# Gender’s Perception: Does the rain noise generated underneath metal deck roof system affects occupants comfort?

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## Abstract

Occupants’ perception towards the value of indoor environment has always been a crucial issue. Having a good quality in an indoor environment influences the way occupants’ behave in their daily activities. Moreover, there are differences on the gender perspective on how they perceive the value of indoor environment. However, gender perception towards rain noise effects in relation to students’ activities has been overlooked until today. From the findings it can convey beneficial information regarding the quality of life towards students’ living. Conclusively, the overall finding reveals those female students are more annoyed compared to the opposite gender.

Keywords: Rain noise; metal deck roof system; perception; gender differences; student activities


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## 1,0 Introduction

There are a lot of studies related to noise effects in relation to gender differences. Due to the diversity in the range of sound frequencies, it makes a difference in subjective response. Based on previous studies related to subjective responses on noise, they merely focused on mechanical instrument, electronic appliances and vehicles. However, there are no such studies on the effect of gender differences towards sound or noise impact beneath building elements such as roof or floor system.

Drop impact from the rain generated underneath roof system significantly triggers ambient noise in a building. In fact, most of the countries located under tropic region and adapted lightweight roof system in their roof system arefaces serious acoustic problem when come to rainy days. Malaysia is one of the countries that received highly rainfall intensity per year. The Department of Metrological, Malaysia (2010) in Penang and Petaling Jaya recorded that on "18 May and 7 June 2010", Kuala Lumpur and Penang areas received heavy rain between 20 to 32mm/hr (about 6 hours raining non-stop to give equivalent 120mm to 192mm rain) which caused instant flood on those areas. The Department of Metrological, Petaling Jaya (2010), Malaysia also recorded the total rainfall in year 2010 was 3,652mm with the number of rainy days was 233. It seemed it rained on every alternate day!

Since this study involves subjective and physical measurement, the objectives of this paper are divided into twofold. First to evaluate gender differences towards rain noise problem in relation to student activities. Second to measure real time rain noise measurement at building apartment fixed with metal deck roof system.

### 1.1 Previous findings on gender differences

Within the last few years, gender perception towards noise exposure has become a crucial issue of debate amongst researchers. In fact, most of the researchers concur that there were gender differences exposures on noise effects. Hunter et al (2005) and Michaud et al (2008) discovered that females are more sensitive towards noise exposure compare to the males. However, there are some arguments on gender differences related to noise effects. According to Zimmer and Ellermeier, (1999) and Bluhm (2004) there are no such differences between noise and gender.

### 1.2 Previous findings on rain fall noise underneath metal deck roof system

According to Suga and Tachibana (1994) noise level generated by the rain fall underneath un-insulated metal deck roof is up to 70dB. Meanwhile, Idris et al (2012) discovered that rain noise impact underneath un-insulated metal deck roof system can reach 90dB. Even though, there are varieties of noise levels, sound created by the rain fall beneath roof system significantly contribute to the serious acoustic problem in a building (Andy et al, 2007).

Indeed, Philip et al (2010) pointed out the greater proportion of rain intensity the higher sound pressure level beneath roof system could be created. Moreover, Carter et al, (2002) added that rain noise problem may increase indoor ambient noise in a building. Besides that, these problems also can interfere with (i) speech pronunciation, (ii) quality of communication and (iii) listening problem (Andy et al, 2007). In fact, rain noise problem also can be considered as the most irritating noise in human life (Lee, 2004).

### 1.3 Students' life and their activities

Nowadays, students' life and their activities has become prime concern. Where, most of the students who are studying in public and private universities have to live or rent at the outside campus (off-campus). Due to (i) the increasing of universities students, (ii) the limitation of the hostel and facilities as well as (iii) universities policies, most of the students have to find their own house to live. Hence, low and medium cost housing has become their preferences due to the rising of living cost. However, the issue is how off campus students perceived value of indoor environment? Numerous scholarly studies related to students' life have highlighted on the socio-economic (Najib et al, 2011), housing satisfaction (Thomsen, 2008) safety, and facilities parameter (Amole, 2009). In fact, most of the previous studies merely focused on on-campus living environment rather than off-campus living environment. Moreover, student satisfactions towards indoor environment are merely emphasized on the thermal comfort Kadiri and Okasun, 2006; Dahlan et al, 2011) rather than the other comfort parameter.

On top of that, student activities also can be used to identify comfort level in an indoor environment. Daily student activities for instance studies, conversations, doing assignments, surfing internet, rests and sleeps (Idris et al, 2012) was common activities that have been done by the student in their hostel or rented houses. Basically most of the activities will be disturbed when they face common unpleasant condition for instance (i) unwanted sound comes through many paths of building element as well as (ii) the level of temperature is higher. However, since this study focused on the rain noise impact; therefore, unwanted sound created by the rain noise underneath metal deck roof system are crucial.

