BEFORE THE HoN'BLE NATIONAL GREEN TRIBUNAL,
SOUTHERN ZONE AT CHENNAI

Original Application No. 103 of 2020

IN THE MATTER OF:
Tribunal on its own motion Suo Motu.

And

The District Environment Engineer,
Tamil Nadu Pollution Control Board & Others.

.....Respondents.

INDEX

Advocate
Thiru.S. Sai Sathya Jith,
Advocate, Chennai.

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL, SOUTHERN ZONE, CHENNAI

Original Application No.103 of 2020

IN THE MATTER OF:
Tribunal on its own motion Suo Motu.

And

The District Environment Engineer,
Tamil Nadu Pollution Control Board & Others.

.....Respondents.

ADDITIONAL REPORT FILED ON BEHALF OF THE FIRST RESPONDENT – TAMIL NADU POLLUTION CONTROL BOARD.

I, S.Malarvizhi, Daughter of Thiru. K. Subburam, aged about 58 years, having office at No.76, Mount Salai, Guindy, Chennai 600 032, do hereby solemnly affirm and sincerely state as follows:

1. I submit that I am working as the Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board, Chennai and I am authorized to file this report on behalf of the first Respondent and as such I am well acquainted with the facts of the case from the records available in our office.
2. It is respectfully submitted that the OA was registered as Suo Motu as against the operation of Power looms located in Tharamangalam, Salem District for causing noise pollution.
3. It is respectfully submitted that, the Respondent's Board on 17.09.2022 filed its report on OA No. 103 of 2020 before the Hon'ble National Green Tribunal.
4. It is respectfully submitted that on 20.04.2023, the Hon'ble Tribunal has passed an Order as follows:

   " 2. After the work order is issued by the Tamil Nadu Pollution Control to Anna University and after formal acceptance of the same, Anna University may require a minimum of 3 (Three) months time for a comprehensive study to address the issue.

20/01/2025
JOINT CHIEF ENVIRONMENTAL ENGINEER
TAMIL NADU POLLUTION CONTROL BOARD
No.76, MOUNT SALAI, GUINDY,
CHENNAI-600 032.

3. Let the study consider not only the noise mitigation measures comprehensively but also the cost effectiveness, as these are all by and large cottage industries.

4. The Environmental Engineers of the Tamil Nadu Pollution Control Board are also directed to coordinate with Anna University whom they have engaged for this purpose".

5. It is respectfully submitted that as per the above direction passed by the Hon'ble Tribunal, the respondent Board vide order dated 30.06.2023 engaged the Centre for Environmental Studies - (CES), Department of Civil Engineering Anna University, Guindy to conduct the "Pilot Plant Study to identify device / technology to mitigate noise pollution generated from the power loom". On 19.11.2024, the CES, Anna University has submitted its final report of the said study along with certain recommendations for mitigation of noise pollution generated from the power loom. **(CES Study report is enclosed** as **Annexure - I).**

6. It is respectfully submitted that, CES, Anna University, on 18.12.2024 made a presentation on the final report of the said study before the senior officials of the Board. After a detailed discussion it has been decided to conduct a meeting with the other stakeholders like Power loom Associations, Ministry of Micro, Small and Medium Enterprises (MSME), Tamil Nadu Small Industries Development Corporation Limited (TANSIDCO), Department of Handlooms and Small Industries Development Bank of India (SIDBI), Chennai to obtain their view / suggestions on the recommendation of said study report and to take necessary action on implementation of the recommendations of the said study. **(Minutes of the Meeting held on 18.12.2024 is enclosed vide Annexure II)**

7. It is submitted that, necessary action on implementation of the recommendations of the said study, will be taken after obtaining the view / suggestions of the various stakeholders.

20/01/2025

JOINT CHIEF ENVIRONMENTAL ENGINEER
TAMIL NADU POLLUTION CONTROL BOARD
No.76, MOUNT SALAI, GUINDY,
CHENNAI-600 032.

Therefore, it is humbly prayed that this Hon'ble National Green Tribunal (SZ), may be pleased to pass such further order or other orders as this Hon'ble Tribunal may deem fit and proper in the facts and circumstance of this case and thus render justice.

20/01/2025
JOINT CHIEF ENVIRONMENTAL ENGINEER
TAMIL NADU POLLUTION CONTROL BOARD
No.76, MOUNT SALAI, GUINDY,
CHENNAI-600 032.

VERIFICATION

I, S. Malarvizhi, Daughter of Thiru K.Subburam, working as the Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board, Chennai – 600 032, having office at No.76, Mount Salai, Guindy, Chennai – 32, do hereby verify that the contents of above report are true to the best of my knowledge through records.

20/01/2025
JOINT CHIEF ENVIRONMENTAL ENGINEER
TAMIL NADU POLLUTION CONTROL BOARD
No.76, MOUNT SALAI, GUINDY,
CHENNAI-600 032.

Therefore, it is humbly prayed that this Hon'ble National Green Tribunal may be pleased to [illegible] as this Hon'ble Tribunal may deem fit and proper in the facts and circumstances of the case and thus render justice.

JOINT CHIEF ENVIRONMENTAL ENGINEER
TAMIL NADU POLLUTION CONTROL BOARD
No.76, MOUNT SALAI, GUINDY,
CHENNAI- 600 032.

VERIFICATION

I, R. [illegible], Daughter of Thiru K. [illegible], working as the Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board, Chennai – 600 032, having office at No.76, Mount Salai, Guindy, Chennai – 600 032, do hereby verify that the contents of above paragraphs are true to the best of my knowledge through records.

JOINT CHIEF ENVIRONMENTAL ENGINEER
TAMIL NADU POLLUTION CONTROL BOARD
No.76, MOUNT SALAI, GUINDY,
CHENNAI-600 032.

PILOT PLANT STUDY TO IDENTIFY DEVICE/TECHNOLOGY TO MITIGATE NOISE POLLUTION GENERATED FROM THE POWERLOOM

A REPORT

Submitted to

TAMIL NADU POLLUTION CONTROL BOARD

CHENNAI

Submitted by

CENTRE FOR ENVIRONMENTAL STUDIES

DEPARTMENT OF CIVIL ENGINEERING

ANNA UNIVERSITY, CHENNAI

NOVEMBER 2024

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

CES	-	Centre for Environmental Studies
TNPCB	-	Tamil Nadu Pollution Control Board
NGT	-	National Green Tribunal
SZ	-	Southern Zone
dB (A)	-	Decibel in 'A' weighted scale
PPE	-	Personal Protective Equipment
HP	-	Horsepower
Hz	-	Hertz (cycles per second)
Pa	-	Pascal
μ	-	Micro
NIHL	-	Noise Induced Hearing Loss
L eq	-	Equivalent noise level
SS	-	Stainless steel
PU	-	Poly urethane
PVC	-	Poly Vinyl Chloride
IPAN	-	Individual Protections Against Noise
NRC	-	Noise Reduction Coefficient
RPM	-	Revolutions per minute
R.C.C	-	Reinforced Cement Concrete
ANC	-	Active Noise Cancellation
SPL	-	Sound pressure level
IEC	-	International Electrotechnical Commission
ANSI	-	American National Standards Institute
NRR	-	Noise Reduction Rating
TUFS	-	Technology Upgradation Fund Scheme
SNR	-	Single Number Rating

CHAPTER 1

INTRODUCTION

1.1 POWERLOOM INDUSTRY - INDIAN SCENARIO

According to Policy Note of Handlooms, Handicrafts, Textiles and Khadi Department, Government of Tamil Nadu for the year 2022-23, India has 24.86 Lakh power looms and Tamil Nadu accounts 5.63 Lakh power looms. The majority of the power looms are located in Maharashtra, with about 39% of the total power looms. Andhra Pradesh, Gujarat, Uttar Pradesh, Karnataka and Tamil Nadu are other top power loom products producing States in India. The prevailing level of technology varies from obsolete plain looms to high-tech shuttle less looms (Source: India Brand Equity Foundation, Ministry of Commerce and Industry).

1.2 POWERLOOM INDUSTRY - STATE SCENARIO

In Tamilnadu, the power loom industries are mainly concentrated in western parts, such as Coimbatore, Tiruppur, Karur, Erode, Namakkal and Salem districts. Besides, there are some pockets in the southern parts of the state, such as Madurai, Tenkasi, Theni and Virudhunagar.

According to the survey carried out by the Ministry of Textiles in 2003, it is observed that around 91% of the looms in the state's power loom sector are plain looms of low technology without any electronic/mechanical warp stop motions or the positive let off motion. Only less than 7.5% of the looms are of improved type and identified as semi-automatic looms having warp/weft stop motion as well as positive let off motion. The survey data reveals that 1% of the looms are automatic and 0.3% of the looms are of shuttle less. Among the plain looms, 60% are stated to be new and only 40% were second hand machines at the time of installation. Fig.1.1 Shows percentage of available types of power looms in the state.

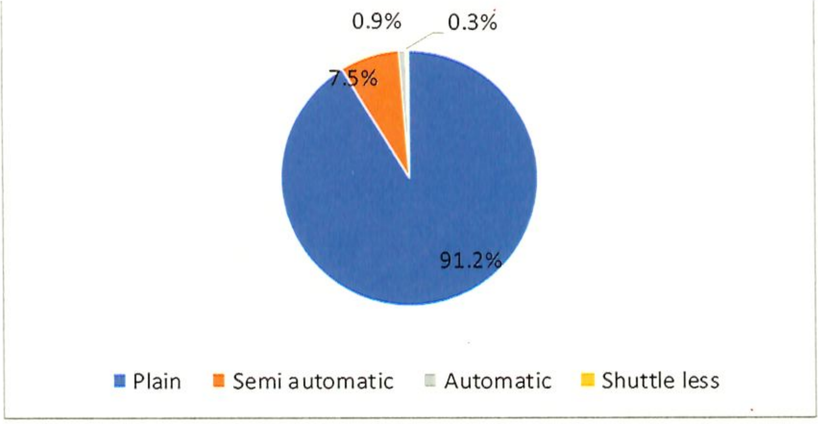


Figure 1.1: Power loom clusters in Tamil Nadu
(Source: Ministry of Textiles, 2003)

1.3 BACKGROUND OF THE PROJECT

Tharamangalam is a Municipality located 26 km away from Salem Town with 18 wards of total area 9.72 Sq. km. The Honorable NGT vide its order dated 13.02.2023 in O.A. No. 103 of 2020 (SZ) filed by Thiru. S.Sakthivel against the power looms located in Tharamangalam, Salem District has directed the Tamilnadu Pollution Control Board to conduct a study in the Tharamangalam Village, Salem District, where power looms are located in mixed residential area, to identify suitable technologies and measures by which the noise pollution from power looms can be reduced and the noise level in the adjacent residential area can be brought within tolerable level so as to comply with the noise pollution (Regulation and Control) Rules, 2000": Accordingly, the TNPCB has awarded the project titled "**Pilot plant study to identify device / technology to mitigate noise pollution generated from the power loom"** vide letter no. TNPCB/T1/F.012740/2023 dated 30.06.2023 with the following Terms of References.

1.3.1 TERMS OF REFERENCES OF THE STUDY:

1. To review and report the international practices with regard to the noise control measures / device / technology in power looms which are prevalent.
2. To develop contour map of noise level at a representative power loom at day and night with and without noise control measures from the source to every one meter with 1.5 m height from ground level on all four directions.
3. To identify suitable technology / device to reduce noise level of power looms and their effect on reduction of noise level in compliance with the noise pollution (Regulation and Control) Rules, 2000.
4. To identify and analyse source correction methods to reduce noise level in power loom plant for the compliance of ambient noise levels with the noise pollution (Regulation and Control) Rules, 2000.
5. To identify various measures on noise control between source and receiver to reduce noise levels at residential and other zones for the compliance of ambient noise levels with the noise pollution (Regulation and Control) Rules, 2000 and their economic analysis.
6. Identification of suitable PPE or work practices for the power loom workers.

CHAPTER 2
REVIEW OF LITERATURE

2.1 OVERVIEW OF NOISE AND THEIR HEALTH EFFECTS

Sound is produced when an object vibrates in open air and the process emits pressure waves into the air. The decibel (dB) scale defines the level of sound and these scales are from 80 to 100 dB (A) [very loud], 100 to 125 dB (A) [uncomfortable] and 140 dB (A) [threshold of pain]. A normal human being can sense sound pressure varying in the range of 20 μPa to 20 Pa. The A-weighted scale parallels the sensitivity of the human ear and uses the lowest audible sound that the human ear can detect as the reference point for determining the decibel level of a noise. The human ear is able to hear upto 130 dB (A). Any noise rating above 80 dB (A) produces physiological effects and any long exposure at or above 90 decibels will produce permanent damage to a person's hearing. Noise generally consists of many tones with varying rates of vibration or frequency. The frequency, expressed in cycle per second (cps) or Hertz, is usually in the range of 20 - 20,000 cps. The ear is not very responsive to very low or very high frequencies as it is elective to the tones of medium frequency. (MK Talukdar, 2001)

As mentioned earlier, the dB (A) scale matches the response of the human ear and is therefore well suited for evaluating the noise. The potential health effects of noise pollution include increased stress levels, sleep disturbance or hearing damage, may feel irritable, on edge, frustrated, or angry. The brain is always monitoring sounds for signs of danger, even during sleep. As a result, frequent or loud noise can trigger anxiety or stress. According to a 2018 review, there is evidence that short-term exposure to noise pollution can temporarily raise blood pressure and increase blood viscosity.

2.2 NOISE GENERATED FROM THE TEXTILE INDUSTRIES

In textile industries, various activities in different sections are causing noise, that are discussed below. (Source: Hasanuzzaman and Chandan Bhar, 2016)

2.2.1 GINNING SECTION

The ginning workers are exposed to high noise exceeding 85 dB (A) for 8-12 hours on daily basis that results noise induced hearing loss of the workers (NIHL). Workers exposed to noise beyond 90 dB (A) as in spinning section suffer from serious hearing impairment and the degree of damage in hearing capacity depends on the duration of works.

2.2.2 WEAVING SECTION

The source of noise in weaving industry is due to the outdated machinery, poor design, and construction and crowding in the workplace. It was found that noise in weaving preparatory section is low whereas it is very high in front of loom shed. Actual noise generated by the weaving looms was in the range of 85 to 104 dB(A), of which highest is in shuttle loom, which confirmed that noise in weaving room terrifically exceeds the permissible limit for 8 hours working. Weaving industry worker works in a noisy environment of 85 to 104 dB (A) repeatedly, which push the worker to suffer from permanent hearing loss in addition to the loss in efficiency. Irrespective of being in the age of automation, Indian textile industry still uses old and outdated machinery and equipment except limited number of spinning industries, that causes several problems in the workroom. Upgradation of the decentralized units with the modern equipment and machinery may help to reduce these problems in the ginning, spinning and weaving departments.

2.3 NOISE EXPOSURE LIMITS

As per the standards of the noise pollution (regulation and control) rules, 2000, the following tables give the noise exposure limits of both industrial workers and common people. Table 2.1 and 2.2 refers the standards of ambient noise and permissible noise exposure limit for industrial workers.

Table 2.1: Standards of Ambient Noise exposure limits

S.No	Class	Zone	L eq in dBA	
			Day	Night
1	A	Industrial	75	65
2	B	Commercial	65	55
3	C	Residential	55	45
4	D	Silence Zone	50	40

(Source: Noise pollution (regulation and control) rules, 2000

Table 2.2: Permissible noise exposure limits for industrial workers

S.No	Exposure time (hrs)	Limit in dB(A)
1	8	90
2	4	93
3	2	96
4	1	99
5	1/2	102
6	1/8	108
7	1/16	111
8	1/32(2 minutes) or less	114

(Source: Occupational Safety and Health administration)

2.4 NOISE CONTROL MEASURES

There are two possible ways to reduce the noise, one of them is ANC (Active Noise Control), in which the sound field is modified by elector-acoustical means. Here, an opposite sound is produced for the sound being produced in the machine. So, that both of them nullify each other. But this method is much more complicated. The second way is kind of a passive one which includes ear protectors, acoustic enclosures and vibration dampening. Vibration dampening involves reduction of natural frequency of vibration and resonance. Any noise problem may be described in terms of a source, a transmission path and a receiver. Noise control may take the form of altering any one or all of these elements. The noise source is where the vibratory mechanical energy originates, as a result of a physical phenomenon, such as mechanical shock, impacts, friction or turbulent airflow. With regard to the noise produced by a particular machine or process, experience strongly suggests that when control takes the form of understanding the noise-producing mechanism and changing it to produce a quieter process. The best approach for noise hazard control in the work environment, is to eliminate or reduce the hazard at its source of generation, either by direct action on the source or by its confinement.

M.K Talukdar (2001) reported inertia forces that are produced in a machine are responsible for noise and vibration. By reducing the mass and/or acceleration can achieve this e.g as impact force generated by the shuttle weft movement. The reduction in the mass can be achieved through substitution with another material like carbon. Reduction of acceleration to reduce the speed and/or to increase the distance. Another possibility of reducing the noise is the optimum design of the sequence of motion at a given speed. Nowadays cam gears are replaced by crank gears gives harmonious transmission and steep drop in the excitation spectrum of forces resulted in acoustically problem free machine.

Bies et al (1996), reported for punch presses that, any reduction of the peak impact force (even at the expense of a longer time period over which the force acts) will dramatically reduce the noise generated. Substitution of materials includes plastic for metal such as replacement of steel sprockets in chain drives with sprockets made from flexible poly amide plastics, substitution of parts of equipment including modification of gear teeth by replacing spur gears with helical gears (resulted in 10 dB (A) of noise reduction), replace gear drives with belt drives, replace metal gears with plastic gears, replace steel or solid wheels with pneumatic tyres. When a choice of mechanical processes is possible to accomplish a given task, the best choice, from the point of view of minimum noise, will be the process which minimizes the time rate of change of force or jerk (time rate of change of acceleration).

Kuhan et al. (2020) explains various materials and their properties which can be used as the sound reduction material. Among them, sorbothane is a material suggested for sound reduction in loom. Sorbothane is a visco-elastic polymer like silicone rubber or silastic, a thermoset, poly ether-based, polyurethane material had a very high damping coefficient. An experiment conducted between Natural rubber and sorbothane, showed 33% and 36% deflection when it is loaded with 1 pounds for natural rubber and sorbothane respectively. During unloading, the area in the hysteresis loop was found to be more in the sorbothane than the rubber. At 0 pounds, natural rubber re-gains almost 28% of its deflection whereas sorbothane regains only 11%. Due to its visco elastic behaviour, it hardens when the sound waves dissipate heat energy. Sorbothane is a unique material exhibiting both solid and liquid properties. Sorbothane combines shock absorption, vibration isolation and vibration damping characteristics. When the shuttle is hitting the picker, the vibrations are halted by sorbothane placed on the sides of the picker in the power loom. Sorbothane has been utilized to create effective vibration absorbing pads to absorb and isolate harmful shock and vibration.

Sadao Aso et al (1965) highlighted that a piece of glue was fixed on the surface of the stopper and a suitable spring was changed to reduce the impulsive noise. Then the noise made by the picking mechanism in the high frequency range decreased 4-5 dB (A). After the gearing was insulated with a cover, made up of asbestos board 5mm thick which are hemmed with plywood, inside of the plywood is pasted with a glass fibre board of 5cm thick, the radiated noise by gearing driving part has fallen by 4-8 dB (A) in the mid and high frequency range.

Patel Dhaval Rasikbhai (2017) highlighted the loom is considerably irregularity with picking mechanism during running. The mechanism is not fully controlled, which causes vibration and noise which needs more improvement. The bottom shaft assembly of mass and elasticity affects the system the alacrity and cause the variation in cycles of running loom. The picking stick check is source severe stress and vibration which needs a more operative method of stick checking is necessary.

