THE ACOUSTIC TREATMENT & SPEECH INTELLIGIBILITY QUALITY ANALYSIS OF MASJID UTeM USING ADVANCE TOOL SIMULATION AND MEASUREMENT

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Signature : ……..…

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I want to dedicate this to my family, especially my mother who always gives her support and understanding during my studies. A million thank you to my father for his financial support mainly. Last but not least, to my colleagues and lecturers for their help and suggestion in order to fulfill this research

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ABSTRACT

The final year project is a requisite subject for engineering students towards completing the Bachelor Degree program. The final year project is exposed to observe students what they have learned in four years at university, thus relates the theoretical and technical knowledge with the relevance in the final year project. Right through the final year project, students were projected to successfully enhancing their skills in technical, communication, management time, creativity as well as able to give personal ideas or opinions. For a mosque in UTeM, the acoustical requirements in terms of intelligibility and liveliness are dissimilar for the types of sounds-recitation and speech on religious subjects. To attain an overall satisfactory acoustical performance, it is significant to find an optimum Reverberation Time (RT) and the best directivity, which is the major factors affecting intelligibility and liveliness. Experiment is conducted to find the effect of RT by making it a variable, while keeping other factors as non-variable and fulfilling ideal conditions for maximum intelligibility. Bearing in mind, the acoustical problems always occurred in acoustical building. To improve the problem, this researched is come out with the new idea of solution by using biodegradable sound absorber materials which is the mixture of Dried Rice Straw and *Kekabu*. All the outputs is represent by using DPlot Simulation.

ABSTRAK

Projek tahun akhir merupakan salah satu mata pelajaran wajib bagi pelajar kejuruteraan untuk melengkapkan program Ijazah Sarjana Muda. Projek tahun akhir menentukan dan memastikan pelajar apa yang telah mereka pelajari dalam tempoh empat tahun di universiti, sekali gus mengaitkan pengetahuan teori dan teknikal dengan permohonan dalam projek tahun akhir. Melalui projek tahun akhir, pelajar dijangka berjaya meningkatkan kemahiran mereka dalam bidang teknikal, komunikasi, pengurusan masa, kreativiti, serta mampu untuk memberi idea atau pendapat peribadi. Melalui kajian di masjid UteM, keperluan akustik dari segi kejelasan dan keberkesanan adalah berbeza bagi jenis bacaan, ucapan tazkirah mahupun azan. Untuk memastikan prestasi akustik memuaskan, adalah penting untuk mengenalpasti RT yang paling optimum dan keberkesan pembesar suara yang terbaik, ini kerana kedua dua aspek ini yang merupakan faktor utama yang mempengaruhi kejelasan dan keberkesanan sesuatu bunyi. Eksperimen dijalankan untuk mengkaji kesan RT dengan menitikberat faktor luaran demi mendapatkan kejelasan bunyi yang paling maksimum. Setiap bangunan tidak pernah terlepas dengan masalah akustik. Untuk mengatasi masalah ini, kajian ini telah menggunakan idea baru bagi penyelesaian masalah akustik tersebut iaitu dengan menggunakan bahan-bahan mesra alam sebagai penyerap bunyi seperti campuran Jerami Padi dan Kekabu. Semua hasil dapatan kajian di nyatakan dan diilustrasikan dalam simulasi DPlot.

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CHAPTER 1

INTRODUCTION

Praying and lecturing, this both activities are mainly related to the speech which is important part of services in Mosque. However, an acoustical problem in the intelligibility of speech is the general rule in this type of building that may isolate our ability to recognize speech. Therefore, the purpose of this paper is to study the acoustical treatment and speech intelligibility quality analysis of Masjid UTeM using advance tool simulation and measurement.

1.1 Background study

The concept idea of the acoustic treatment & speech intelligibility quality analysis in different dimension rooms in Masjid UTeM are a eminence of sound distribution. The importance of loudspeaker directivity in respect of speech intelligibility will represent.

There are several numbers of acoustical parameters that can gauge the quality of sound. In a very limited budget, one of the parameter where practically used is loudspeaker. The arrangements of loudspeaker affect the sound distribution. This can be interpreted in terms of directivity factor. The propagation of sound also varied accordingly to room shape and the volume of room. For that reason, the relations between loudspeaker and sound propagation can be quantified in terms of directivity.