## 2.0 Methodology

This study employs quantitative approach where subjective and physical measurements are used to derive the data collection. Subjective measurement is used to gather the information on subjective responses towards gender differences related to the rain noise problem while, physical measurement is used to obtain the range of noise generated underneath metal deck roof system. This study focuses on the responses of gender differences towards noise issues governed by rain fall generated underneath metal deck roof system at building under-studied. The overall methodology of this research comprises of four stages which is briefly discussed in Table 1.

Table 1. Sequences of research methodology

| Step | Progress |
|---|---|
| Step 1: | To survey buildings in Shah Alam that fixed with metal deck roof system. It was found that apartment buildings at Seksyen 8, Seksyen 6, Seksyen 17, Seksyen 24 and Seksyen 16, are fixed with these types of roof system. |
| Step 2: | A set of the questionnaire were distributed to students who live/rent on the top floor of the buildings using random sampling. |
| Step 3: | To measure the rain noise received or heard in the centre of the living rooms of selected apartments. |
| Step 4: | To analyse the results of the questionnaire and physical measurements. |

## 3.0 Findings and Analysis

Previous studies related to the gender differences often utilize subjective responses in order to get the overall findings (Shepherd et al, 2010). However, there are few studies measured both measurement i.e. physical and subjective measurements. Fransson et al (2007) pointed out the findings will be more accurate and reliable of using both subjective and physical measurement.

### 3.1 Subjective measurement – evaluation on gender differences towards rain noise problem in relation to student activities

Apparently, a subjective response towards noise issues has become a crucial issue. Previous studies indicated that *noise disturbances, noise effects*, *annoyances*, *comfort* and *productivities* are usually used to measure the noise effect towards human life (Idris, 2012; Kin et al 2009). However, there are varieties in subjective responses and the findings significantly can be used to enhance the quality of human live.

According to Diener and Eunkook (1997) subjective responses on noises depend on human experiences, and it had become accurate when the measurement also emphasized on human experiences. Thus, this study attempts to investigate subjective responses towards rain noise effect in relation to student activities. Based on the data collection gathered from cross sectional survey, a total of 190 completed questionnaires were deduced based on means score and independent-sample t-test.

Table 2. Males and females perception towards rain noise effect in relation to their activities.

| Ranked | Activities | Means | Ranked | Effects | Means |
|---|---|---|---|---|---|
| ***1*** | ***Conversation*** | ***3.83*** | ***1*** | ***Communication*** | ***3.80*** |
| 2 | Study | 3.39 | 2 | Unfocused | 3.54 |
| 3 | Assignment | 3.31 | 3 | Stress | 2.90 |
| 4 | Internet and Rest | 2.45 | 4 | Sleep | 2.35 |
| 5 | Sleep | 2.34 | 5 | Health effects | 1.49 |

Table 2 contains both of males and females perception towards the rain noise effect in relation to their activities. It was observed that both of the gender concurred that conversation activities (mean=3.83) is the most influential factor that was disturbed when its rain. On top of that, when asked them about the main effect of rain noise created underneath metal deck roof system, both of the gender ranked communication problem (mean=3.80) as a main effect of rain noise. Based on the previous studies (Idris, 2012; Lee, 2004; Andy 2001) claimed that sound generated by rain noise amplified with metal deck roof system significantly reduces speech clarity which contributed to communication problem in a building.

Besides communication problems, concentration on the study and doing assignment also had been disturbed with the mean scores of 3.39 and 3.31 respectively. In fact, both of the gender having unfocused and stress effect with the mean scores of 3.54 and 2.90

respectively. From these findings, it can be summarized that both of the gender are aware and sensitive about rain noise even they are concentrate with their studies.

The rest of activities such as surfing internet (mean=2.45) and sleep (mean=2.34) were a response as the least influential disturbance activities. Besides that, when asked them about sleep (mean=2.35) and health effects (mean=1.49), both of the gender agreed that it gives a minimal effect in their daily activities. The fact that noise can create an adverse effect on human development resulting in reduction of human well being is well known. According to the Paunović (2009) the effect of noise usually can trigger serious psychological, physiological and social effects. However it depends on the noise range and duration they are exposed too.