2.4.1 CONTROL OF NOISE AT SOURCE

To control noise at the source, it is first necessary to determine the cause of the noise and secondly to decide on what can be done to reduce it. Modification of the energy source to reduce the noise generated often provides the best means of noise control. The various possible options for control of loom's noise at source are listed in the table 2.3

Table 2.3: Control of Noise at the source				
Sl. No.	**Control Methods**	**Reference**	**Description of Method**	**Remarks/Limitation**
1.	Reduce mass of shuttle	M K Talukdar, 2001	Substitution with another materials	It is made up of wood with SS cover at the tip.
2.	Reduction of Acceleration	M K Talukdar, 2001	Reduce the speed / increase the distance	Decreases number of revolutions per minute and affect production
3.	Replacement of SS by Nylon for pick ball	Benal et al., 2022	Noise Reduction- 3 dB(A)	Limited life
4.	Addition of Rubber Material for Picker	Kuhan et al., 2020	Lining the picker with PU (Elastic Material) Noise Reduction-Not reported	shock absorption, vibration isolation and vibration damping
5.	Use of springs in stopper	Sadao Aso et al (1965)	Noise Reduction 4 to 5 dB(A)	Change in design to be done
6.	Replace gear drives with belt drives	Bies et al (1996)	Replace steel or solid wheels with pneumatic tyres	Possible only at the design stage
7.	Providing cover for gear-chain transmission	Sadao Aso et al (1965)	Noise reduction of 4 – 8 dB(A), cover made of Asbestos board with 5 mm thick, glass fibre board of 5 cm thick over plywood	Noise reduction occurs in the mid and higher frequency
8.	Alteration in the picking – checking mechanism	Patel Dhaval (2017)	Mechanism is fully controlled and the loom had considerable regularity with picking mechanism during running	Incorporation of such alteration is very complex and only possible at design stage

2.4.2 CONTROL AT THE TRANSMISSION PATH

If noise cannot be controlled to an acceptable level at the source, attempts should then be made to control it at some point during its propagation path; that is, the path along which the sound energy from the source travels. In fact, there may be a multiplicity of paths, both in air and in solid structures. The total path, which contains all possible avenues along which noise may reach the ear, has to be considered. There are several basic approaches to reduce sound which includes: increasing the distance between source and receiver, using noise barriers to reflect or absorb the energy of the sound waves; using damping structures such as sound baffles. Absorbing sound spontaneously converts part of the sound energy to a very small amount of heat in the intervening object (the absorbing material), rather than the sound being transmitted or reflected. If the major noise problem lies in the medium frequency range (500 Hz to 4000 Hz), the acoustical absorption is good option, M.K Talukdar (2001).

The acoustic enclosure is one of the most important engineering designed structures for modifying the sound transmission path and suppressing the airborne noise effectively by adding sound-absorbing materials. The noise reduction performance of acoustic enclosure depends on many factors such as material, geometry, panel thickness, location of the source, the thickness of sound absorbing material, and location of the implementation of acoustic material on the structure. By optimization of acoustic material properties in a defined range of frequency, it is possible to maximize the noise reduction of the structure by making use of an adequate amount of sound-absorbing material of different surface shapes.

Ricci et al (2018) emphasized that the purpose of an enclosure is to surround the noise source with a specific material, ideally with no air gaps and fabricated it by following the proper design features. To limit the sound transmission outwards, the enclosure design must be achieved with a massive material as rigid as possible (mass effect, with a high sound transmission loss). The material is generally associated to a low sound absorption coefficient, which results in sound pressure level increase inside the enclosure (rise of reverberation). It is therefore necessary to add an absorbing material in the inner enclosure surface with a high sound absorption coefficient (absorptive material by itself is not effective in reducing noise). Sound absorption materials are porous materials wherein the sound energy is dissipated due to viscous and thermal losses that take place in tortuous pore channels. If the sound can be transmitted through the floor, then a vibration insulation needs to be considered to decouple the structure-borne connection between the vibrating equipment and the exterior layer. A first design step was to select the absorbing material as efficient as possible in the requested frequency range. The more the material is porous, the more the material will be absorbent. When comparing porosity of different materials used in building construction, it turns out that the best absorbing material was mineral wool with typical porosity range of 0.92-0.99 found above open cell acoustic foams. The thickness of the absorbing material is another important parameter: more the thickness then more will be the absorption.

Ricci et al, 2018 conducted a noise study at Indus steel Belgium and designed the aforementioned enclosure. Measurements revealed zones with acoustic pressure levels of more than 110 dB (A), even at over twenty meters from the punching machine in a frequency range between 1,000 and 3,000 Hz. The calculated attenuation of the enclosure as a function of the frequency then compared to the attenuation of different Individual Protections Against Noise (IPANs). An attenuation of 30–40 dB (A) is observed in the range between 500 and 3,000 Hz, while IPANs are less effective. Between 2,000 and 4,000 Hz, most of IPANs are less efficient. Mineral wool of 50 mm thickness was selected from various trails with different thickness which covering an absorption coefficient close to 1 (with respect to Sabine's hypothesis) in the frequency range from 500 to 4,000 Hz. After choosing the absorbing material, a multi-layer wall was imagined. This type of wall is composed of several layers: a massive wall, the aforementioned absorbing material and a wall keeping the absorber in place. The last layer of the wall is a perforated plate. This metal sheet does not play any acoustic role but is used to maintain the absorber in place. The perforations rate must be more than twenty percent in order to not interact with the transmission of the sound.

Amos et al (2018) designed and carried out performance test of a soundproof enclosure for the purpose of attenuating the sound radiated by 2.5 kVA Honda generator from a control value of 102 decibel to a comfortable noise level of about 86 decibel at a distance of 4 m. Material selection for the insulation of the soundproof is based on noise reduction coefficient which is a common parameter used for measuring sound absorption of a material. It is defined as the ratio of energy absorbed by a material to the energy incident upon its surface. Mineral wool was selected in the study because of its higher noise reduction coefficient (NRC) of 0.78. The soundproof enclosure measuring 0.9 m x 0.78 m x 0.72 m was fabricated using mild steel sheet of 2 mm thickness. The inside of the enclosure was lined with a 15 mm thick mineral wool (sound absorber) and padded with 5 mm thick plywood. An induction fan was installed to extract heat from the enclosure and dispel to the surrounding. Results revealed sound attenuation of 9.5, 12.9, 11.6, 12.2, 15.1, 14.5, and 15.5 dB(A) at distances of 0.6, 1.2, 1.8, 2.4, 3.0, 3.6, 4.2 m respectively. This result agrees with some of the findings reported by some acoustic researchers such as Kuku et al (2012) that developed a sound proof enclosure that can reduce noise by as much as 20% using reverberation room method.

Scientists at the MS Ramaiah University, Bangalore build an enclosure using a particle board with PU foam internal lining. It partially surrounded the noise sources in the machine. The enclosure had 25 mm particle board pasted with 50 mm cone shaped acoustic foam. The team implemented the idea at one of the power looms in a home factory. With all the windows closed and looms covered with special enclosure, the noise levels were reduced by 32 dB(A) (decibel). While standing outside the house, it was found that the noise levels were at just 55 to 58 dB(A) i.e., sound pressure level reduced from 90 to 55 decibel, which is standard set by the Central Pollution Control

Board. Even though they were standing next to the loom, it appeared as if they were standing in a room with normal sound of any office setup.

IIT Indore fabricated an enclosure made of steel material consisted of five flexible panels welded together. The enclosure has dimensions of 1 m × 0.8 m × 1 m, and the thickness of each panel was 1.15 mm. The sound pressure level (SPL) measurement is taken at a distance of 1 m for each surface of the enclosure. The measurement data was acquired in the range of frequency between 63 and 8000 Hz of 1/3 octave band. Hand-held circular saw of model GKS 7000 with a rated power input of 1100 W is considered as a noise source. The sound pressure level value of the noise source is measured to be 88.75 dB(A). The background noise was measured to be 45 dB(A). It is found that adding a pyramid shape PU foam inside the acoustic enclosure causes a larger noise attenuation of 23.75 dB(A). The 1/3 octave analysis shows that wedge shape and pyramid shape acoustic materials have a better effect on the acoustic performance of enclosure in comparison to plane PU foam in the entire frequency region (63-8000 Hz). The pyramid shape PU foam is very efficient in the high-frequency region between 2000 and 8000 Hz. Pyramid shape PU foam is very effective for improving the acoustic performance of the enclosure (P.Gupta et al., 2021).

C. Singh et al (2020) conducted the experiments by preparing a scale down model of a house using bricks and clay cement. The dimensions of the closed cavity are 50x30x40 cm^3. One of the faces of the model was kept open to fix the noise barrier material to that face, different materials such as glass, plywood, thermocol (scientifically known as polystyrene), plastic fiber and coconut fiber sheets were fixed on the open face one by one. A motor vehicle engine was used as the noise source and different noise levels were generated by varying the RPM of the engine. It revealed that the noise absorbing capacity is higher for thermocol and glass sheets when compared to the plastic fiber, coconut fiber and plywood sheets for the RPM range of 2000-10,000. The noise level without placing the sound absorbing materials inside the cavity were 63 dB (A) and 86 dB (A) corresponding to such RPM. Maximum decrease in the sound level of 12 dB (A) and 9 dB(A) from 77 dB (A) at 6000 RPM were recorded for thermocol and glass sheet. The sound absorption capacity of thermocol is due to its porosity which helps to damp the noise.

Nazire Deniz Yilmaz et al (2016) suggested another type of foams which found use in acoustical materials is melamine foams. Similarly to polyurethane foam their production is based on petro-chemicals and they are thermoset; hence, not recyclable, whereas the flammability is not the case as polyurethane foams and the environmental impact of melamine foams is lower than polyurethane foams. However, they are not as cost efficient and tear resistant as polyurethane foams.

Different synthetic materials show excellent acoustic performance, but it is necessary to deal with their high cost and environmentally harmful effects. At present, the most commonly used acoustic material is various types of polyurethane (PU) foam. Natural materials have the potential to replace conventional insulating materials because of their good acoustic properties, low price, low weight, availability, their lower CO_2 emissions, recyclability and biodegradability. In addition, waste from the production of other products can be used for the preparation of acoustic panels. At 20 mm thickness and for the entire frequency band (0 to 2500 Hz) hemp achieved higher values than PU foam, and in the frequency bands 100–400 Hz and 1000–2500 Hz it was better than mineral wool. Out of different natural materials tested, hemp dominated in all thicknesses and frequency bands. For conventional materials, the highest values occurred alternately for polyurethane foam and mineral wool (Gumanova et al, 2022).

The various possible options for control of loom's noise along the transmission path are listed in the table 2.4

Table 2.4: Control at the Transmission Path				
Sl. No.	**Control Methods**	**Reference**	**Description of Method**	**Remarks/Limitation**
1.	Enclosure	MS Ramaiah University, Bengaluru	(i) Partial Enclosure by 25 mm particle board pasted with 50 mm cone shaped acoustic foam (ii) Noise Reduction - 32 dB(A)	i) Difficult in model loom scenario, ii) Restricted space, only walls can be used enclosure support, iii)Generates heat or occupational noise, iv) Roof ventilation is not possible
2.	Control at Transmission Path using PVC strip curtains	TNPCB	(i) Noise Reduction upto 6 dB(A)	(i) 2mm, 3mm and 5 mm thick PVC strips are available. (ii) Absorbing less noise (iii) Reflecting or transmitting more noise
3.	Control at Transmission Path - PVC strip	Th.Selvaraj's House	(i) PVC strips of 3mm thick in windows. (ii) Noise Reduction 10 dB(A)	(i) Transparent (ii) 25% overlap

2.4.3 CONTROL AT THE RECEIVER END

Limiting emissions at the sources is the most natural way to reduce the noise level. However, engineering solutions are often costly and in practice, many industries focus on the use of Individual Protections Against Noise (IPANs) as the primary countermeasure to noise. ISO 12100 standard strongly prioritizes to reduce the noise (health risk) of a machinery by using inherently safe design measures that reduce the associated risks by a suitable choice of design features of the machine itself and/or interaction between the exposed persons and the machine. The employer has a liability to maintain noise maps of their facilities and identify the dangerous zones where IPAN must be worn. Indeed, workers must be informed about the possibility of hearing loss and given protecting equipment which they may choose to wear or not. IPANs must be made available to workers when the lower level is reached; above the higher level, the use of IPAN is to be enforced. Daily exposures above 87 dB(A) (or peak pressures above 140 dB(C)) inside workers' ears are not acceptable (even with IPANs) and sound exposure must be reduced. These dispositions were incorporated into Belgian law in 2006. PPE made of materials suitable to peak frequency noise range (1400 - 5000 HZ) may be suggested (Ricci et al, 2018).

Bambang Suhardi et al (2019) suggests noise control in the weaving department (noise levels lies in the range of 87 - 105 dB(A)) is attained using ear protector in the form of ear muff with NRR (Noise Reduction Rating) 48 dB(A).

2.5 SUMMARY OF NOISE CONTROL MEASURES

2.5.1 CONTROL AT THE SOURCE - POSSIBLE METHODS

(a) Substitution and Elimination

1. Elimination followed by Substitution is the prime option for any impact control.
2. Major source of noise in conventional shuttle loom is the shuttle movement. Therefore, elimination of shuttle in conventional shuttle loom and substitute with shuttle-less looms shall be the prime option.

(b) Engineering control at source

1. Active measures - primary measures to prevent noise and vibration by determining the cause of noise.
2. Inertia forces produced in a machine are responsible for noise and vibration.
3. At shuttle loom, impact force is generated by the shuttle weft movement.
4. To reduce force, either the mass or acceleration or both mass and acceleration are to be decreased.

$$\textbf{Force} = \textbf{Mass} \times \textbf{Acceleration}$$

2.5.2 LIMITATIONS OF CONTROL METHODS

1. Provision of enclosure is difficult as the power looms are having moving parts in all three axes and requires frequent supervision and attention. Further, at the study area, the units are functioning in dwelling units and provision of enclosure with clear space will occupy more area of their living space. Different materials used for fabrication of enclosures are enlisted in the table 2.5
2. The noise generated from shuttle looms need to be approached as a social, environmental and economic problem instead of only environmental problem.
3. Methods that do not affect the regular operation, lesser noise production, less energy consumption and increase production efficiency are to be considered.
4. The source control methods reported in literature are additional works, which need to be carried out during only design or manufacturing stage.
5. In existing /old shuttle looms, changing the design is technically not feasible.

Table 2.5: Summary of Studies on Enclosure Materials

S. No	Enclosure Material	Sound Characteristics	Thickness	Noise reduction	Advantages	Disadvantages
1.	Rigid wall + Mineral wool + perforated plate (Ricci et.al, 2018)	500 – 4000 Hz	50 mm	30 to 40 dB(A) [At source 110 dB(A)]	(i) High porosity in the range 0.92 - 0.99 (ii) Porosity is more than open cell acoustic foams.	Mineral wool is non-biodegradable
2.	Mineral wool + Plywood + Mild steel (Amos et.al, 2018)	At source - 102 dB(A)	15mm (mineral wool)+ 5mm (plywood) + 2mm (Mild Steel)	At 4.2m - 87 dB(A) [Reduced by 15 dB(A)]	(i) Higher Noise Reduction Coefficient (NRC = 0.78)	Mineral wool if inhaled enters the alveoli and create lung problems and can irritate the skin if touch
3.	Foam panel + composite sawdust + grinded glass + plywood (Kukuet.al, 2012)	At source - 88.2 dB(A)	perforated foam and plywood- 15 mm & (sawdust+ grounded	Average reduction of 76%	Acoustically designed by using Reverberation method	Grinded glass, can increase the mass of the panel and are not flexible

			glass)-50mm			
4.	Particle board + Cone shaped PU lining (MS Ramaiah university, Bangalore)	At Source-90 dB(A)	25mm (particle board) + 50 mm PU lining	30 dB(A)	Commercially available	i) Difficult in model loom scenario, ii) Restricted space, only walls can be used enclosure support, iii)Generates heat or occupational noise, iv) Roof ventilation is not possible
5.	Steel panel + Pyramid shaped PU foam (IIT Indore)	2000 Hz – 8000 Hz	1.15 mm (steel panel)	23.75 dB(A) [At Source – 88.75 dB(A)]	(i) Pyramid shaped PU foam is very efficient (ii) Pyramid and wedge-shaped PU materials have better acoustic performance than plane PU foam.	Attacked by most solvents, Toxic isocyanates, Flammable, need to apply more than one layer, Odour, Difficult to recycle
6.	PU foam (flexible)	Suitable for medium frequency range (500 Hz - 4000 Hz)	50mm	NRC follows, 500 HZ - 0.85 1000 Hz - 0.95 2000 Hz - 0.90 4000 Hz - 0.90	Endurance against dynamic loads, good compressibility and high recovery rate, Abrasion resistance, Low cost, Flexibility, Durability, Thermal insulation.	Flammable, Environmental impact
7.	Scale down model of a house constructed using brick and clay cement (50 x 30 x 40 cm^3)	1) At 2000 RPM – 63 dB(A) 2) At 6000 RPM – 77 dB(A)	In several mm		-	Scaled down model only

	(Singh et.al, 2020)	3)At 10000 RPM – 86dB(A)				
	a) Thermocol placed at one face of the cavity	77 dB(A) at source	-	12 dB(A)	High porosity helps to damp the noise.	Better damping at low noise level i.e 63 dB(A) but low damping at higher noise level i.e 86 dB(A)
	b) Glass sheet	77 dB(A) at source	-	9 dB(A)	Better damping at higher noise level i.e 86dB(A) than thermocol	i) Heavy weight ii) Prone to get break up
8.	Glass fiber or glass wool	medium frequency range (500 Hz - 4000 Hz)	50mm thick and density- 16 kg/m^3	NRC for, 500 HZ - 0.96 1000 Hz - 1.00 2000 Hz - 1.00 4000 Hz - 1.00	Used in ceiling tiles, duct liners, Interior lining in building, Vehicles and Aircraft.	It causes problems to human health and Environmental protection.
9.	Melamine foam (Deniz yilmaz et. al, 2016)	medium frequency range (500 Hz - 4000 Hz	50mm	NRC for 500 HZ - 0.80 1000 Hz - 0.89 2000 Hz - 0.97 4000 Hz - 0.94	Non-flammable, Low Environmental effect, Lightweight, Prevents Echo, reverberation, Waterproof	Thermoset, Non-recyclable, Higher cost and less tear resistant than PU foam, Toxic fumes.
10.	Hemp (Gumanova et.al, 2022)	medium frequency range (1000 Hz - 2500 Hz	20 mm	NRC for 1000 HZ - 0.60 1700 Hz - 0.9 2000 Hz - 0.98 2500 Hz - 0.94	(i) good acoustical performance over PU & mineral wool. ii)Low cost, Less weight, Lower CO_2 emission, Recyclable & Biodegradable	Flammable, Less durability, Lesser insects and pests' resistance-

2.6 SUMMARY OF LITERATURE REVIEW

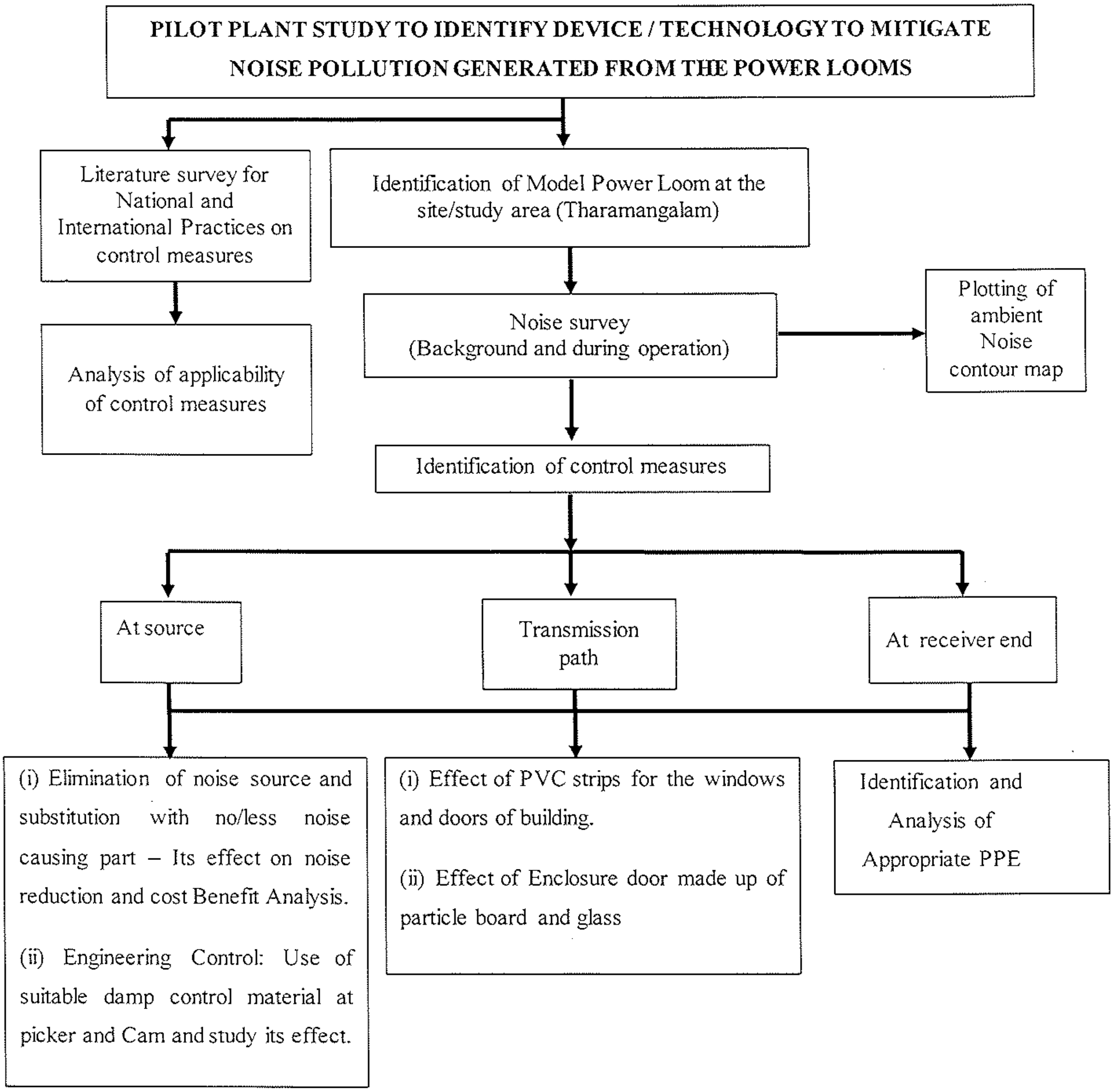
Aforementioned literature study summarized the following control measures and the key points.