The other way to get a good sound production is sound absorber. In this project, the Dried Rice Straw *(jerami padi)* & *Kekabu* are used to find out either both material is a good sound absorber or not.

1.2 Objectives of the Study

The objectives of the project are as following:

i. To study the effect of directivity on speech intelligibility with respect to room sizes and loudspeaker configuration.

ii. To find out the correlation between sound pressure level (SPL) and reverberation time (RT) due to directivity configuration of speech intelligibility.

iii. To observe the absorption coefficients of two sound absorber which is Dried Rice Straw*(jerami padi)* and *Kekabu*

1.3 Problem Statement

This project is proposed to overcome the production of echoes that occur in entire room of Masjid UTeM. Due to that, the listeners cannot reach the maximum accuracy of speech while being in the mosque. The production of high sound

pressure level in acoustic wave makes it possible to achieve good speech intelligibility. Hence, this project wished for conquer the production of high sound pressure level.

Nowadays, the used of synthetic materials as sound absorber is still applied extensively. The used of the synthetic material also known as non-biodegradable material may cause pollution to the environment. Therefore, the researcher studies on the problems and came out with the idea using waste materials, dried rice straw (*jerami padi)* and *kekabu* which much cheaper as sound absorber.

1.4 Scope of project

The scopes of the project are as follows:

i. Rectangular room is used for experimentation in two different volumes and dimension.

ii. Directivity is investigated by three directivity configuration on Sound Pressure Level (SPL) and Reverberation Time (RT). Three loudspeaker directivity configuration.

iii. There are few points in room's dimension is chosen to identify SPL and RT

iv. Calculate total absorption coefficient of dried rice straw and *kekabu.*

1.5 Project Methodology

This part will cover five main things to fulfil this research which are description of methodology, step of measurements, room's layout and software simulation.

