Vinu, R. (2015). Characterization of Thermal Stability of Synthetic and Semi-Synthetic Engine Oils. Lubricants, 3(1), Article 1. https://doi.org/10.3390/lubricants3010054

Vipper, A., Zadko, I., Karaulov, A., & Ermolaev, M. (2001). Antifriction action of engine oil additives. Lubrication Science, 14(1), 43–56. https://doi.org/10.1002/ls.3010140104

Wallington, T. J., Kaiser, E. W., & Farrell, J. T. (2006). Automotive fuels and internal combustion engines: A chemical perspective. Chemical Society Reviews, 35(4), 335–347. https://doi.org/10.1039/B410469M