- Reducing the mass and /or acceleration of the shuttle,
- Replacement of steel sprockets in chain drives with flexible poly amide plastics sprockets,
- Replacing spur gears with helical gears, replace gear drives with belt drives,
- Replacement of metal gears with plastic gears replace steel or solid wheels with pneumatic tyres,
- Placing Sorbothane on the sides of the picker to halt the vibration and changing suitable spring to reduce the impulsive noise by the picking mechanism,
- Insulating the gears with a cover, polyethylene / Polyurethane picking points, picking cones, nylon drive pinion and
- Substitution of crank bearings with their metallic counterparts.

However, the noise reduction at source was insignificant and the changes for an existing second-hand shuttle loom is impossible. Further, the conventional shuttle loom is an obsolete technology in most of the developed countries and have shifted from conventional shuttle looms to sophisticated shuttle less looms. Though many enclosure methods and materials are available as shown in table 2.5, only one such study (MS Ramaiah University) was conducted for power looms at the loom shed. Earplug can reduce noise by 30 dB (A) while earmuff can reduce noise between 40 and 50 dB(A).

CHAPTER 3

MATERIALS AND METHODOLOGY



3.1 IDENTIFICATION OF THE MODEL SITE

1. The three districts of Coimbatore, Erode and Salem in Tamil Nadu are having the largest concentrations where power looms are the major source of livelihood for lakhs of rural population.
2. Sub-Clusters of Salem are Rasipuram, Elampillai, Vembadithalam, Jalakantapuram, Tharamangalam, Edapdi, Attayampatti, Omalur and Tiruchengode.
3. Generally power looms in Tamil Nadu have a motor capacity of less than 2 HP.
4. Majority of power looms are plain looms in these clusters.
5. The Honorable NGT vide its order dated 13.02.2023 in O.A. No. 103 of 2020 (SZ) filed by Thiru. S.Sakthivel against the power looms located in Tharamangalam, Salem District has directed the Tamilnadu Pollution Control Board to conduct a study in the Tharamangalam Village, Salem District.

3.2 SPECIFICATIONS OF SOUND LEVEL METER

1. Class 1 **(SWAN 308)** sound level meter.
2. Comply with IEC 61672-1:2013, ANSI S1.4-1983 and ANSI S1.43-1997.
3. Real-time 1/1 and 1/3 Octave in accordance with IEC 61260-1:2014 and ANSI S1.11-2004
4. Linearity range: 22dBA~136dBA **(SWAN 308)**
5. Single range to cover 123dB **(SWAN 308)**
6. Frequency weighting: A/B/C/Z. Time weighting: Fast/Slow/Impulse
7. 3-Profile and 14 custom define measurement are calculate in parallel with different frequency/time weighting
8. Calculate SPL, LEQ, Max, Min, Peak, SD, SEL, E

9. LN statistical and time history curve display

10. User define integral period measurement, integral period up to 24h

3.3 IDENTIFICATION OF CONTROL MEASURES

3.3.1 Elimination

Elimination involves identifying sources of noise in the power loom industry and explore opportunities to eliminate or replace noisy equipment with quieter alternatives. Workers in the weaving department are on duty to oversee the weaving process and connect the yarn if there is a broken yarn. Workers have to stand by near the loom machine with a high risk of noise exposure. The elimination of weaving process cannot be done because the merging between weft threads and warp thread is done in the weaving process.

3.3.2 Substitution

Old loom machines produce high level of noise. However, the process of substitution of loom machines with new technology produce low level of noise. Rapier looms, water jet, air jet looms produce less noise compare to conventional plain looms. Converted shuttle less loom from shuttle loom reduced the environmental noise. Hence noise levels comparison along with cost benefit analysis were carried out for shuttle less looms (Rapier) and conventional shuttle looms.

3.3.3 Engineering control

Implement engineering controls to reduce noise at the source or along its transmission path. This could involve modifying or retrofitting existing plain loom with noise-reducing components, such as vibration isolators, sound enclosures, or mufflers. Engineering controls by providing enclosures was very complicated because weaving activities are a work done by direct interaction between workers and machines. These loom machines cannot be left for a certain time interval it makes workers have to be closer to the machine.

In order to reduce ambient noise, PVC strip curtain was provided in two dwelling units at Tharamangalam. The result showed that the strip curtain in the door opening helps to reduce the noise level of around 6 dB(A). Hence, curtain made of good absorption material was recommended as noise control measures by TNPCB and also suggested that number of plastic layers would be increased in such a way that the incremental noise due to power loom on ambient air at the boundary of public place not exceed 10 dB(A).

3.3.4 Personal Protective Equipment (PPE)

PPE is provided in the form of ear protection to workers in the area of workplaces. There are two types of ear protectors to protect from the workplace noise, namely earplugs and earmuffs. Every ear protector has the ability to reduce noise. The effectiveness and ability of ear protectors in reducing noise can be seen based on NRR values. **3M 1110** corded ear plug was used inside the Conventional loom shed.

3.4 NOISE CONTOUR

Noise Contours were plotted in dB(A) for both conventional shuttle loom and rapier loom at every 1.5m distance radially with 1.5 m height from ground level [as specified in Terms of Reference (TOR)]. Noise contours were plotted by using Arc GIS software.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 MODEL POWER LOOMS AT THARAMANGALAM

TNPCB has identified two model power loom sheds at Tharamangalam. The team of TNPCB officials and CES faculty jointly visited the units first on 14.12.2023 and collected preliminary data as presented below in table 4.1.

Table 4.1: Details of model power looms at Tharamangalam

S.No	Description	Details of the loom	
1	**Location of the loom**	Th. Selvaraj's house	Th. Manoharan's house
2	**Latitude**	11.692167°	11.691955°
3	**Longitude**	77.972397°	77.97199°
4	**Building type**	R.C.C	R.C.C
5	**Dimension of loom shed**	6m x 5m x 3m	8.8m x 4.9 m x 3m
6	**Type of loom**	Plain loom without Jacquard	Plain loom without Jacquard
7	**No. of looms**	3	3
8	**Motor capacity**	0.75 HP	0.75 HP
9	**Working hours**	8 AM - 8 PM	8 AM - 8 PM

The weaving is being carried for generations at household level by the weavers as family business. The hand looms operated by their ancestors shifted to power looms in the course of time. There is no separate loom shed and the power looms are operated within residential house in a portion of the hall. Most of the power looms are shuttle looms, which is already an obsolete technology and they were purchased as second hand machines after 15 to 20 years of running and being operated for further 10 to 15 years. Due to the age of machines, the picks per minute i.e weft motion was observed to be very low which results in lesser production and consumes more time and electricity.

Also, since the units are operated within their house, all family members including children and aged persons are exposed to the high noise generated by the looms. Such problems are not only at Tharamangalam but common in all household shuttle looms operated areas. There are many parts involved in functioning of a shuttle loom, for primarily three motions, namely warp, weft and beat up. Though there are many moving parts, the shuttle movement for weft motion is the prime source of impulsive noise. A single crossing of the shuttle from one side of the loom to the other is known as one pick. There are two types of shuttle looms based on picking type (i) under pick and (ii) over pick. The Picking mechanism in an over pick (existing in model loom shed) is presented below in fig.4.1 and pictorial representation of model powerloom at study area along with its parts are shown in fig.4.2.

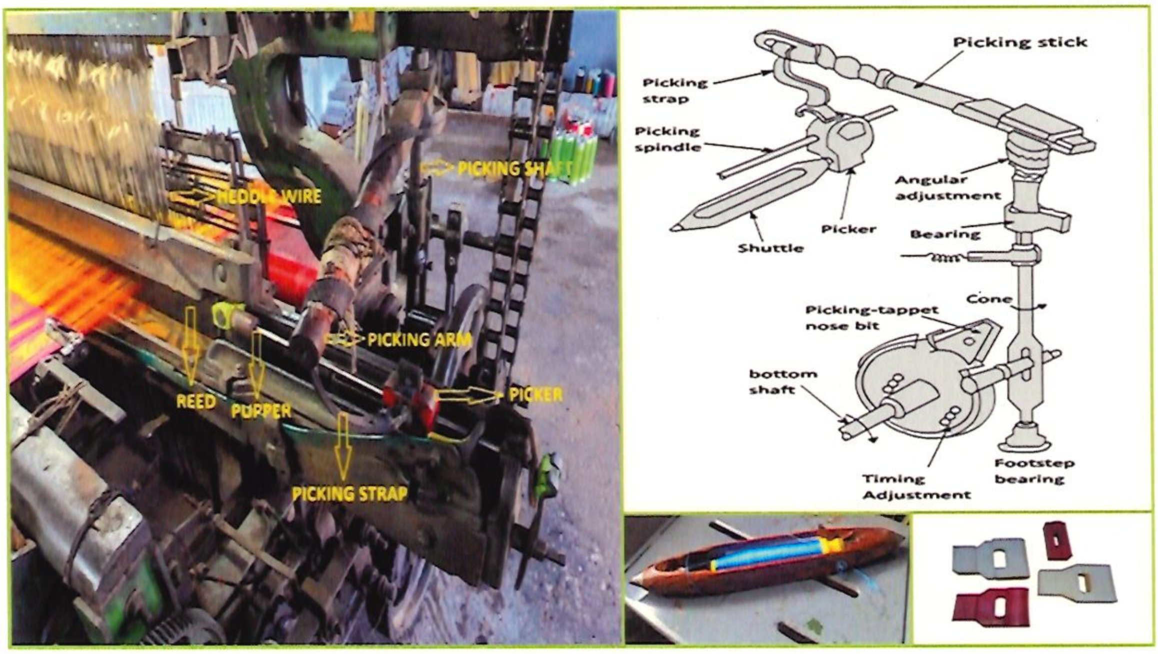


Figure 4.1: Schematic diagram of a shuttle loom and their parts

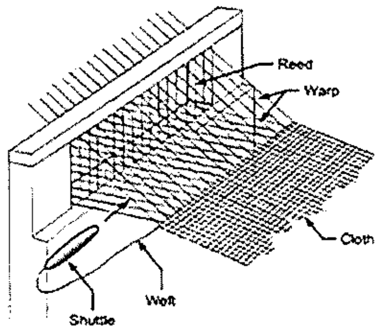
Figure 4.2: Model power looms at Tharamangalam and Sequence of motion in a powerloom

Shuttle Loom: The shuttle loom is the oldest type of weaving loom which uses a shuttle which contains a bobbin of filling yarn that appears through a hole inside. The shuttle is batted across the loom and during this process, it leaves a trail of the filling at the rate of about 110 to 225 picks per minute (ppm). Although very effective and versatile, the shuttle looms are slow and noisy. Also, the shuttle sometimes leads to abrasion on the warp yarns and at other times causes thread breaks. As a result, the machine has to be stopped for tying the broken yarns. The basic mechanisms in any type of loom can be classified as follows:

4.2 TYPES OF MOTIONS IN WEAVING

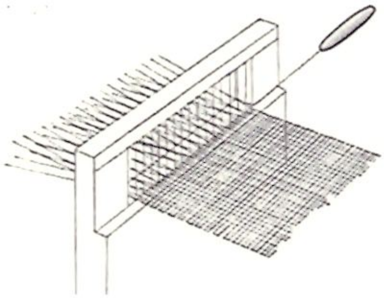
4.2.1 PRIMARY MOTIONS OF WEAVING

Shedding: Separating the warp yarns into two layers by lifting and lowering the shafts, to form a tunnel known as the 'shed'.



Picking or Filling: Passing the weft yarn (pick) across the warp threads through the shed.

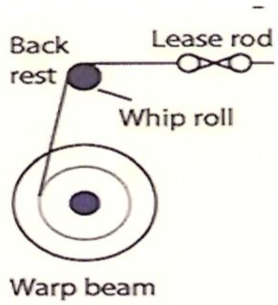
Beating-up: Pushing the newly inserted weft yarn back into the fell using the reed.



4.2.2 SECONDARY MOTIONS OF WEAVING

Let off: The warp yarns are unwound from the warp beam during the primary processes.

The warp beam, which holds the lengthwise yarns, is located at the back of the machine and is controlled so that it releases yarns to the weaving area of the loom as needed.



Take up: The woven fabric is wound on the cloth beam during the above three processes.

4.2.3 AUXILIARY MECHANISM

To get high productivity & good quality of fabric, additional mechanisms, called "Auxiliary mechanisms" are added to a plain power loom. The auxiliary mechanisms are useful but not absolutely essential. The auxiliary motions consist of the warp stop motion, weft stop motion and warp protector motion. The warp stop motion is used to stop the loom in the event of warp breakages. This is necessary to prevent fabric defects such as missing ends and floats. The weft stop motion is used to stop the loom in the event of weft exhaustion or weft breakages. This is necessary to prevent missing weft threads called cracks, in the fabric. The warp protector is used to prevent multiple warp thread breakages in the event of shuttle getting trapped in the middle of the warp sheet.

4.3 PRELIMINARY NOISE SURVEY

4.3.1 DESCRIPTION OF LOOMSHED IN MANOHARAN'S RESIDENCE

All the noise survey was conducted using class 1 sound level meter (Make: SWAN, Model: SWAN 308) with 1/1 octave band filter and type 1 microphone. The measurable frequency was A/B/C&Z. Ambient noise survey was conducted on 22.12.2023, with and without operating the power looms at Mr. Manoharan residence. The building comprises a living room, a kitchen and veranda on right side of the living room constrained by a compound wall of height 2m and the inner dimensions are mentioned in fig. 4.3. The street road is adjacent to the main door facing east direction and adjacent to the compound wall facing the north. Neighborhood buildings surrounded on the west and south direction of the building. Three plain looms are installed at left side corner area of the living room. Each loom releases sound energy in all possible directions radially. Hence it was planned to conduct radial contouring for every 1.5 m distance by fixing centre of the locus as either midpoint of the loom or between the looms.

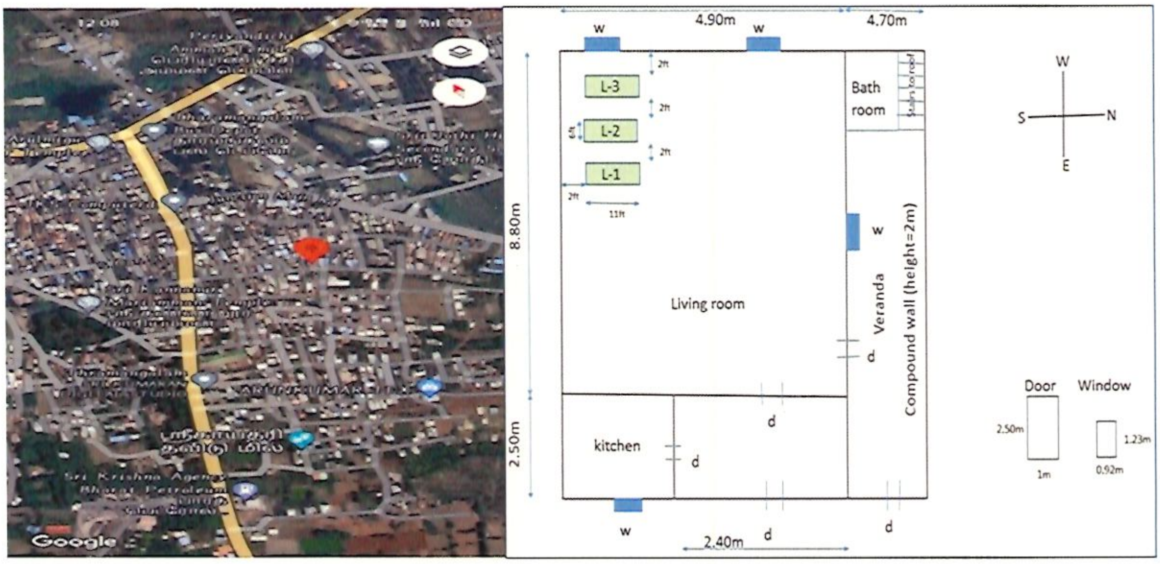


Figure 4.3: Location and Layout of the site at Th. Manoharan's house

4.3.2 AMBIENT NOISE CONTOUR FOR DIFFERENT CONDITIONS

The background noise levels measured radially at every 1.5 m distance (1.5 m height) at all possible directions are presented in the table 4.2 and plotted in fig.4.4. At centre point of loom, the noise levels were around 38 dB(A). At 1.5 m distance, the noise levels varied in the range of 35 - 47 dB(A) and at 3m distance, it was in the range of 34 - 51 dB(A). Above 40 dB may be due to extraneous noise generated from the outside. At 4.5 m, the noise levels were in the range of 37 - 51 dB(A) within the building and reached a maximum value of 65 dB (A). At 6m, the noise level was in the range of 38 dB(A) to 52 dB(A) within the building and between 61 - 64 dB (A) outside the building. At 7.5 m, the noise levels were from 43 to 51 dB(A) within the building and 60 to 64 dB (A) outside the building. At 9 m, the noise level ranges from 42 dB(A) to 49 dB(A). The noise level increased to above 60 dB (A) only during vehicle movement in the street road.