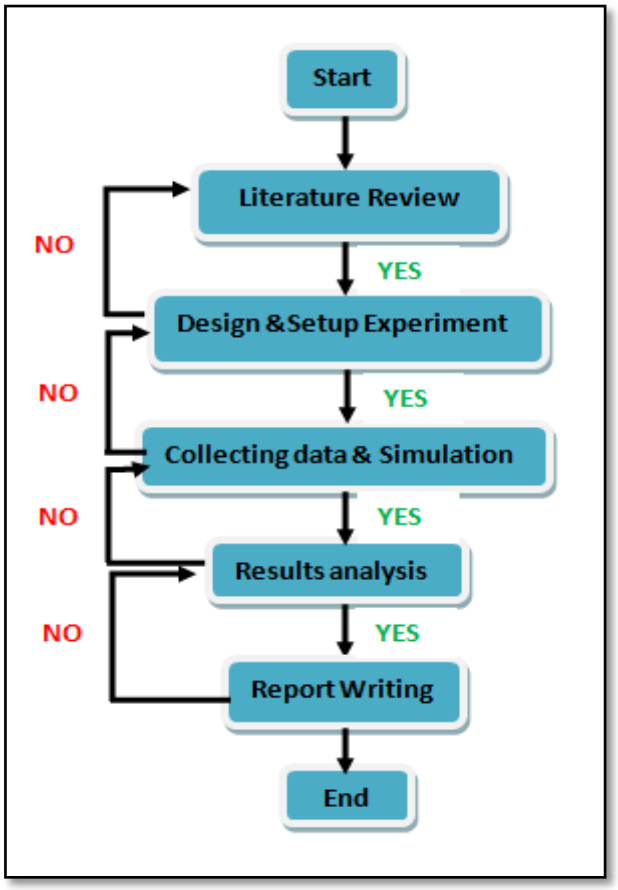
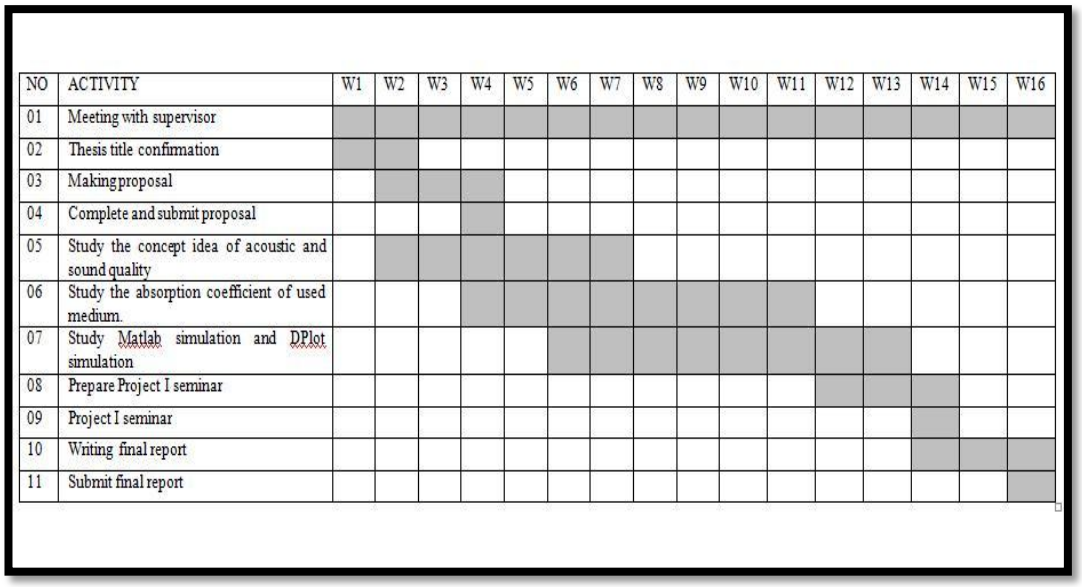
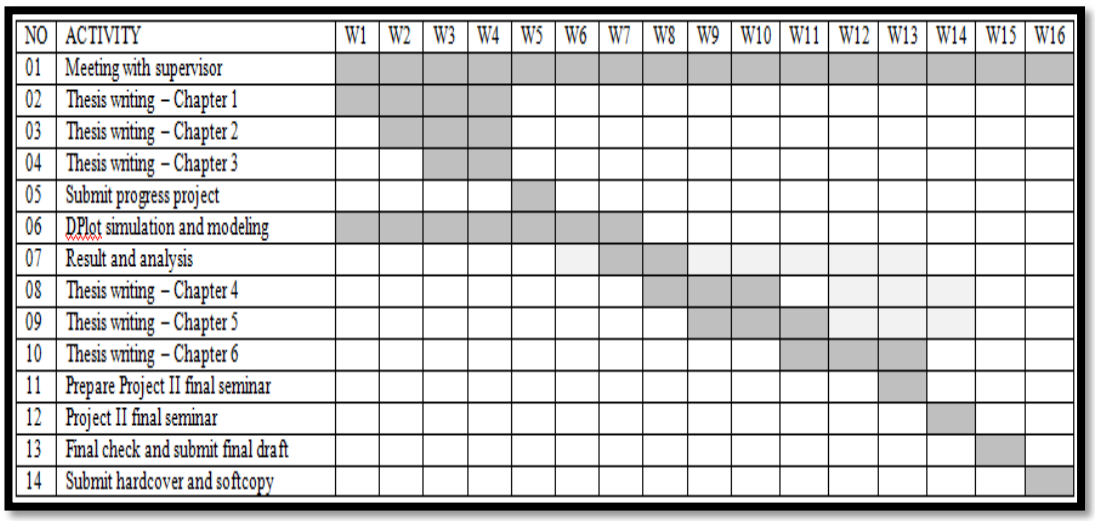


Figure 1.1: The overall process of project



NO	ACTIVITY	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
01	Meeting with supervisor																
02	Thesis title confirmation																
03	Making proposal																
04	Complete and submit proposal																
05	Study the concept idea of acoustic and sound quality																
06	Study the absorption coefficient of used medium.																
07	Study Matlab simulation and DPlot simulation																
08	Prepare Project I seminar																
09	Project I seminar																
10	Writing final report																
11	Submit final report																