Table 4.2: Background noise measurement at Th. Manoharan's Loom Shed

0 m	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
38.4	35.2	43	39.4	41.9	43.2	49.4
38.8	35.3	38	38.9	38.6	48.2	47.5
	36.5	51	39.6	38.9	52.6	45.3
	37.1	35.7	39.2	51.3	44.2	43.5
	39.8	41.2	37.3	52.1	60.3	42.0
	37.1	43.7	40.5	66.6	61.2	49.6
	39.4	45.4	65.3	64.4	58.7	48.0
	36.0	35.3	45.0	61.8	47.0	42.1
	34.8	42.7	41.0	59.3	43.0	46.9
	46.6	35.8	45.3	44.0	43.5	49.0
	47.7	43.9	45.6	43.0	43.2	42.9
	46.5	42.9	44.0	37.6	42.0	45.4
	34.1	36.6	42.0	43.1	45.3	44.6
	38.0	34.0	39.0	42.4	43.9	48.6
	37.8	41.9	38.7	47.0	47.0	47.1
	36.9	41.6	38.2	44.0	46.1	
	41.1	40.5	40.3	45.1	43.6	
	35.2	34.5		44.2	51.9	
	35.6	34.4		45.3		
		41.1				

Table 4.3: Noise level during operation of single loom at Manoharan's loom shed

0 m	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m	10.5 m
95	95.0	93.5	90.6	91.0	88.0	85.8	82.5
94.5	94.6	93.7	91.5	91.2	84.5	85.5	82
96.2	94.0	93.3	91.8	91.3	84.8	86.7	75.0
	94.2	93.8	91.2	92.2	85.3	85.2	76.8
	95.8	93.4	92.8	79.5	81.2	78.2	77.5
	93.2	92.3	92.3	77.2	78.5	75.2	76.4
	93.5	93.6	78.8	76.8	77.5	77.8	
	93.7	92.8	79.4	77.5	77.2	77.0	
		92.5	79.6	77.7	75.8		
		91.5		74.6			
		92.0					

From the table 4.3, at centre point the noise level of 95 dB (A) was observed due to cumulative effects of two machines on both sides. From 1.5m to 10.5 m, the noise level inside the loom shed were above 80 dB(A) and 75 to 80dB(A) outside the loom shed. Up to 6 m from centre point of loom, the noise level was above 90 dB(A) at most of the points within building. Usually the readings near / on the wall showed the peak value that might be due to poor noise absorption by the brick masonry walls with cement plastering.

Table 4.4: Cumulative noise level of two looms at Mr. Manoharan's loom shed

0 m	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m	10.5 m
98.4	97.0	96.7	92	92.6	88.8	87.0	85.6
99.5	97.8	95.8	92.5	92.5	85.0	86.7	81.5
98.8	98.0	95.2	93.5	93.0	84.8	85.8	81
	97.4	96.3	94.2	92.7	85.5	86.2	79.5
	97.0	95.8	94.5	82.0	86.8	78.2	80.2
	96.8	95.2	86.8	81.5	89.0	80.5	78.5
	96.1	93.8	78.2	80.5	85.8	81.5	
	96.0	93.6	91.9	79.2	83.0	81.2	
	96.2	95.0	91.1	76.0	80.2	80.5	
	96.7	94.5	92.7	91.4	78.6	81.5	
	98.4	92.4	93.3	90.1	82.1	85.7	
	93.0	90.6	91.3	89.2	87.2	85.2	
	99.0	95.3	92.2	90.4	85.2		
	94.8	91.9	90.8	91.6	85.1		
	95.3	93.4	92.4				
	98.7	90.1	91.7				
	95.3	90.0	89.7				
	94.7	91.1					
	94.0	89.3					
	95.3	91.4					
	93.7						

The noise level increased by approximately 3 dB(A) when two looms were functioning simultaneously as shown in the table 4.4. At 3m, all readings less than 94 dB(A) indicate measurements taken behind the loom-1 which was switched off for the existing noise monitoring condition. At 4.5 m, above 86 dB(A) was observed behind windows whereas 78 dB(A) was measured behind the wall. Until 10.5 m, the noise level observed greater than 80 dB(A) was within the building and between 78 to 80 dB(A) were at outside building. While operating three looms simultaneously, at 1.5 m the noise level was above 100 dB due to reverberation effect of the walls adjacent to the looms. Further, impact noise caused by the weft movement was recorded to be 104 dB at the shuttle height. The noise within building was above 80 dB(A) at all points and minimum 77dB(A) was noted outside building as shown in the table 4.5

Table 4.5: Cumulative Noise Level of Three Looms at Mr. Manoharan's Loom Shed

0 m	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m	10.5 m
99.4	99.5	99.2	90.7	84.4	90.3	82.7	82.2
99.6	100.8	98.8	91.2	85.4	91.0	83.1	83.2
	100.7	97.3	98.7	85.3	87.3	84.7	81.7
	99.3	99.2	97.8	84.8	84.6	85.0	87.4
	98.5	99.0	98.3	82.4	84.5	85.3	86.6
	99.8	97.4	95.2	99.6	84.4	92.4	80.3
	95.5	99.4	95.6	97.6	83.8	93.3	
	97.0	98.5	96.2	98.7	94.2	91.7	
	99.9	98.9	97.3	98	88.5	90.3	
	98.2	100.2	93.3	99	90.5	92.0	
	96.3	95.7	95.7	94.7	81.2	89.0	
	97.5	94.7	97.3	92.2	82.4	89.6	
	97.1	98.3	94.3	95.1	83.2	87.4	
	99.6	95.6	92.7	95.8	81.6	76.7	
	96.6	96.6	96.6	94.1	84.2	81.2	
	95.3	96.9	94.6	83.4	84.1	77.5	
		96.1	96.1	84.2	81.6	80.6	
		93.1		82.3	86.3	79.3	
		94.1		81.9	90.7	79.9	
		96.1		80.9	89.1	82.4	

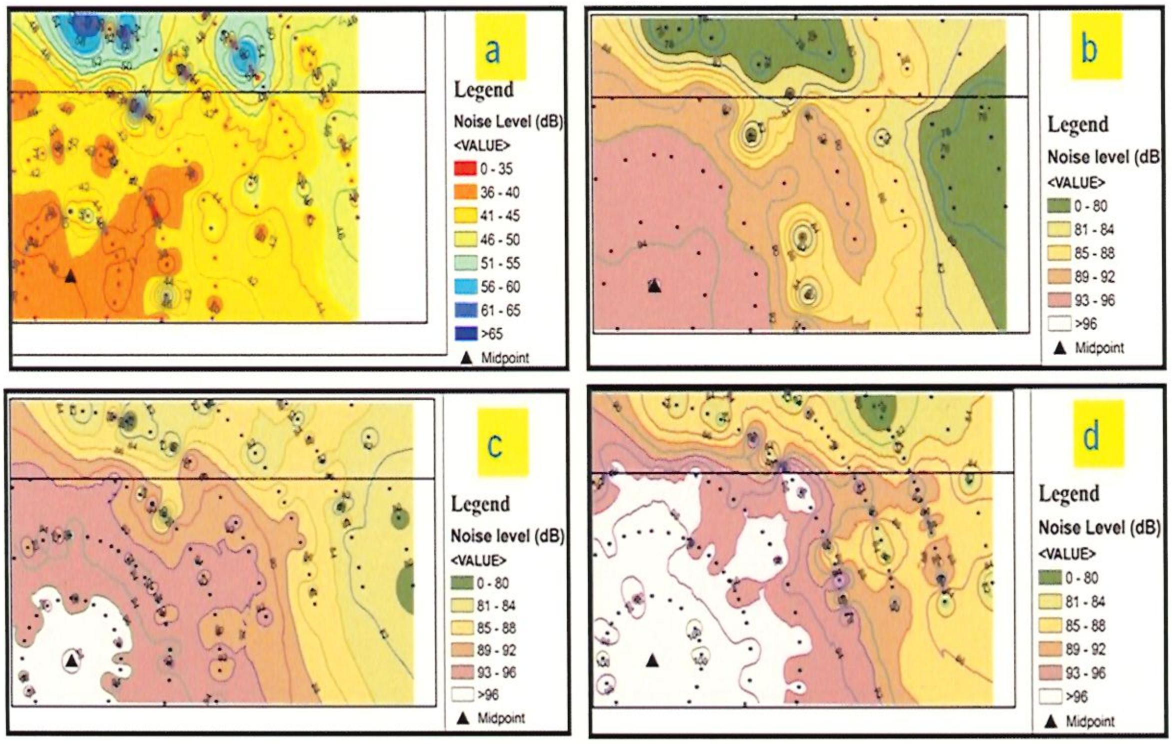


Figure 4.4: Noise Contour of (a) Background noise (b) Single loom (c) two looms (d) three looms operation

4.3.3 DESCRIPTION OF NOISE SURVEY AT Th. SELVARAJ'S LOOM SHED

The noise monitoring were conducted and plotted in fig.4.5 both inside and around Th.Selvaraj's house which comprises a living room, a kitchen, a pooja room and a veranda, located between the living room and main gate. The inner dimensions are mentioned in figure 4.5. Street road (inner edge at 1m and outer edge at 3m) is adjacent to the main gate facing North direction. Neighborhood buildings surrounded on the West (at 4 m), South (>6m) and East (2m) directions of the building. Three windows are in south and west directions. Three plain shuttle looms are installed at south west area of the living room. Noise study was conducted radially in all directions for every 1.5 m distance, when operating three looms simultaneously. The Centre of the locus was fixed as midpoint.

4.3.4 AMBIENT NOISE CONTOUR FOR THE EXISTING LOOMS

Table 4.6: Background noise (with loom-2 as centre) in dB(A)

0 m	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
53.5	54.8	54.3	52.6	67.7 (V)	53.1 (G)	58.3 (R)
54.2	55	52.3	49.3 (V)	57.4 (Bw)	49.5 (R)	50.1 (R)
	52.8	52.3	50.9 (V)	50.6 (Bw)	53.2 (W3)	51.8 (R)
	52.6	52.1	51.5 (K)	55.7 (K)	57.2 (W1)	49.7 (W3)
	52.6	50.4	54.4 (K)	56.8 (P)	62.0 (W5)	59.1 (W5)
	52.2	51.9	45.4 (P)	56.6 (W1)	58.3	60.7
	52.6	51.8	50.7(P)	48.1	58.8 (W4)	59.1 (W4)
	52.0	53.3	55.8 (W1)	54.0 (W2)		
	52.2	56.5 (W1)	47.9	53.8 (W3)		
	52.8	46.2 (W2)	52.1 (W2)			
		53.0 (W3)	52.7 (W3)			
W1, W2& W3-Windows along loom1, 2 &3, W4 & W5 - Windows at kitchen and pooja room V-Verandah, K-Kitchen, P-Pooja room, Bw-Behind wall, R-Road, G-Gate						

It may be noted from table 4.6 that ambient noise level inside the living room ranged from 50.4 dB(A) to 54.8 dB (A). Due to extraneous noise originated from the looms operated by nearby resident in south direction of the site, corresponding noise level along the radial direction of window 1 varied from 55.8 dB (A) to 57.2 dB (A). Extraneous noise generated from these sources affect the readings taken at kitchen (K) and pooja room (P) and had more pronounced effect in the decibel was observed along the windows (i.e W4 &W5) faced in south direction.

Table 4.7: Noise level during operation of three looms (with loom-2 as Centre)

0 m	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
99.6	98.4	98.9	97.5	92.9 (V)	81.3 (G)	77.2 (R)
100	99.5	98.8	93.3 (V)	81.1 (Bw)	75.5 (R)	75.3 (R)
99.8	99.6	98.9	89.9 (V)	71.4 (Bw)	71.2 (W3)	68.9 (R)
	99.4	99.5	94.6 (K)	89.1 (K)	69.0 (W1)	68.4 (W3)
	100.4	99.4	91.7 (K)	85.2 (P)	68.6 (W5)	67.3 (W5)
	100.6	98.6	90.9 (P)	69.3 (W1)	70.2	67.9
	106.3	98.2	89.3 (P)	72.2	77.2 (W4)	72.6 (W4)
	102.1	98.3	76.6 (W1)	75.6 (W2)		
	99.2	89.7 (W1)	74.9	73.4 (W3)		
	98.5	82.8 (W2)	77.7 (W2)			
		90.3 (W3)	75.7 (W3)			
W1, W2& W3-Windows along loom1, 2 &3, W4 & W5 - Windows at kitchen and pooja room V-Verandah, K-Kitchen, P-Pooja room, Bw-Behind wall, R-Road, G-Gate						

Table 4.7 shows cumulative noise values in dB(A) recorded during simultaneous operation of three looms which showed maximum of 100 dB (A) at the centre of the middle loom. Even at 3m distance, all readings were observed to be more than 98 dB(A) except at behind the PVC strip curtains, where the noise levels were from 82 to 90 dB(A). Similar observations were made at 4.5 m distance, where the noise level was more than 89 dB(A) at all points within building, where as it was from 75 to 77 dB(A) behind PVC strip curtains of windows. Therefore, it may be concluded that the PVC strip curtains were acting as a good noise barrier and reduces at least 10 dB(A) of noise. However, the ambient noise was noted to reduce below 70 dB(A) only from 7.5 m away from centre point at few locations, and did not reach the standard value even at 9.5 m.

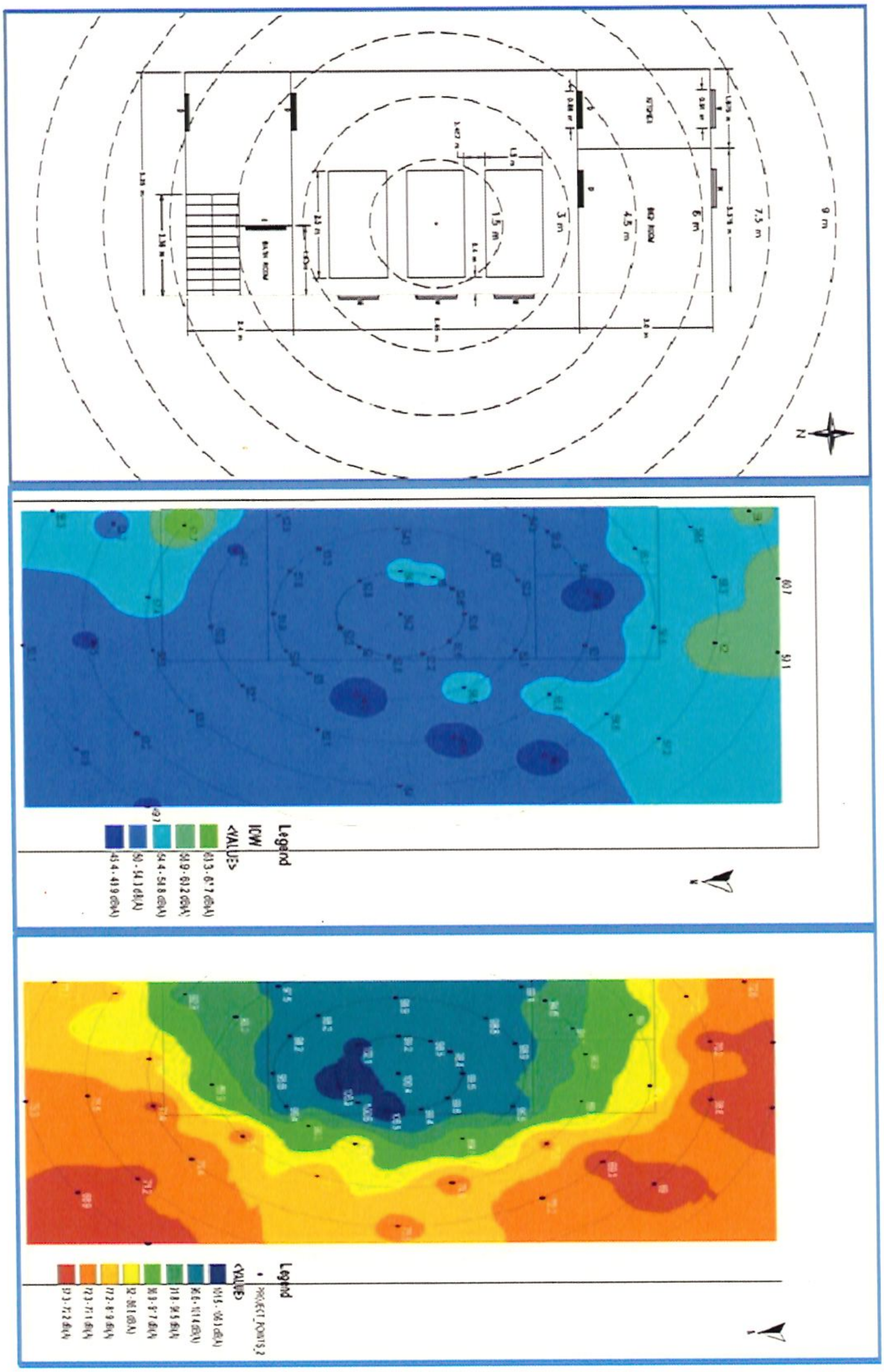


Figure 4.5: Layout of Site and Noise Contour at Th. Selvaraj's Loom Shed

Based on the noise survey, it is concluded that the prevalent shuttle looms cause noise mainly due to shuttle movement, that results noise levels of about 100 dB(A). The ambient noise monitored at 9 to 10.5 m away from the looms also recorded above 70 to 80 dB(A). Therefore, control at source of noise shall be primary option. The elimination of source of noise and substitute it with less or no noise causing mechanism will be better approach in noise control. In this case, since shuttle is the main source of noise, eliminating the shuttle and upgradation of existing shuttle loom into shuttle-less looms will generate comparatively low noise at source. Besides, the plain shuttle loom is already an obsolete technology, and Government of India has been taking steps to upgrade the plain shuttle looms into shuttle-less looms from the year 1999 under the scheme **"Technology Upgradation Funding Scheme" (TUFS)** followed by "Power Tex Scheme". Though the objective of the scheme is not reduction of noise but technology upgradation to improve the quality and productivity, such upgradation will be an integrated approach to resolve environmental, economic and social issues associated with small scale decentralized shuttle power looms. There are four types of shuttle-less looms namely, rapier looms, air jet looms, water jet looms and projectile looms. However, the in-situ upgradation of existing shuttle loom in to rapier loom is easier with the same width and power of shuttle loom by adding conversion kits, than the other three types of shuttle-less looms. Therefore, CES, Anna University, identified three rapier loom sheds at Ariyanur (Salem), Rasipuram (Namakkal) and Taramangalam and conducted noise survey during their operation. The results are presented and discussed below.

4.3.5 NOISE MONITORING FOR IN-SITU UPGRADED RAPIER LOOMS

The loom shed at Ariyanur (Periya seeragapadi, Latitude 11.578533° and Longitude 78.0454°) is having four in-situ upgraded rapier looms having single width with 0.75 HP motors, similar to the model shuttle looms at Taramangalam. Radial noise measurement was taken inside and outside the loom shed and the readings are presented in Table 4.8. The Figure 4.6 represents Layout of the site and Noise contour of rapier looms at Ariyanur (Periya seeragapadi).

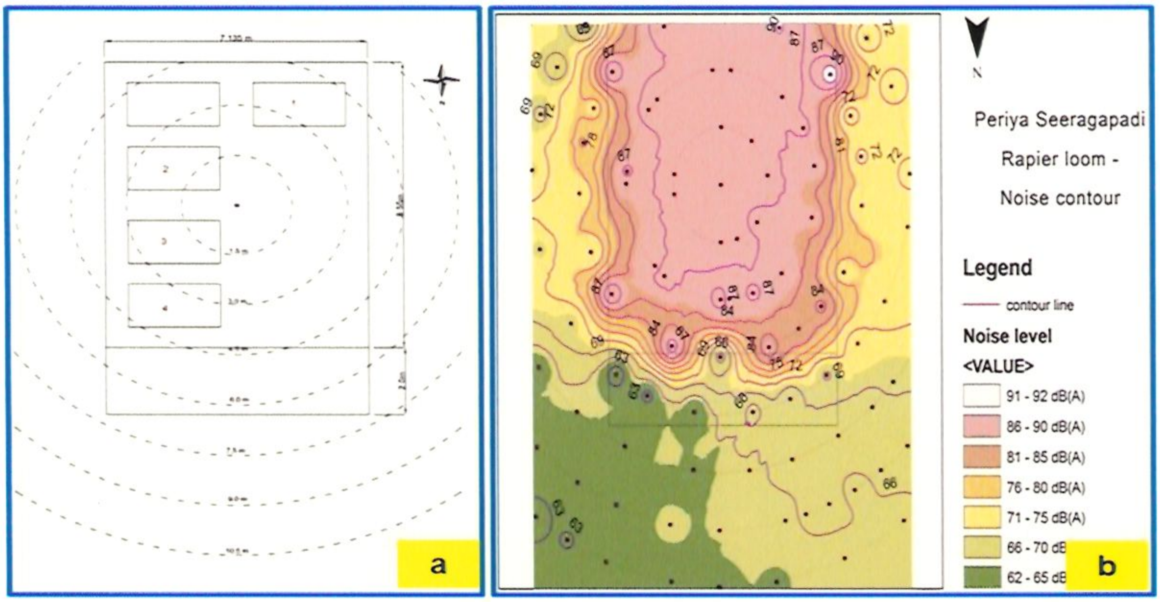


Figure 4.6: (a) Layout of the site (b) Noise contour of rapier looms at Periya seeragapadi

Table 4.8: Radial noise measurement for periya seeragapadi rapier loom site

0 m	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m	10.5 m
88.2	87.5	88.8	89.2	69.9	69.3	66.7	65.3
	88.4	87.9	88.9	70.3	68	66	65
	87.9	89.2	90.1	71.1	67.6	65.4	64.8
	88.1	88.9	91.6	72.4	66.6	67.1	64.7
	87.2	87.5	84.6	72.6	65.9	66.3	64.3
	86.6	86.5	83.9	70.4	64.8	65.2	64
	87.6	85.7	85.7	69.7	64.5	65	62.9
	88	86	87.9	69.9	65	65.3	62.4
		87.4	89.1	70	64.1	64.8	
		86.3	70.5	68.5		64.5	
		87.9	71.4	67.3		64	
		87.8	72.7	64.5			
		86.7	73.4	69.8			
		85.9	71.9	67.3			
		87.5	72.6	65.4			
		87.4	74.9	63.2			
			73.9	62.6			
			65.2	61.8			
(All readings are in dB(A))							

From the table 4.8, the noise level at centre point was measured to be 88.2 dB(A) while operation of all four machines, which about 10 dB(A) lesser than the noise generated during operation of three shuttle looms at Taramangalam. All the noise levels at different distances from machines were less than 90 dB(A) unlike shuttle looms, except at two points nearer to the wall due to reverberation effect. Also, the noise level was observed to be less than 65 dB(A) from 6 m away from centre point outside the building.

4.3.6 NOISE MONITORING DURING OPERATION OF RAPIER LOOMS AT RASIPURAM

The loom shed in Rasipuram is having six rapier looms out of which five are double width and one is single width. All the looms are having 2 HP motors. In order to compare noise generated by rapier loom with shuttle loom, three rapier looms (two double width and one single width) were operated and radial noise measurement was carried out. The results are presented in Table 4.9 and Figure 4.7.

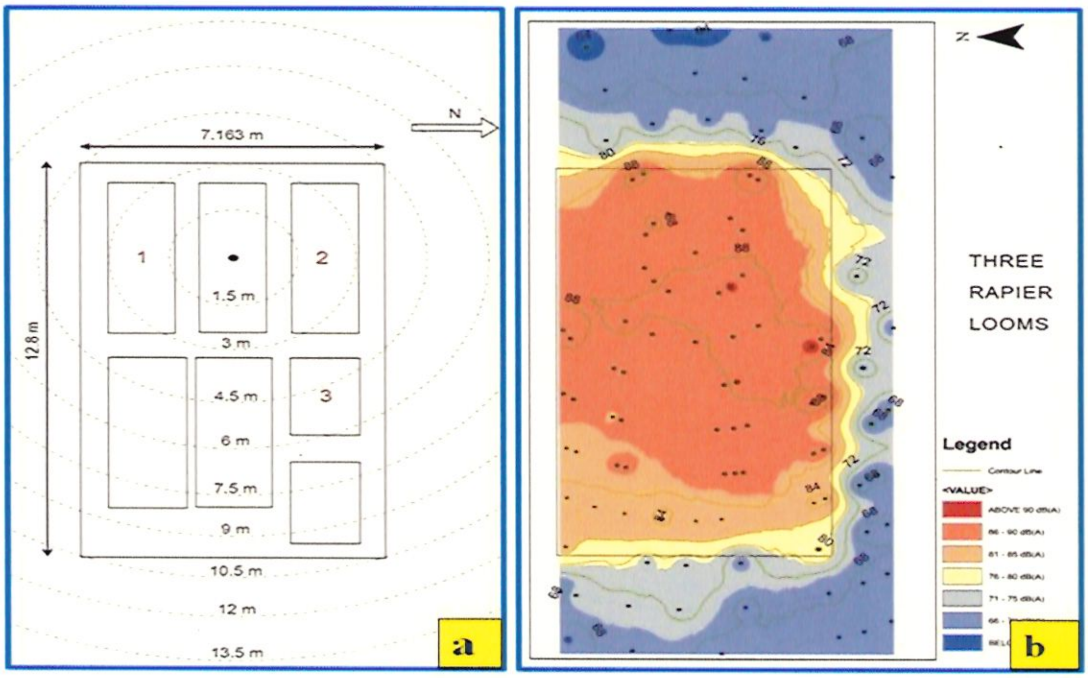


Figure 4.7: (a) Layout of the site at Rasipuram site (b) Noise contour for rapier looms at Rasipuram

The maximum noise at centre point was 89.4 dB(A). All the reading inside the building was less than 90 dB(A) unlike shuttle loom, except near the walls. The noise level decreased to 65 dB(A) at 7.5 m outside the building, from the source. Whereas, the ambient noise monitored at 9 to 10.5 m away from the shuttle looms at Taramangalam were above 70 to 80 dB(A).

Table 4.9: Radial noise measurement for Rasipuram rapier loom site -dB(A)

(Centre point)	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m	10.5 m	12 m	13.5 m
89.4	85.8	88.3	90.1	89.3	84.9	83.5	74.8	71.3	64.8
87.4	87.6	88.8	88.6	89.7	86	84.5	80.6	70.7	68.5
	86.5	88.6	88.3	87.1	85.9	83.7	73.9	67.1	65.7
	88.8	87.6	87.2	85.2	85.2	83.3	74.6	72.5	
	86.7	87.2	85.8	85.2	84.9	84.1	68.9	68.3	
	86.9	88.9	86.4	86	84.8	68			
	87.3	89.5	90.3	84.9	85.5				
	88.3	90.2	91.1	86.3	85.3				
	90		90.9	85.1	85.1				
	90.1		89.6	85	84.7				
	90.7		70.7	66.1	64.9				
	91.4		68.3	66.7	63.5				
			69.3	66.5	64.6				
			68.4	66.7	64				

4.3.7 NOISE MONITORING AT RAPIER LOOM SHED IN THARAMANGALAM

The Rapier Loom shed in Tharamangalam, (latitude-11.692944 and longitude 77.972439) is having four rapier looms. All the four looms are double width having 3 HP motors and imported from China. The shed has no windows or any other openings except an entry door. Inner dimensions of the shed was 11.3 m x 8m. Noise survey was conducted at every 1.5 m in all possible radial directions upto 6 m and beyond which could not measure, since all sides are covered by walls of adjacent buildings. At centre point, the noise level was measured to be 90.4 dB (A) whereas it reached a maximum value of 92.8 dB(A) in some points at 1.5 m distance. Higher noise level than any other observed rapier looms in the study may be due to very constrained narrow space between the two parallel looms (i.e two parallel looms are very closely placed) and higher motor capacity (3HP). Minimum noise level at 6m was observed to be 84.2 dB(A). Table 4.10 and Figure 4.8 depict the radial noise measurement values of rapier looms at Tharamangalam.

Table 4.10: Radial noise measurement for Tharamangalam rapier looms (dB(A))

0 m	1.5 m	3 m	4.5 m	6 m
90.1	90.4	91.2	88	85
90.2	90.6	91.6	87.5	84.2
90.4	89.7	90.9	86.4	84.3
89.9	90.6	88.8	87.8	86.5
	92.1	88.6	88	86.1
	92.8	89	88.6	86.4
	92.6	89.4	87.8	86.5
	91.2	90.5	90.1	86.4
	89.9	89.1	86.9	86.3
	87.4	88.5	86.5	
	88.1	87.3	86.2	
	87.8	87	86.3	
	87.6	86.8	86.4	
	87.5	87.2	89.1	
	89.1	86.9	89.4	
	90.4	88.5	89.7	
		88.3	89.6	
		89.5		
		89.6		

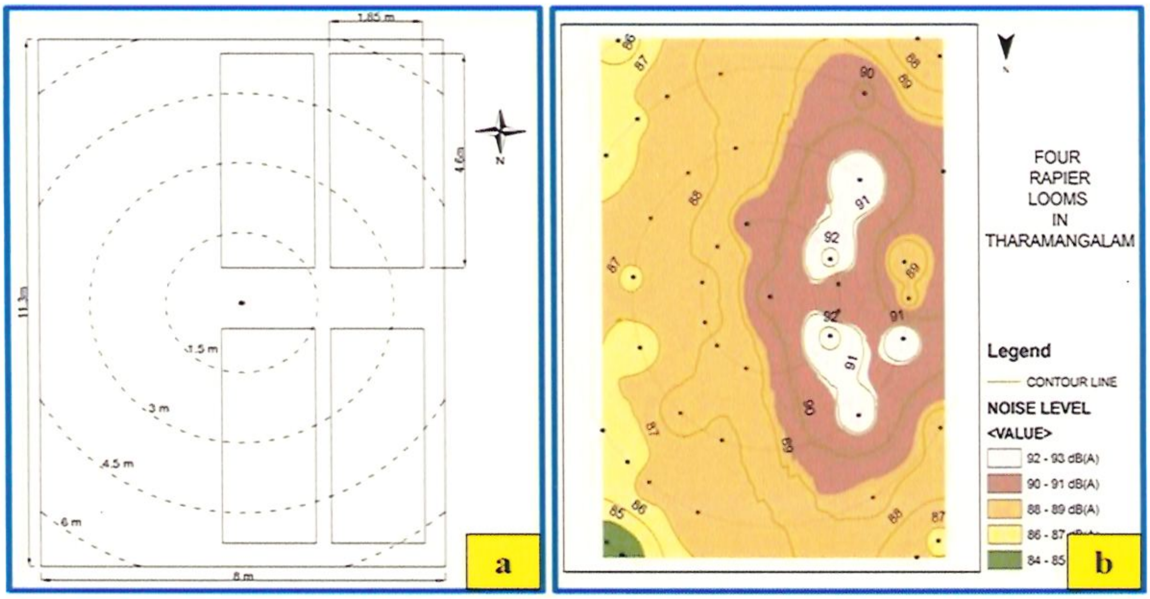


Figure 4.8: (a) Layout of the site at Tharamangalam (b) Noise contour for rapier loom at Tharamangalam

4.3.8 COMPARISON OF NOISE AMPLITUDE AND FREQUENCY LEVEL BETWEEN SHUTTLE AND RAPIER LOOMS

Apart from the Noise levels in dB, the frequency of noise (Hz) is also an important factor, when impact due to noise is concerned. The human ear is not equally sensitive to same sound pressure levels but different frequencies.

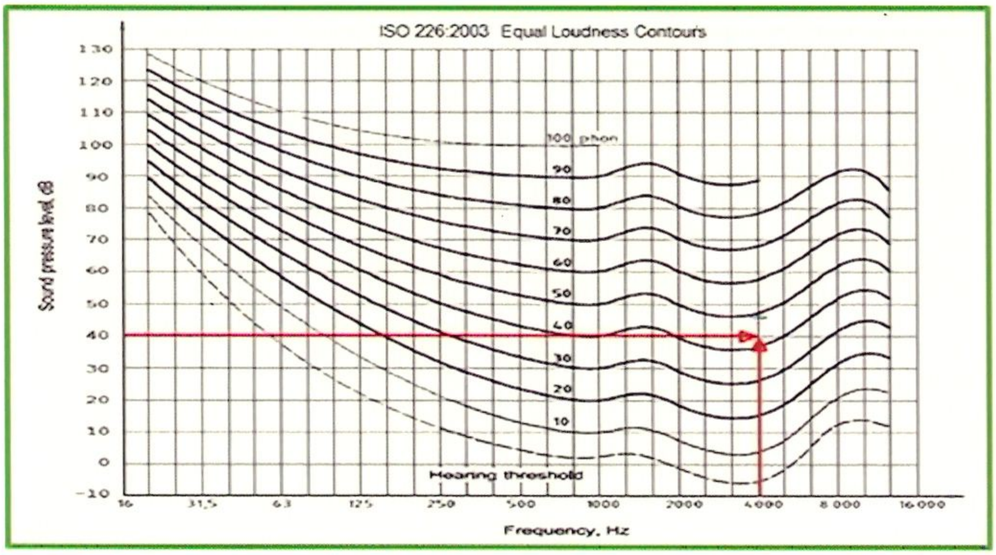
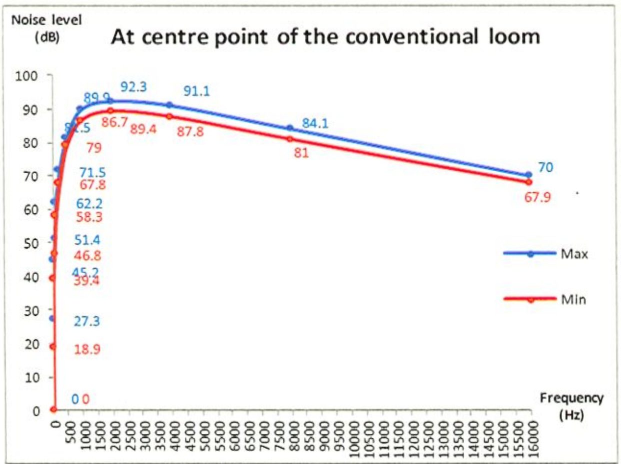
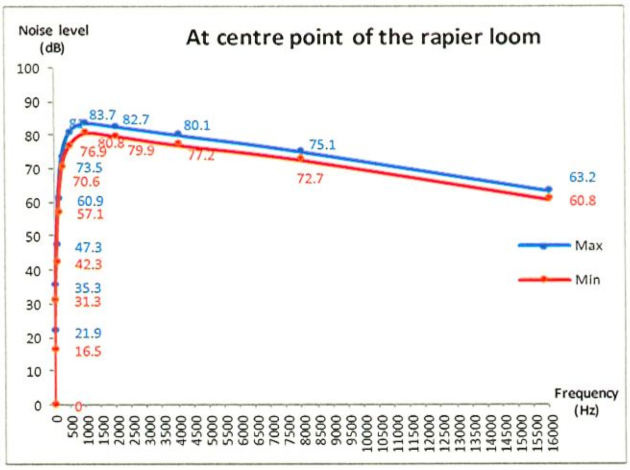
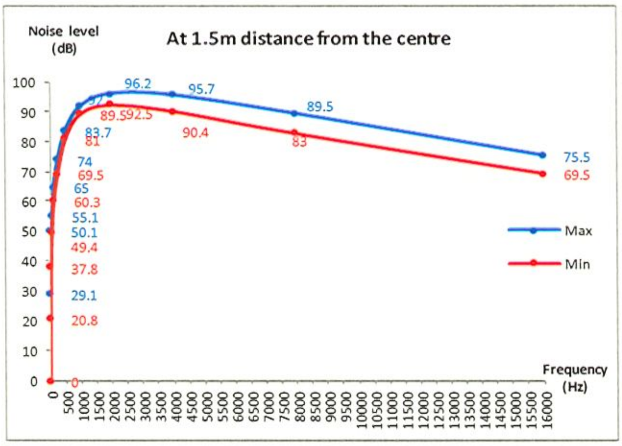


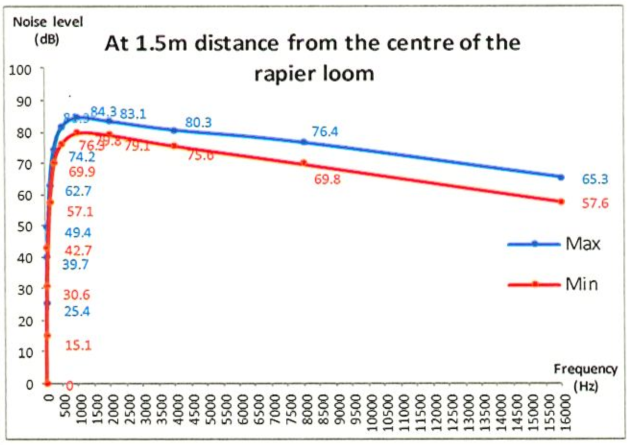
Figure 4.9: Graphical representation of Sound pressure level and Frequency

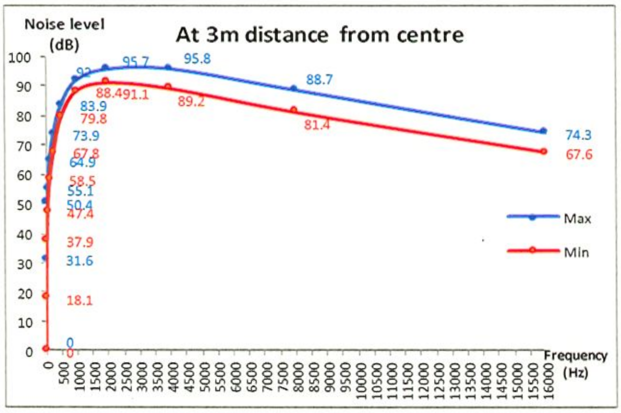
The frequencies between 2-4 kHz are the most sensitive and there is a chance of noise induced hearing loss in this range. For frequencies lower and higher than 2-4 kHz, the ear becomes less sensitive (Figure 4.9). Hence, the frequencies of noise generated by existing shuttle looms at Taramangalam and modified rapier looms at Rasipuram was studied at every 1.5 m interval. Three looms were operated at both the loom shed for comparative study. It may be noted that shuttle looms were having 0.75HP motors and rapier looms are having 2 HP motors. 1/1 octave band measurement mode was used to record noise at different frequencies. The Figure 4.10 represents the Graphical comparison of conventional and rapier loom at Rasipuram site.