Figure 1.2: PSM 1 Gantt Chart



NO	ACTIVITY	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
01	Meeting with supervisor																
02	Thesis writing – Chapter 1																
03	Thesis writing – Chapter 2																
04	Thesis writing – Chapter 3																
05	Submit progress project																
06	DPlot simulation and modeling																
07	Result and analysis																
08	Thesis writing – Chapter 4																
09	Thesis writing – Chapter 5																
10	Thesis writing – Chapter 6																
11	Prepare Project II final seminar																
12	Project II final seminar																
13	Final check and submit final draft																
14	Submit hardcover and softcopy																

Figure 1.3: PSM 2 Gantt Chart

1.6 Report Outline

This report consists of three chapters, which describe the entire process of the research work. The outlines of the report are as follows:

Chapter 1 reviews the background of the research, objectives, problem statement and followed by scopes of work and report outline.

Chapter 2 highlights the details of the project comprises literature review and theory pertaining to the reason of idea outcome of the project.

Chapter 3 discussed the research methodology and the measurement processes that have been made of the study.

Chapter 4 summarized the result findings and discussed for every results due to objectives.

Chapter 5 conclude the overall process of researched and points out the objectives of the researched are achieved or not.

CHAPTER 2

LITERATURE REVIEW

There are several criteria we need to consider in order to produce good intelligibility of speech. In any room, acoustics awareness is the needs to better perception of speech. Therefore, in this chapter we discuss the aspects of acoustic in production of high quality of speech.

2.1 Directivity of Acoustic

The ability to transmit or receive sound waves is more strongly in some directions than in others. The directivity is determined by the interference of coherent sound vibrations that arrive at some point of the medium from individual sections. In this study, the directivity is caused by the interference of pressures on the surface of the receiver.

Speech sounds do not have a same potency in all directions (Everest, 2001). Mouth is one of the paradigms of speech sources. Mouth is a continuous source of speech sound. The sound source can be characterized by their power and directivity. Frequency is an essential of speech intelligibility and this should be scattered in the same way in form of directions of all the listeners (Esterhuizen, 2007).

The important of the directivity is to signify the direction of the sound generated by voice in the direction we want it to go. There are three directivity configurations which is directivity factor, directivity index and directivity of loudspeaker. Refer to Rossing *et al.* (2002), the directivity factor, Q is defined as the ratio of the sound intensity at the distance, r in front of a source to the sound intensity averaged over all directions.

Table 2.1**:** Monopole sound source Q and d at various locations (Rossing *et al.*, 2002**)**

Source Location	Directivity factor, Q	Directivity Index, d (dB)
Between floor and ceiling	1	0
Flat Surface	2	3
Intersection of floor and wall	4	6
Corner of room three plane	8	9

Directivity factor, D or Q factor :

$$D = \frac{I}{Io} \qquad (2.1)$$

Directivity Index, d :

$$\mathrm{d} = 10 \log D = 10 \log \frac{I}{Io} \quad (2.2)$$

Where :

I = Sound Intensity measured at distance, r

Io= Comparison sound intensity at distance, r

Io= $\frac{W}{4\pi r2}$

W= Energy produced by respected sound source

Table 2.1 shows the indicator of directivity factor and directivity index due to different locations. Refer to equation (2.1), the directivity index is obtained in unit decibel (dB). The mathematical expression of directivity factor relies on the directionality of sound source. The sound that radiates equally in all directions (a spherical source) has a directivity factor Q which is equal to 1. This theory shows that the sound is well distributed and maybe the production of the echoes happens here. Based on the table 2.1 the hypothesis can be made, the larger value of directivity factor the higher the directional sources.

2.2 Directivity of loudspeaker

As discussed in 2.1 the definition of directivity elsewhere in general terms. In loudspeaker system, the directivity is the characteristic of how a loudspeaker distributes sounds in different directions. It also an indication of how directional the loudspeaker is. Loudspeaker with wide bandwidth, flat and smooth magnitude and uniformly wide directivity are more preferred as to direct sound to the target point (Olive, 2003). Bass frequencies have very long wavelengths which make it difficult to control the direction they travel.