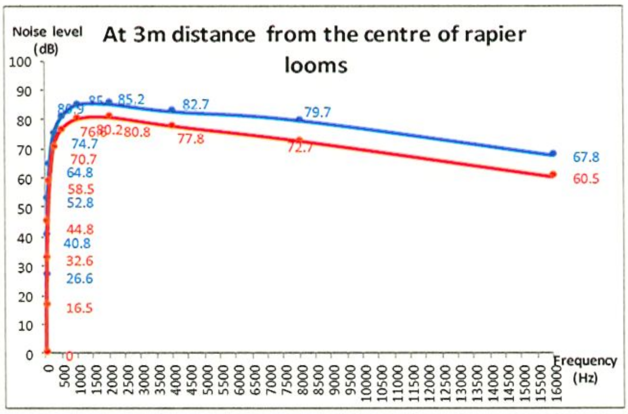

Noise level (dB)
At centre point of the conventional loom
Max
Min
Frequency (Hz)

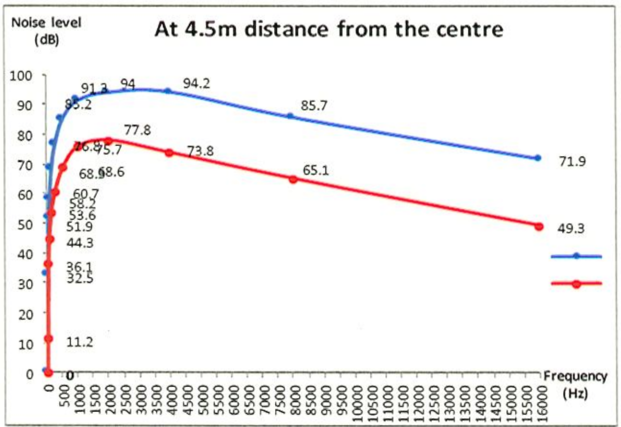

Noise level (dB)
At centre point of the rapier loom
Max
Min
Frequency (Hz)

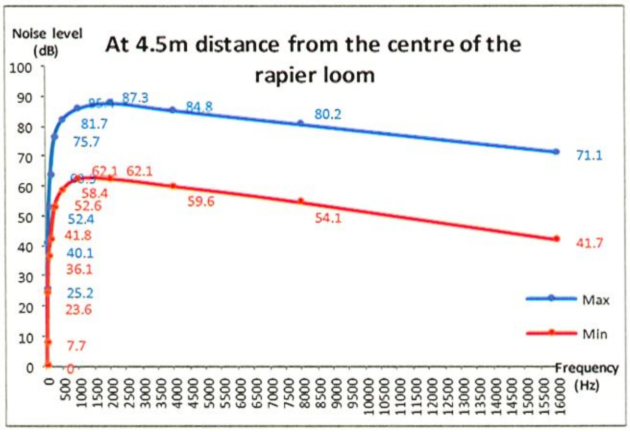

Noise level (dB)
At 1.5m distance from the centre
Max
Min
Frequency (Hz)

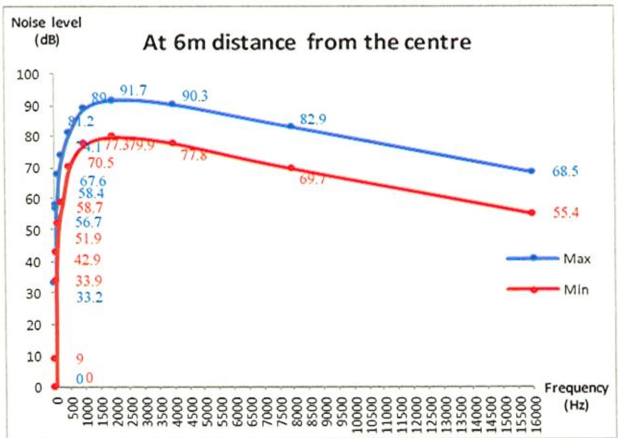

Noise level (dB)
At 1.5m distance from the centre of the rapier loom
Max
Min
Frequency (Hz)

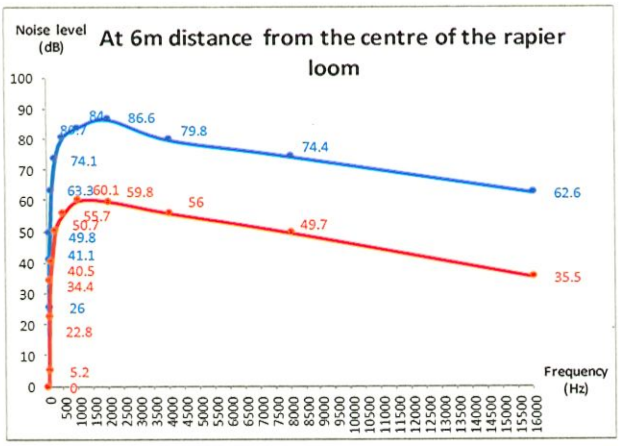

Noise level (dB)
At 3m distance from centre
Max
Min
Frequency (Hz)

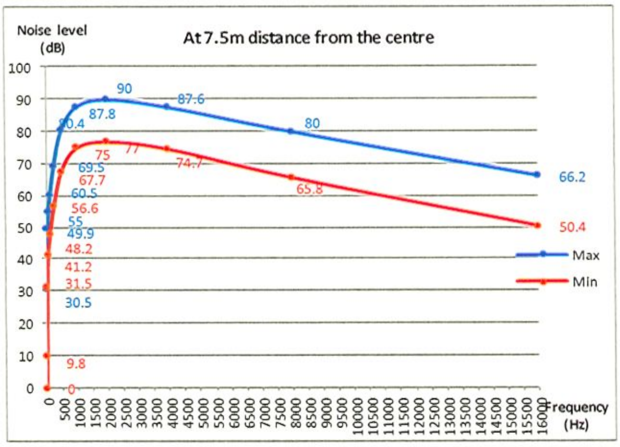

Noise level (dB)
At 3m distance from the centre of rapier looms
Max
Min
Frequency (Hz)

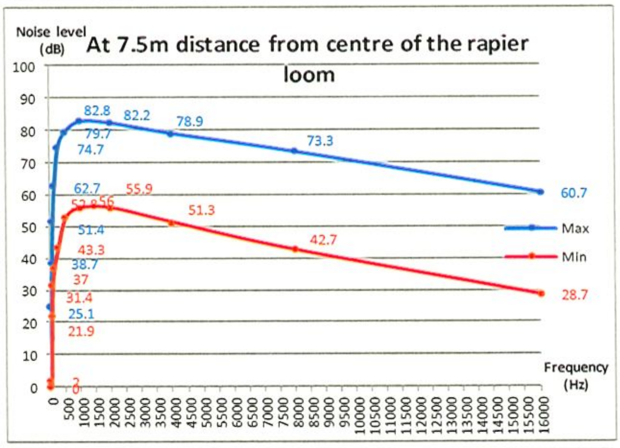

Noise level (dB)
At 4.5m distance from the centre
Frequency (Hz)

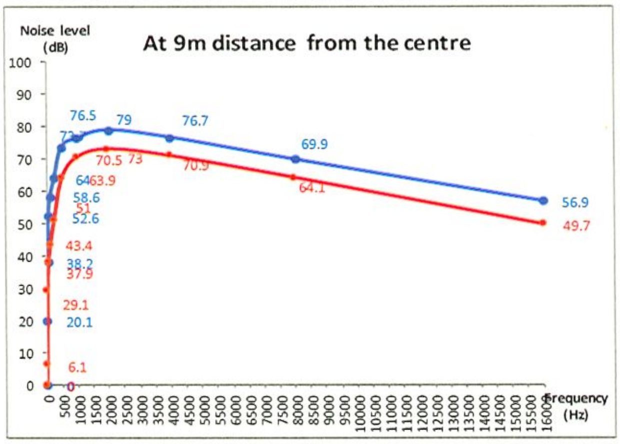

Noise level (dB)
At 4.5m distance from the centre of the rapier loom
Max
Min
Frequency (Hz)

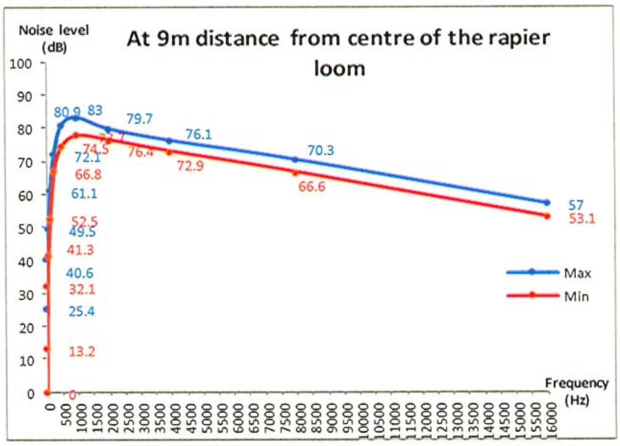

Noise level (dB)
At 6m distance from the centre
Max
Min
Frequency (Hz)

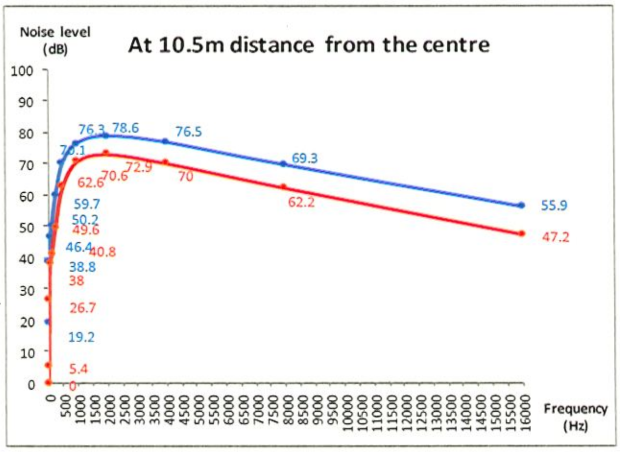

Noise level (dB)
At 6m distance from the centre of the rapier loom
Frequency (Hz)

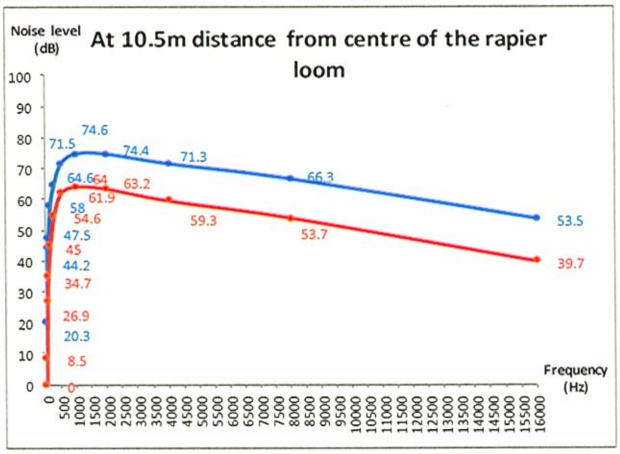

Noise level (dB)
At 7.5m distance from the centre
Max
Min
Frequency (Hz)


Noise level (dB)
At 7.5m distance from centre of the rapier loom
Max
Min
Frequency (Hz)


Noise level (dB)
At 9m distance from the centre
Frequency (Hz)


Noise level (dB)
At 9m distance from centre of the rapier loom
Max
Min
Frequency (Hz)


Noise level (dB)
At 10.5m distance from the centre
Frequency (Hz)


Noise level (dB)
At 10.5m distance from centre of the rapier loom
Frequency (Hz)

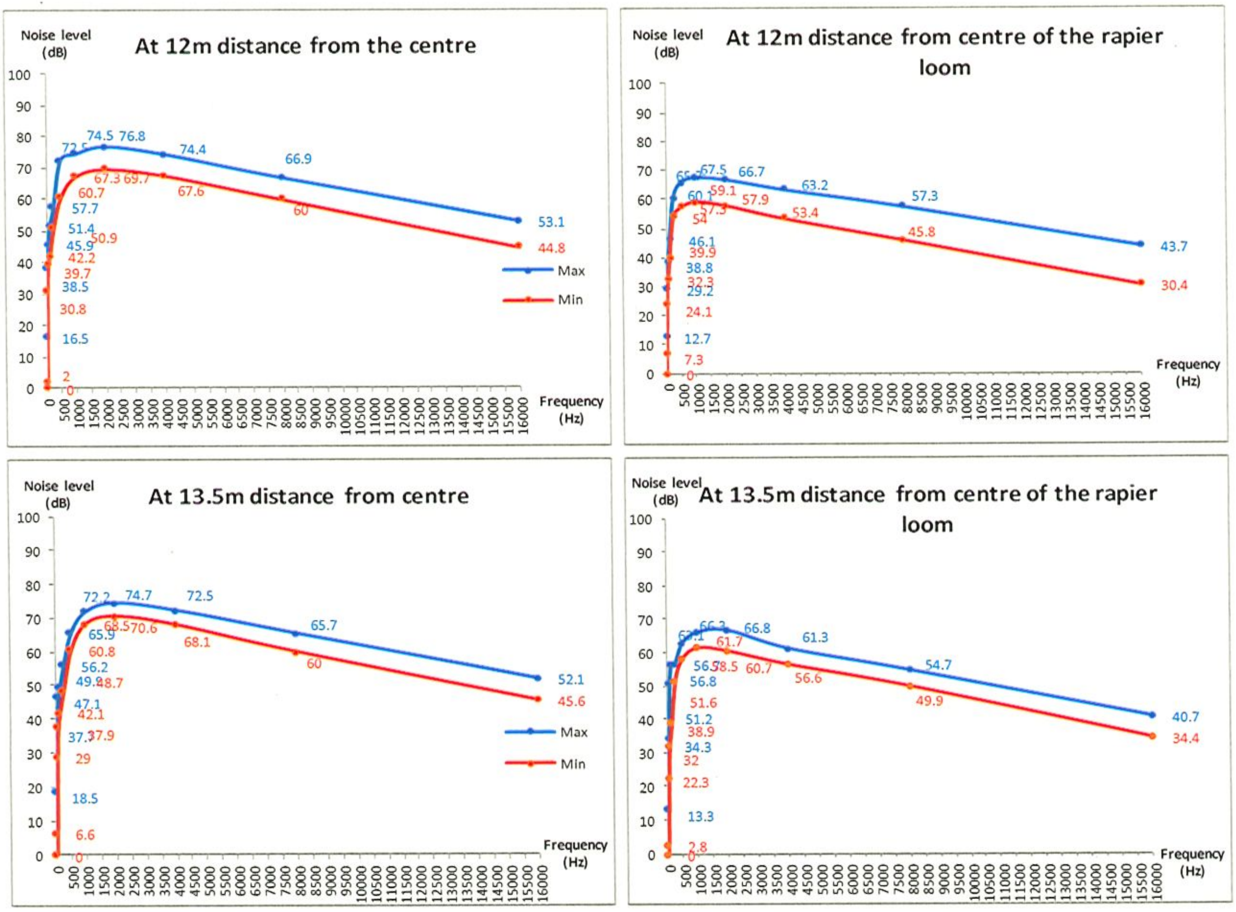


Figure 4.10: Graphical comparison of conventional and rapier loom

Table 4.11: Comparison of frequency and noise level between rapier and conventional looms

Radial Distance	Conventional loom		Rapier loom	
	Frequency (Hz)	Noise range dB(A)	Frequency (Hz)	Noise range dB(A)
(Centre point)	2000	89.4 to 92.3	1000	80.8 to 83.7
1.5 m	2000	92.5 to 96.2	1000	79.8 to 84.3
3.0 m	4000	91.1 to 95.8	2000	80.8 to 85.2
4.5 m	4000	77.8 to 94	2000	62.1 to 87.3
6.0 m	2000	79.9 to 91.7	2000	59.8 to 86.6
7.5 m	2000	77 to 90	1000	56 to 82.8
9.0 m	2000	77 to 83	1000	73 to 79
10.5 m	2000	72.9 to 78.6	1000	64 to 74.6
12.0 m	2000	69.7 to 76.8	1000	59.1 to 67.5
13.5 m	2000	70.6 to 74.7	2000	61.7 to 66.8

It may be noted from the above figure 4.10 and table 4.11 that at most of the points, the frequency of noise generated by rapier looms were at 1000 Hz, whereas the shuttle looms generate at 2000 Hz. At few locations such as near the walls and in between closely located looms, the rapier looms generate at frequency of 2000 Hz and that of shuttle looms was 4000 Hz. Therefore, the noise generated by rapier looms are less hazardous due to its low frequency than the shuttle loom.

4.4 COMPARISON OF OCCUPATIONAL NOISE EXPOSURE AT CONVENTIONAL SHUTTLE LOOM AND MODIFIED RAPIER LOOMS

The occupational noise exposure by power loom operators were monitored and compared while operating conventional shuttle looms at Tharamangalam (Mr. Selvaraj's Loom shed) and Rapier Looms at Rasipuram. The operating conditions, duration, idling time and occupational exposure are presented in Table 4.12. The 8-hr occupational noise exposure of shuttle loom was 95.69 dB(A), whereas 12-hr noise exposure of rapier loom was only 80.47 dB(A).

Table 4.12: Occupational Noise Exposure by Conventional Shuttle Looms and Rapier Looms

Type of Loom	Shuttle Loom	Rapier Loom
Location	Tharamangalam	Rasipuram
Number of Looms	3	6
Working / Exposure Duration	8 hrs	12 hrs
Operating Time	10.50 am to 06.50 pm	9.46 am to 9.45 pm
Idling Time	30 minutes	3 hrs
Background Noise Level during idling time	60.5 dB(A)	46.42 dB(A)
Motor (HP)	0.75 HP	2 HP
Noise Exposure	95.69 dB(A)	80.47 dB(A)

4.5 COST BENEFIT ANALYSIS FOR CONVERSION OF EXISTING SHUTTLE LOOM INTO SHUTTLE-LESS RAPIER LOOM

The cost- benefit analysis and payback period for conversion was calculated based on actual units consumed and number of revolutions per minute at Model shuttle Power Loom (Mr. Selvaraj's Loom Shed), market price of rapier loom and literature data for new shuttle loom.

Units consumed by 3 looms for two months (Based on 26 months' EB bill) = 760 units

$$\text{Total production hours} = \frac{\text{EB units}}{\text{energy required}} = \frac{760\text{units (kWh)}}{2.238\text{kw}} = 340 \text{ hrs}$$

(Note: The Loom shed has three 0.75 HP motors. Assuming 75 % efficiency, energy required =2.238 kW)

Observed average number of revolutions per minute of the existing looms= 57rpm

Therefore, Number of revolutions to be in 340 hours = 57 x 340 x 60

= 11,62,800

No. of revolutions per day in a new shuttle loom having 140 rpm

= 140 rpm x 24 x 60 min=201600 rev

No. of revolutions per day in the existing shuttle loom having 57 rpm

= 57 rpm x 24 x 60 min=82080 rev

But Actual revolutions generated = 19380 rev [i.e 2 months' average 1162800/60]

Loss in revolutions due to reduction in speed (age) = (140-57)/140 = 59.3% ≈ 60%

Loss in revolutions due to other factors = (82080-19380)/ 82080 =77%

4.5.1 COMPARISON OF TIME REQUIREMENT BY DIFFERENT LOOMS

The time required to produce 1162800 revolutions that was produced by existing second-hand shuttle loom having 57 rpm was compared with New Shuttle loom of 140 rpm and converted rapier loom having 120 rpm. *[Note: Though the rapier looms produce 150 to 170 rpm, the 120 rpm was considered as worst-case scenario].* (Mohammed Mustaqueem et al, 2017)

- Time required to produce 1162800 rev by new shuttle loom= 1162800/140 = **138 hrs**
- Time required to produce 1162800 rev by existing loom = 1162800 /57 =**340 hrs**

The existing loom takes 2.5 times more than new shuttle loom to produce same revolutions.

- Time required to produce 1162800 rev by modified rapier loom (120 rpm) = **162 hrs**

Modified rapier looms will take about 50% less time than existing shuttle loom to produce same number of revolutions.

4.5.2 COMPARISON OF ENERGY COST FOR VARIOUS TYPES OF LOOMS

The energy cost required by existing shuttle loom, new shuttle loom and proposed modified rapier loom to produce same number of revolutions (i.e) same productivity, was calculated based on the new tariff **(w.e.f 01.07.2024)** by Tamil Nadu Electricity Regulation Commission. The operating duration was the time taken to attain 1162800 revolutions by one existing shuttle loom at Taramangalam in 2 months.

(i) For Existing 2nd hand shuttle loom at site: 57 rpm

= 339.35 hrs x 2.238 kw x Rs 8.00/unit = **Rs.6075.72**

[As the number units is more than 750 units, Rs.8.00/- per unit was considered]

(ii) For New Standard shuttle loom having 140 rpm

= 138.16 hrs x 2.238 kw x Rs. 6.95/unit = **Rs. 2148.99**

(iii) Modified rapier (2^{nd} hand) loom having 120 rpm

= 161.19 hrs x 2.238 kw x Rs. 6.95/unit = **Rs. 2507.18**

The Savings in Energy cost is

Rs.6076- Rs. 2507 = Rs.3569 / 2 months i.e Rs.1785 / month

4.5.3 CALCULATION OF PAYBACK PERIOD FOR CONVERSION OF EXISTING SECOND-HAND SHUTTLE INTO MODIFIED RAPIER LOOM

If the cost of conversion is Rs. 1.50 Lakhs (maximum as per market price) time taken to take back the Rs.1.50 Lakhs from monthly savings of EB charges

Rs.1,50,000 /Rs.1785 per month = 84.04 months (7 years)

Government of Tamil Nadu provides free electricity upto 1000 units,

But actual average units consumed is 760 units.

Therefore, if that subsidy is considered, then savings for 760 units =Rs. 6080/2
=Rs. 3040/month

Payback period for initial investment of 1.50 lakhs = 49.44 months (4.12 years)

Thus, from the above cost benefit analysis, replacement of shuttle loom with insitu-upgraded rapier loom may be a viable option.

4.6 TECHNOLOGY UP-GRADATION FUND SCHEME (TUFS)

It may be noted that the shuttle loom is already an obsolete technology and Government of India has taken an initiative called 'Technology Up-gradation Fund Scheme (TUFS)' by Ministry of Textiles from 1999 to upgrade from the conventional shuttle loom into shuttle-less looms. Financial support was provided under TUFS for import of second-hand shuttle-less looms from European Union, import of new shuttle-less looms from European Union, Japan and China and for buying brand new Indian Power looms. There are four different types of shuttle-less technology such as Air Jet, Projectile, Rapier and Water Jet fitted with or without electronic jacquard/electronic dobby. A total of 36570 shuttle-less looms have been imported under TUFS during the XI plan of which, maximum (around 44%) were Rapier machines. Out of 14,27,000 power looms in 5 major clusters such as Bhiwandi, Ichalkaranji, Surat, Erode and Bhilwara only 69,700 looms were shuttle less looms that implies only 4.9% were modernized under the scheme (Source: National Productivity Council, 2013). The traditional weavers were not interested in shifting to high tech Shuttle-less power looms, as a result the modernization of the looms is very less. In the 12th five-year plan, from 2012 to 2017, only 1194 looms were modernized by importing or buying brand new Indian looms. The economically weaker power loom units were unable to invest in brand new modern looms and have been seeking the In-situ modernization plan for upgrading their existing plain power looms, which was not addressed under TUFS as minimum benchmark is shuttle less loom, such low-end plain power loom owners do not find it feasible to straightaway upgrade to shuttle less looms by replacing existing plain looms. Therefore, Government has decided to provide financial assistance to economically weaker plain power looms units for up-gradation of their existing ordinary loom, by attachment of additional kits like Weft stop motion (Optical Weft Feller), Warp stop motion (Electro Mechanical Type (or) Photo Cell Type). The scheme is named as power Tex scheme and implemented from 2017 to 2020 with the following subsidy as shown in the table 4.13.

Table 4.13: Subsidy under the Power Tex scheme

For In-situ Upgradation	Kit attached	Category	Maximum GOI subsidy/ loom
(a) From existing plain power looms to semi-automatic shuttle looms	(i) Weft stop motion and Warp stop motion	General	Rs.20,000
	(ii) Efficient braking device		
	(iii) Semi positive let off motion	SC	Rs.30,000
	(iv) Dobby		
	(v) Jacquard		
	(vi) Self-lubricating nylon parts	ST	Rs.36,000
	(vii) Anti crack device		
	(viii) Pirn winding machine		
(b) From existing upgraded semi-automatic shuttle looms under Insitu Upgradation scheme to shuttle less rapier looms (excluding attachments at (a) above)	Attachment of rapier kit for power looms	General	Rs.25,000
		SC	Rs.37,500
		ST	Rs.45,000
(c) From existing plain power looms directly to shutterless rapier looms (including attachment kits (a) and (b))	**(i) Weft stop motion and Warp stop motion, Efficient braking device, semi positive let off motion, Dobby, Jacquard, Self-lubricating nylon parts, Anti crack device, Pirn winding machine (ii) Rapier kit**	**General**	**Rs.45,000**
		SC	**Rs.67,500**
		ST	**Rs.81,000**

Hence if the State or Central Governments extend the subsidy for conversion (in-situ modification) of existing second-hand shuttle looms into rapier looms like Power Tex scheme, it would be a solution for the environmental, economic and social problems faced by household level shuttle loom owners in long term. It may be noted that the one-time subsidy for modernizing or upgradation of the units will lead to reduce energy consumption and substantially the subsidy provided for electricity in long term.

4.7 ADVANTAGES AND DISADVANTAGES OF DIFFERENT SOUND ABSORPTIVE MATERIALS FOR AN ENCLOSURE

The property of a sound absorptive surface is to convert the sound energy (Kinetic energy) into other forms of energy, generally heat energy (due to friction) and get absorbed. The degree to which this surface absorbs sound is known as absorption coefficient. Table 4.14 gives the overall ideas about advantages and disadvantages of different acoustic absorbers available commercially in the market which reduces the noise level to a certain limit.

Table 4.14: Advantages and Disadvantages of Various sound absorptive materials

S. No	Materials	Composition	Advantage	Disadvantage
1	Rock wool or mineral wool	Basalt or dolomite + steel slag	mineral wool is made almost entirely from raw materials that are recyclable, natural, and renewable. (Sustainable)	tiny fibers can be easily accidentally inhaled or ingested during installation.
			It can be used to insulate every part of a home, including the roof, walls, and floors. (Versatile)	These stone fibers can also become embedded in the skin, causing rashes, itchiness, and general skin irritation.
			The high R-value of mineral wool insulation ensures that it is incredibly energy efficient. (no carbon footprint)	If inhaled, the tiny fibers of mineral wool can potentially irritate the alveoli and cause various lung problems
			Made from tough and durable raw materials like steel slag and	Because of its state-of-the-art manufacturing process, Mineral wool

			igneous rock mineral wool insulation offers exceptional longevity.	insulation is more expensive than other comparable materials, like cellulose and fiberglass.
			melting of basalt rock above 1,600°C effectively eliminates any organic material. Thus, lack of organic material prevents the growth of mold, mildew, and fungus, and enhances the longevity of the material.	The greater weight makes it harder to handle during ceiling and roof installation and also more manpower is required thus, making the entire process more expensive.
			The stone fibers within a batt have natural air pockets, preventing moisture buildup.	Non-bio degradable
			It is non-combustible and can easily withstand temperatures up to 1,000°C	
			mineral wool insulation does not catch fire and not releases smoke or toxic gases when exposed to flames and high heat.	
			The high density of Rock wool batt makes them effective at noise reduction.	

			The greater rigidity of this material ensures that it can be cut more precisely (easy to install) Old and discarded mineral wool can be recycled to form new insulation products. (recyclable)	
2	Glass wool	Sand, soda ash, limestone, and recycled glass are the key components of glass wool. The typical composition of glass wool is roughly 70% recycled glass	It is made of fire-resistant material. So, it can withstand fire up to 300°C.	Although glass wool is made of recyclable materials, it has a negative environmental balance, especially because its raw materials are non-renewable.
			Its flexibility makes fiberglass a very affordable option	Also prone to exposure to water or moisture due to water-related sensitivities. In regions with high levels of humidity, fiberglass isn't as efficient at repelling moisture. So, if exposed to such conditions, it needs to be

				replaced from time to time.
			Made from recycled glass and sand, fiberglass is a natural fire retardant. There's also fiberglass material that's treated with a fire retardant to improve the level of safety.	Fiberglass settles and sags, so its R-value decreases over time.In general, its R value per inch is lesser than rock wool.
			Less expensive than rock wool	In regions with high levels of humidity, fiberglass isn't as efficient at repelling moisture.
				Compared to other insulation materials, fiberglass is less dense and effective against air leaks.
3	Polyurethane foam	Polyurethane foam is a polymer composed of organic units joined by urethane links. It's created through the reaction of di-	Polyurethane foam offers excellent thermal and acoustic insulation. (Highest R value among aforesaid materials)	polyurethane foam is lightweight. This makes it easy to handle and install, particularly in construction and automotive applications where weight reduction is crucial.
			Polyurethane foam is relatively cost-effective	Volatile organic compounds (VOCs) released during manufacturing and off-

		isocyanates and polyols		gassing can affect indoor air quality.
				Polyurethane foam is highly flammable. Although flame retardants are often added, this can introduce additional chemical concerns
				the biodegradability of polyurethane foam is limited, and recycling can be challenging. Most polyurethane foam ends up in landfills, where it can take many years to decompose.
				While polyurethane foam can be cost-effective, there is significant variability in quality
				Although generally durable, polyurethane foam can degrade and discolor over time, especially with exposure to sunlight and extreme temperatures. This can affect its appearance and performance in certain applications.

4.8 STUDY ON ENCLOSURES

The prime objective of providing an enclosure to an equipment or a machine is to isolate it from human exposure. However, in this case of the decentralized household looms, it is not practically possible as the looms are operated in a portion of their living space. Moreover, if an enclosure is installed, it has to be in such a way to provide clear spacing both inside and outside of such enclosure for inspection and free movement. Accordingly, noise monitoring was conducted on the neighbourhood of the particular site with/without closing the doors and windows of Th.selvaraj's loom shed on 08.07.24 as shown in fig.4.11. At normal working conditions, when all sound escaping routes (i.e doors, windows and gate) were open, the noise levels were reduced below 55 dB(A) at 30m distance. Solid masonry walls encompass the looms acts like an enclosure and make them soundproof to block all sound escaping routes. Even if acoustic absorptive materials are used on the walls and roof, but the doors and windows are kept opened, the noise will escape through these routes.

Figure 4.11: Noise Monitoring for Enclosure Study

4.9 ENCLOSURE STUDIES AT ANNA UNIVERSITY CAMPUS

In this regard, two types of enclosures for providing at doors were studied at Anna University campus (i) with wooden glass window and composite door with an aluminum frame, that has attenuation of 16 dB(A) and (ii) mass-spring-mass system which involves single layer brick wall + glass wool + plaster board that has attenuation of 30 dB(A) that is normally used for audio recording studios. However, considering the cost, skilled labor requirement, natural lighting and ventilation requirement of loom shed operators the enclosure (i) was chosen to install with some modifications at model power loom shed in Tharamangalam to study level of noise reduction.

4.10 AMBIENT NOISE SURVEY ALONG THE STREET

Accordingly, on 08.07.24, the noise survey was conducted at the premises of model power loom site and along the street of the building. The noise generated by particular looms (3 nos) was measured at distance of every 5m along the street. Windows has dimensions of 3 feet& 8 inches' height and 2 feet& 10 inches' width; main door has 6 feet& 11 inches' height and 4 feet& 9 inches' width provided with no glazing on right side and the grill gate with 8.07 feet height and 6.23 feet width. These openings were acting as major sound escaping paths which ultimately increase the ambient noise level in the street. The locations of noise monitoring are shown in Figure 4.12 and the noise levels at those points are presented in table 4.15.

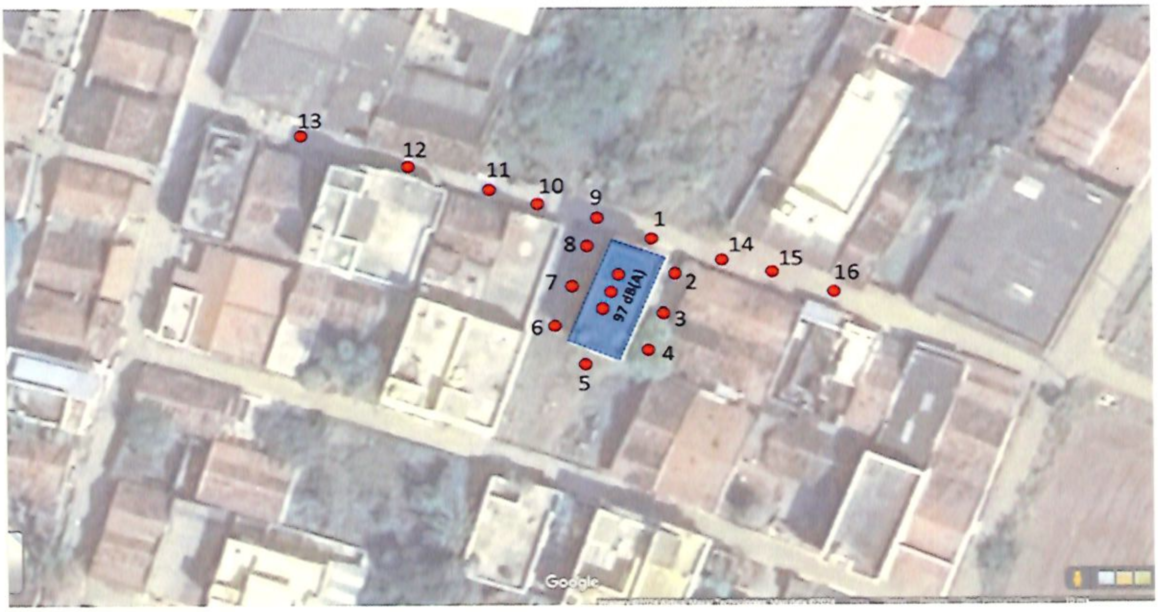


Figure 4.12: Ambient Noise Measurement locations along the street

Table 4.15: Ambient Noise Levels along the street

Measurement Location	With doors and windows open dB(A)	With windows closed and doors open dB(A)	Doors and windows in closed dB(A)
1	82	83	68
2	66	69	61
3	63	62	58
4	71	62	60
5	76	62	61
6	71	64	65
7	81	76	76
8	74	72	70
9	72	71	67
10	67	64	61
11	57	56	51
12	53	53	48
13	49	48	46
14	65	57	57
15	60	55	56
16	56	53	53

An enclosure was made up of UPVC frame with partly glazed and partly paneled with particle board covered by UPVC. The 5mm thick glass was lined up with "Q" rubber beading and fixed. The sound level was monitored along the frame and wherever leakages was observed, arrested with sealant. Further, the main gate was provided with 3mm transparent PVC strips with 25% overlap for 70 square feet. The noise level before the enclosure (inside the loom shed), between the enclosure and PVC strips and cumulative effect of enclosure and PVC strips (outside the main gate) was monitored as shown in Figure 4.13 and presented in Table 4.16. Enclosure alone reduced noise 20 dB(A) whereas PVC curtains reduced another 10 dB(A). Both enclosure and PVC strips had cumulative effect on noise reduction of about 30 dB(A).

Table 4.16 Noise Level After Providing Enclosures

Location	With doors and windows open dB(A)	Windows closed and doors open dB(A)	Doors and windows closed,dB(A)	Windows closed with UPVC door & PVC curtains at gate dB(A)
1	82	83	68	63
2	66	69	61	59.5
3	63	62	58	52.8
4	71	62	60	59
5	76	62	61	68
6	71	64	65	69
7	81	76	76	73
8	74	72	70	71
9	72	71	67	63
10	67	64	61	60.1
11	57	56	51	49.5
12	53	53	48	49
13	49	48	46	-
14	65	57	57	55
15	60	55	56	50.5
16	56	53	53	50

Figure 4.13: Noise level after installation of noise control measures along the transmission path **(i) at loom [99.4 dB(A)] (ii) before UPVC door [98.2 dB(A)] (iii) behind UPVC door [76.7 dB(A)], (iv) before PVC curtain [76.6 dB(A)], (v) behind PVC curtain [66.9 dB(A)], (vi) behind gate [63.0 dB(A)]**

Figure 4.14: Installation of control measures **at Transmission path**

[before, during and after installation of UPVC door and PVC strip curtains]

The total cost of the UPVC door and PVC curtains with the mentioned specifications was Rs. 40,000 only.

4.11 STUDIES ON EFFECT OF PPE ON NOISE REDUCTION

Ear Plugs and Ear Muffs are common PPEs for Individual's Noise Exposure Reduction. Being cost effective and convenient to use, a corded ear plug (Model: 3M 1110) was used in the study which is soft, hypoallergenic foam and a tapered design help provide a noise reducing seal in the ear canal. These earplugs are easy to roll down and once inserted in the ear, soften with body temperature for comfortable extended wear. Though individual's exposure is felt to be reduced drastically while wearing the ear plug, the level of attenuation by the earplug could not be measured. Therefore, a study was carried out in a transparent container, in which the noise level meter was kept inside container and monitored the sound level before and after using the earplug at the sound escaping route. The experimental arrangement is shown in Fig.4.15. Duration of the measurement was 20 minutes for each case and are tabulated below.

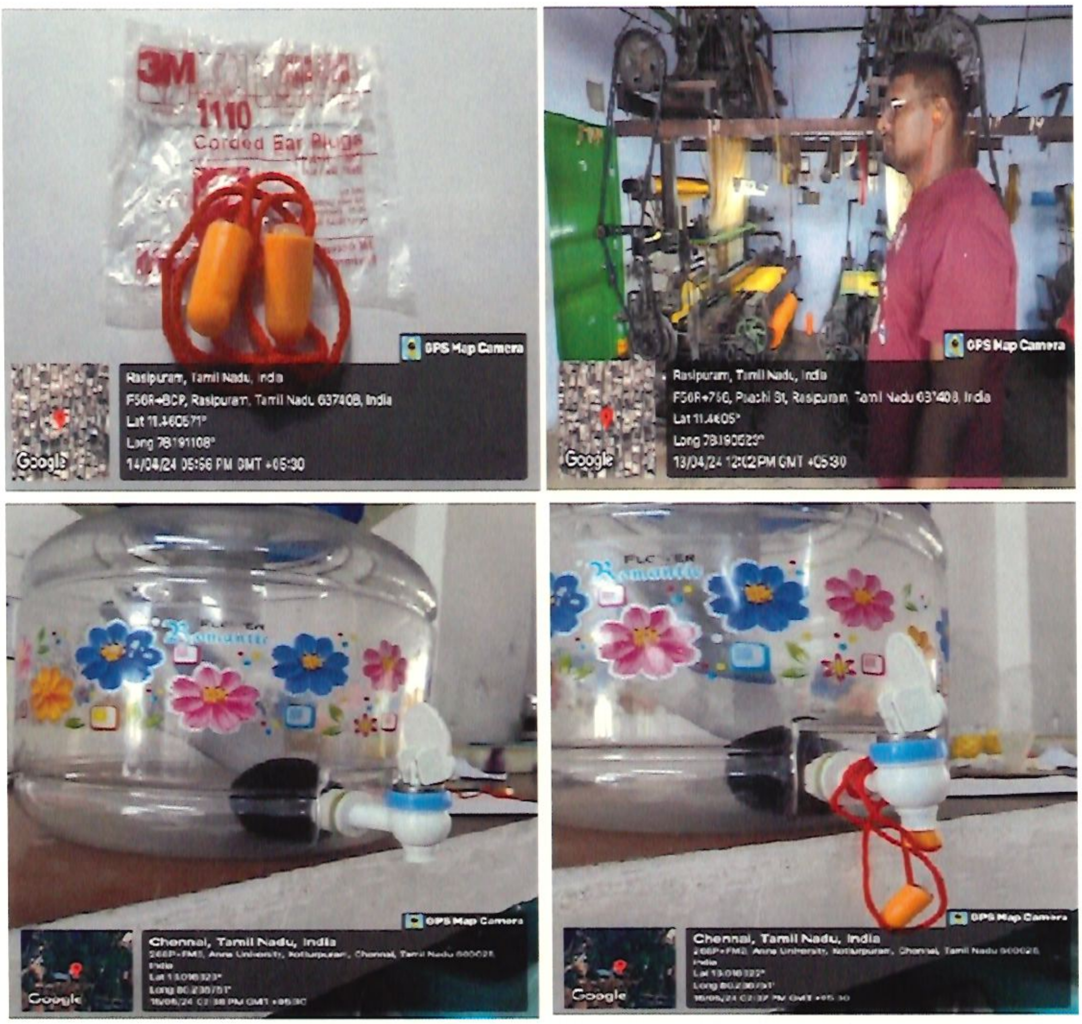


Figure 4.15: Demonstration of PPE for sound attenuation

Table 4.17: Trial 1 for checking the attenuation of the earplugs

WITHOUT PPE (Units in dB(A))			**WITH PPE** (Units in dB(A))		
89.5	95.6	94.1	74.2	76.6	75.4
91.1	94.8	97.3	76	76.2	76.3
90.3	96.5	96.3	75.2	76.6	75.9
90.9	96.6	94.7	75.7	75.7	76.1
93.6	94.4	92.5	77.1	76.7	75.7
93.9	96.9	93.2	76.8	74.5	75.9
91.6	98.4	95.6	75.9	76	75.9
94.1	92.8	96.5	76.5	74.3	76.4
96.6	91.5	96.8	76.3	75.6	75.8
95.9	92.7	95.4	77.2	75.2	76.7
96.9	92.6	98.5	75.2	74.7	77
94.7	95	97.8	76.3	75.9	76.5
94.7	95	96.8	75.4	76.5	76.4
95.4	93.6	95.7	76.6	75.8	75.9
95.6	94.5	97.2	75.9	76.7	75.9
96	94.7	96	74.5	75.5	77.1
95.8	95.7	94.4	76	76.1	76.4
94.3	95.9	95.8	77.1	75.9	76.6
94.2	97.2	95.7	76.7	75.5	77.3
93	96.7	98.2	76.5	75.9	76.9
94.5	97.6		77.6	76.4	
96.9	96.3		76.2	77	

Table 4.18: Trial 2 for checking the attenuation of the earplugs					
WITHOUT PPE (Units in dB(A))			WITH PPE (Units in dB(A))		
88.3	93.7	102.6	75.2	78.3	76.6
93.2	97.8	101.4	76.8	78	78.4
91.2	97.6	102.1	76	77	77
94.4	97.6	101.9	76.4	76.8	77.2
93.6	104.4	101.6	78.3	76.2	77.8
93.5	94	99.6	77.1	76.5	76.3
93.5	93.5	101.3	77	74.2	76.4
93.9	93.7	101.7	77.3	76.7	77
93.8	98.7	101.4	77.5	76.4	76.6
92.8	99.3	101.9	75.9	75.3	77.8
88.4	100.7	101.9	76.4	76.7	77.8
90.6	100.5	101.7	76.8	77.8	77.5
97	100.6	101.1	76.4	76.4	76
95.8	100.9	97.9	78.3	77	76.9
94	100.8	99.1	76.8	76.5	77
95.9	100.5	101.2	77.6	77.1	78.5
98.4	100.4	101.9	77.6	76.8	78.4
98.4	99.9	102.8	77.9	76.5	78.6
97.7	100.5	103.4	78.3	77.5	77.3
99.2	99.4		76.7	77	
92.2	100		78.1	76.4	
90.2	101.5		78.2	75.5	

4.11.1 STUDY ON THE ATTENUATION LEVEL OF EARPLUG

Table 4.19: Comparison of Noise level dB(A) at Various frequencies with and without PPE

500 Hz		1000 Hz		2000 Hz		4000 Hz	
Without PPE	**With PPE**	**Without PPE**	**With PPE**	**Without PPE**	**With PPE**	**Without PPE**	**With PPE**
46	35.7	72.8	53.7	55.3	54.2	74.1	51.5
45.6	43.4	71.6	67	69.8	66.9	72.9	63
42.6	43.3	69	66.8	70.3	66.1	65.8	61.8
42	42.6	68.4	66.5	70.4	66.4	63.8	61.6
41.8	42.2	69.6	66.1	70.4	66.5	62.9	61.7
41.9	42.6	68.7	67.3	70.5	66.9	62.5	61.2
43.4	43	69.7	66.9	76.1	66.1	64.7	60.9
48.1	43.2	73.6	67.8	76.7	67.2	77.7	62.2
53	44.2	77.2	68.2	80.9	67.2	83.5	63.7
55	44.1	79.3	68.2	81.8	68.3	86.1	64
55.6	43.7	79.8	67.8	83.4	68.2	86.9	64.4
55.3	44.5	80.4	68.6	85.6	68.2	86.4	64.3
55	44.3	80.7	68	86.4	68	86.9	64.2
55.9	44.5	80.8	68.2	86.9	68.1	87.1	64.1
55.3	45.4	80.2	68.2	87.2	68.2	87.1	64.6
54.7	44.9	80	67.9	87.4	68	87.2	65.1
54.9	44.5	79.7	68.2	87.4	68.1	86.3	64.5
54.9	44.6	80.5	67.9	87.5	68.3	85.8	64.4
55	44.6	80	68.8	88.1	68.4	85.8	64.6
54.6	45.3	80.4	68.3	88.1	68.7	85.4	64.2

54.8	44.9	79.9	68.5	88.5	68.4	86.8	64.4
54.6	45.2	79.7	68.3	88.6	68.8	85.1	64.5
55	45.6	79.9	68.4	88.8	68.7	85.4	64.2
54.6	46.2	79.7	69.3	88.9	68.5	85.6	64.6
54.5	45.7	79.3	68.6	89	68.6	85	64.3
54.3	46.2	79.2	68.8	89	68.2	84.8	64.2
54.3	45.7	78.3	68.5	89.1	67.8	86.8	63.9
51.8	45.9	75.2	68.4	89.4	67.1	82.9	65.3
53.5	45.8	76	67.9	89.4	66.8	84	64.8
49.2	45.1	72.5	68.4	89.4	66.7	79.9	65.1
53.2	44.9	75.7	67.3	89.5	66.8	85.1	64.5
54.2	45	77.7	67.4	89.5	66.8	86.8	64.6
55.3	45	77.4	67.3	89.6	66.5	86.8	65.2
55.2	45	80	67.5	89.7	66.8	87	65.5
55	44.9	79.9	67.6	89.8	67.3	87.5	64.7
54.4	44.5	79.7	68	90	67.6	88.3	64.8
55.1	45.6	80.1	68.5	90	67.4	88.5	65.6
55.5	45.8	79.6	68.8	90	67.6	87.4	66.2
54.5	45.9	78.1	68.6	90.1	67.5	85.7	65.6
54.5	46.7	77.5	69.1	90.3	67.1	85.5	65.4
56.1	45.8	80.2	68.8	90.3	67	89	65.4
55.7	45.5	80.8	68.7	90.4	67.5	89.6	66.3
55.7	47.5	80.1	69.3	90.4	67.4	88.8	66.3
55.8	45.4	79.5	68.2	90.5	68.4	88.8	65.6
56.5	45.3	79.7	68.2	90.5	67.8	89.2	66.3
56.5	45.3	79.9	68.1	90.5	68.1	88.8	65.3
56.1	44.9	80	67.7	90.6	68.4	88.9	65.7
54.6	44.8	79.7	67.7	90.6	68.4	89.7	65.7

54.4	44.4	79.2	68.1	90.7	68.3	89.3	65.8
55.4	44.2	78.8	67.9	90.8	67.9	88.2	66
55.9	44.9	78.8	68	90.9	67.9	88.1	65.1
55.2	45.4	79.2	67.6	90.9	67.6	87.8	65.1
54.6	44.8	80.8	67.8	90.9	68.4	88.1	65.2
55.5	44.4	80	68	91.5	68.7	89.1	64.6
55.5	44.8	80.4	67.4	91.6	69	89.1	65.2
56.4	45.2	80.8	67.7	91.8	68.8	90.5	65.2
56.1	45.2	80.6	67.6	91.9	69.1	89.6	65.5
56.4	45	81.2	67.6	92	68.5	90.3	65.1
56.1	45.8	82	68.3	92.1	68.3	89.5	65.8
56	45.9	82.3	68.3	92.1	68.7	89.9	65.2
56.4	46	82.2	68.5	92.2	68.6	88.9	64.8
55.7	46	82.3	69.3	92.3	68.7	89.8	64.7
55.9	46	82.2	68.5	92.4	68.2	89.1	65.1

It was observed from the table 4.17 and 4.18 that the attenuation of the earplug using sound level meter is 18.95 dB(A) and 20.89 dB(A) respectively. Besides, from the table 4.19, the attenuation of the earplug for 1000 Hz, the attenuation was 10.52 dB(A), for 2000 Hz, the attenuation was 19.40 dB(A) and for 4000 Hz, the attenuation was 20.37 dB(A). 3M 1110 corded ear plug was used inside the loom shed. **Its SNR value is 37. The estimated attenuation of the 3M 1110 corded ear plug is 33 dB(A). After wearing this ear plug, noise was experienced to be significantly reduced.**

4.12 SUMMARY

The entire study is summarised below.

- The prevalent power looms existing at decentralised units (household levels) in Tharamangalam are second hand shuttle looms, which is already an obsolete technology.
- Further, the efficiency of such second-hand shuttle looms in terms of productivity and energy consumption is very low. The high energy consumption leads to other environmental impacts
- The State Government is providing subsidy for electricity
- **The main source of noise in the shuttle loom is shuttle movement for weft motion and the cumulative noise level at source (loom) is 99 to 100 dB(A) which reduced to ambient level of 93 dB(A) at 6 to 7.5 m and 55 dB(A) at 30 m distance from the centre point of loom.**
- Therefore, in order to eliminate the source of noise and also improve the efficiency, conversion of shuttle loom into shuttle less loom is recommended. Though there are different types of shuttle-less looms such as rapier looms, air jet looms, water jet looms and projectile looms, the conversion into rapier loom is preferable, since the conversion can be done at existing shuttle loom at low cost itself without greater modification.
- Modified Rapier looms generate maximum of 88 to 90 dB(A) of noise compared to existing shuttle loom, which is at least 10dB(A) less than that of later. The noise level reduced to 65 dB(A) at 6 to 7.5 m distance from the centre point of rapier loom.
- The frequency range of noise generated by rapier looms are 1000 Hz-2000 Hz, which can cause less impact on hearing than that of shuttle loom, which was in the range of 2000 to 4000 Hz.

- The occupational noise exposure was atleast 10 dB(A) lesser in case of modified rapier loom than that of existing shuttle loom
- Modified rapier looms provide two folds productivity than existing second-hand shuttle loom at a same time of operation and consumes 50% less energy than the existing shuttle loom for same productivity.
- Therefore, in-situ upgradation of shuttle loom into shuttle-less rapier loom will be a better option for not only noise control, but an integrated approach on social, economic and environmental issues faced by obsolete but prevalent shuttle looms at decentralized units.
- Schemes with appropriate subsidy by State and Central Governments for conversion of the looms may be convincible to economically weak weavers. Such one-time support may make positive impact on energy consumption, its relevant environmental impacts and subsidy for electrical consumption
- As these decentralized, small scale shuttle looms are operated within houses of the loom owners, provision of enclosure for loom are not practically feasible, as loom operation requires frequent inspection and space constrain within living space.
- Though acoustic absorptive materials are used in walls, the doors and windo ws will act as sound escaping route.
- A two-step barrier, one at loom room entry, UPVC panel door with partly glazed (for natural lighting), followed by 3mm transparent PVC strip at main entry has reduced the noise level up to 30 dB(A) immediately at outside the shed (6 to 7.5 m) and the noise is found to be 63 dB(A) and the ambient noise was found to be 50 dB(A) at 30 m distance.
- Individual Noise Exposure at Shuttle loom exceed the exposure limit for 8hrs. Use of earplugs as PPE found to decrease individual noise exposure to at least 20 dB(A)

CHAPTER 5

CONCLUSION

The main cause of the noise in conventional shuttle loom is shuttle movement. Upgradation of obsolete shuttle loom into shuttle less loom followed by proper sound proof barrier at doors and windows with transparent materials will reduce the ambient noise level to CPCB standards for residential units at 6 to 7.5 m distance from the looms.

Though individual's noise exposure exceeds the exposure standards, the loom owners are not having awareness on its effect due to either adapted to the noise or fear of losing the livelihood if they accept that the loom is noisy. Hence use of affordable PPEs such as ear plugs shall be made mandatory for the operators by conducting awareness programmes and medical camps through their associations.

The State and Centre Governments may formulate new scheme or review existing scheme for modernization of shuttle loom with appropriate subsidy or loans.

19/11/24

Dr. S. KARTHIKEYAN, M.E., Ph.D.,
Professor
Centre for Environmental Studies
Anna University, Chennai-25

Dr. S. KANMANI, B.E., M.E., Ph.D.
PROFESSOR AND DIRECTOR
CENTRE FOR ENVIRONMENTAL STUDIES
ANNA UNIVERSITY, CHENNAI-600 025.

REFERENCES

1. Prahalad S. Badkar , M. M. Benal (2020) **"Suppression of Vibration and Noise of Picking Mechanism in Power Loom"**, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020.
2. Sadao Aso, Rikuhiro Kinoshita, Heihachi Uematsu and Kiyohumi Sasaki (1965) **"Noise Generated by a Power Loom"**, Based on Journal of the Textile Machinery Society of Japan, Transactions, 18, T13-19 (1965)
3. Report on Status of Powerloom Sector in Tamilnadu - **Focus on Modermisation** - Textile Committee, Govt. of India, Chapter 4, Ministry of Textiles.https://texmin.nic.in/status-powerloom-sector-tamilnadu-focus-modermisation-textile-committee-govt-india
4. Report on **Handlooms, Handicrafts, Textiles and Khadi Department**, Policy Note 2022-2023.
5. Nazire Deniz Yilmaz, R. Padhye and R. Nayak, **"Design of Acoustic Textiles: Environmental Challenges and Opportunities for Future Direction, Acoustic Textiles"**, Textile Science and Clothing Technology, Springer science, 2016, DOI 10.1007/978-981-10-1476-59
6. Amos, AE; Olisa, YP; Kotingo, K; **"Design and Performance Evaluation of a Soundproof Enclosure for a 2.5kVA Generator"**, J. Appl. Sci. Environ. Manage. Vol. 22 1975–1978, December 2018, https://dx.doi.org/10.4314/jasem.v22i12.18
7. K. Ricci, B. Lecrenier, G. Kouroussis, **On the design of an enclosure to minimise noise produced by heavy industrial machines**, Proceedings of the 25th International Congress on Sound and Vibration, Hiroshima (Japan), July 8–12, 2018.
8. David A. Bies, Colin H. Hansen and Carl Q. Howard, **"Engineering Noise Control"**, Fifth Edition, 1996.

9. C. Singh, M Kumar and M L Chandravanshi, **Evaluation of Noise Absorption Capacity of Various Materials,** Materials Science and Engineering 893 (2020) 012004 doi:10.1088/1757-899X/893/1/012004
10. M.K. Talukdar, **"Noise pollution and its control in textile industries"**, Indian journal of fibre and textile research,vol 26, june 2001, p 44-49
11. **To study impact of imported second hand shuttlelesss looms under TUFS on domestic capital goods industry during XI plan**, national productivity council New Delhi (2013).
12. P. R. Lord,M. H. Mohamed **"An Analysis of the Picking Mechanism of a Textile Loom"** ASME Journal of Engineering for Industry, MAY 1975.
13. F. D. Hart, B. M. Patel, J. R. Bailey **"Mechanical Separation Phenomena in Picking Mechanisms of Fly-Shuttle Looms"** ASME Journal of Engineering for Industry, AUGUST 1976.
14. R.Sukanya Devi, S.L.Jhakan Prashad, P.Kuhan (2020) **"Noise Reduction in Shuttle Loom",** International Journal for Modern Trends in Science and Technology, 6(9S): 132-135, 2020
15. Veronika Gumanova, Lydia Sobotova, Tibor Dzuro, Miroslav Badida and Marek Moravec (2022), **"Experimental Survey of the Sound Absorption Performance of Natural Fibres in Comparison with Conventional Insulating Materials"** https://doi.org/10.3390/su14074258
16. New Innovation from Peenya helps Power looms shed noise, MS Ramaiah University, August 2017.
17. Aby Chummar, Soni Kuriakose, George Mathew, **"Study on Improving the Production Rate by Rapier Looms in Textile Industry"** International Journal of Engineering and Innovative Technology, Volume 2, Issue 7, January 2013.
18. Mohammed Mustaqueem, Ansari Nabeel, Shah Tabrez, Md. Farooque, Salman Shaikh, Arshad Rashid, **Converting Plain English Loom into Automatic Rapier Loom,** IJSDR, Volume 2, Issue 5, May 2017.

19. Hasanuzzaman, Chandan Bhar, **Indian Textile Industry and Its Impact on the Environment and Health: A Review, International Journal of Information Systems in the Service Sector,** Volume 8, Issue 4 , October-December 2016.

20. Patel Dhaval Rasikbha, **Design and analysis of picking & checking mechanism of shuttle loom,** IJARIIE-ISSN(O)-2395-4396, Vol-3 Issue-2 2017.

21. Bambang Suhardi, Muhammad Abdu Haq Navi & Rahmaniyah Dwi Astuti (2019) **Noise level analysis to reduce noise exposure at PT. IT,** Cogent Engineering, 6:1, 1666629, DOI: 10.1080/23311916.2019.1666629.

ANNEXURE – II

TAMIL NADU POLLUTION CONTROL BOARD

MINUTES OF MEETING HELD ON 18.12.2024, 11.00 A.M. AT TNPCB CORPORATE OFFICE, GUINDY ON THE FINAL REPORT OF THE "PILOT PLANT STUDY TO IDENTIFY DEVICE / TECHNOLOGY TO MITIGATE NOISE POLLUTION GENERATED FROM THE POWER LOOM" CONDUCTED BY THE CES, ANNA UNIVERSITY

Present:

TNPCB Officials		
1.	Thiru. R. Kannan	Member Secretary
2.	Tmt. M. Vijayalakshmi	Additional Chief Environmental Engineer
3.	Tmt. J. Josephine Sahaya Rani	Joint Chief Environmental Engineer
4.	Tmt. S. Malarvizhi	Joint Chief Environmental Engineer
5.	Thiru. S. Palanisamy	Joint Chief Environmental Engineer
6.	Thiru. D. Ragupathi	Environmental Engineer, O/o. JCEE (M) Salem Nodal Officer
7.	Tmt. K. Deivanai	Environmental Engineer, Corporate Office
8.	Tmt. R. Shalini	Assistant Engineer, Corporate Office
Experts from CES, Anna University		
1.	Tmt. S. Kanmani	Professor & Director
2.	Thiru. S. Karthikeyan	Professor

Preamble:

In compliance of the Hon'ble NGT (SZ) order dated 20.04.2023, the Board vide order dated 30.06.2023 allotted the "Pilot Plant Study to identify device / technology to mitigate noise pollution generated from the power loom" to the CES, Anna University, Guindy. The CES, Anna University, vide letter dated 19.11.2024 has submitted the final reports of the said study. The Board has requested the CES, Anna University, to make a presentation on the final report of the said study on 18.12.2024, so as to proceed further.

Discussion:

The Professor, CES, Anna University presented the summary of the entire study and concluded with the following:

1. The main cause of the noise in conventional shuttle loom is shuttle movement. Upgradation of obsolete shuttle loom into shuttle less loom followed by proper sound proof barrier at doors & windows with transparent materials will reduce the ambient noise level to CPCB standards for residential units at 6 to 7.5 m distance from looms.

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Tel : 044-22353134 - 139 Fax : 044-22353068
Email : tnpcb-chn@gov.in Web : tnpcb.gov.in

2. Though individual's noise exposure exceeds the exposure standards, the loom owners are not having awareness on its effect due to either adapted to the noise or fear of losing the livelihood if they accept that the loom is noisy. Hence use of affordable PPEs such as ear plugs shall be made mandatory for the operators by awareness programmes and medical camps through their associations.
3. The State and Centre Governments may formulate new scheme or review existing scheme for modernization of shuttle loom with appropriate subsidy or loans."

Further, the CES, Anna University has requested to release the balance payment, in view of submission of the final report and also requested to extend the study period until February 2025.

After detailed discussion, it was decided to accept the report submitted by the CES, Anna University and to release the 10 % of the remaining 20 % study cost and to extend the study period until February 2025. Further, it was decided to conduct a meeting with the other stakeholders like Power loom associations, Ministry of Micro, Small and Medium Enterprises (MSME), Tamil Nadu Small Industries Development Corporation Limited (TANSIDCO) etc., to obtain their view / suggestions on the recommendation of said study report and to take necessary action on implementation of the recommendations of the said study.

With the above discussion, the CES, Anna University was requested to coordinate with the TNPCB for the proposed stakeholders meeting and until the final submission of the report to be submitted before the Hon'ble NGT(SZ).

27/12/2024

For Member Secretary

27/12/24

Copy to:
The Director,
Centre for Environmental Studies,
Department of Civil Engineering,
College of Engineering Guindy,
Anna University, Chennai - 600 025.

BEFORE THE HoN'BLE NATIONAL GREEN TRIBUNAL, SOUTHERN ZONE AT CHENNAI

Original Application No. 103 of 2020

IN THE MATTER OF:
Tribunal on its own motion Suo Motu.

And

The District Environment Engineer,
Tamil Nadu Pollution Control Board & Others.

.....Respondents.

ADDITIONAL REPORT FILED ON BEHALF OF THE FIRST RESPONDENT – TAMIL NADU POLLUTION CONTROL BOARD.

Advocate for Respondent: TNPCB
Thiru.Sai Sathya Jith,
Advocate, Chennai.

Date:20.01.2025

Date of Hearing on:21.01.2025