Table 3. Gender differences towards annoyance, comfortable and productivities level towards rain noise problem

| Overall Effects | Gender | N | Mean | t-test | Effect Size (eta squared) |
|---|---|---|---|---|---|
| **Annoyance** | Male | 108 | 3.06 | 6.868 | .20 |
| | Female | 81 | 4.09 | | |
| **Comfortable** | Male | 108 | 2.70 | .033 | .005 |
| | Female | 80 | 2.17 | | |
| **Productivity** | Male | 108 | 2.31 | .141 | .005 |

Table 3 indicates the t-test analysis for overall perception towards annoyances, comfortable and productivities level on the rain noise problem in relation to gender differences. It can be seen that, in overall both of the genders agreed that they are significantly annoyed with unwanted sound created by the rain. An independent t-test was conducted to compare the differences between gender and it has been found that there are significantly difference in annoyances where scores for female students' (means=4.09, SD=1.285) are higher compared to the males students (means=3.06, SD=.745); t (6.868) = 47.16, p = .00 (two tailed). The magnitude of the differences in the means (mean difference = .810, 95% confidence interval: .546 to 1.074) was very high (eta square = .20). In fact, Idris et al (2012) discovered that there are positive co-varies has been found on annoyances and noise disturbances in relation to students' activities. These results reveal that rain noise significantly trigger serious annoyance effect in female students' activities. Luz, (2004) and Iwata, (1984) reported the similar findings but in differences noise sources where women are more sensitive compared to the opposite gender. However, it contrasts to Lundquist et al (2000) findings where they found that there are no gender differences between a boy and girl student on annoyances exposure related to students' activities.

Moreover, the difference between the gender in comfortable perception towards rain noise problem was .116, with a 95% confidence interval from -.110 to .342; the t test statistic was 1.016, with 186 degrees of freedom and an associated P value of P=.311. The effect size of the difference (eta square = .005) it was very small. This result indicates both of the genders are totally disturbed with the sound generated by the rain underneath metal deck roof system at their living area.

Finally when asked them about productivity level, rain noise probably does not give any effect to their productivities (2.31) with the magnitude of the differences in the means (mean difference = .140, 95% confidence interval -.153 to .433) was very small (eta square = .005). Even though they are annoyed and uncomfortable with the sound generated by the rain noise, it seems like it did not influence their productivity level.

### 3.2 Physical measurement - Real time rain noise measurement at selected buildings apartment fixed with metal deck roof system.

Excessive noise generated by the rain fall underneath metal deck roof system significantly increases ambient noise in an indoor environment (Ballagh, 1990; Carter et al, 2002; Idris 2012). In order to evaluate the performance of metal deck roof system, physical measurement is used to measure the range of noise created by the rain fall. Usually, physical measurements are more reliable compared to the subjective measurement because it only deals with the values generates by the calibrated instruments and follow related international procedures i.e ISO 140 Part 18 and ISO 140 Part 7. Physical measurements are only used as a supportive data to supported subjective responses. Since this study involves rain parameters, Classification of rain intensity according to MS IEC 60121-2-2 are used as a classification of rain intensities as shown in Table 4.

Table 4. Rain intensities classification. Sources:MS IEC 60121-2-2 2004 Classification of Environmental Conditions Part 2: Environmental Condition Appearing in Natural Precipitation and Wind

| Rainfall Type | Rainfall Rate (mm) |
|---|---|
| Moderate | Up to 4 |
| Intense | Up to 15 |
| Heavy | Up to 40 |
| Cloudburst | Greater than 100 |

Table 5 (a) and (b) contains the detail results of real time rain noise measurement underneath metal deck roof system against various rain intensities at the selected building apartments. According to Idris et al (2012) noise generated underneath un-insulated metal deck roof system can reach up to 90dB with the intensity of rain is 20mm (heavy rain). Bronzaft and Hangler, (2012) claimed that the acceptable noise level to human hearing sense is between 55-60dB and if it goes higher than that, it might trigger human hearing comfort as well as speech communication. The recorded rain noise level in an indoor environment is 69.9dB to 84.5dB indicating that the background noise in those buildings were extremely high (Table 5a). Since those building apartments understudied were fixed with metal deck roof system without proper insulation where it only covered with Meico Board ceiling, the occupants' inside the buildings might face serious acoustic problem when it rains.

Table 5. (a) Real time rain noise measurement against various rain intensities and (b) Noise level at (1/1) single octave frequency range

| Type of Building | Rain Intensity (mm) | (a) Maximum level of noise, $L_{eq}$ (dB) | Frequency | | | | | (b) Calculated SIL (dB) | Types of speech |
|---|---|---|---|---|---|---|---|---|---|
| | | | 500 | 1k | 2k | 4k | 8k | | |
| Apartment 1 | 20 (Heavy) | 82.7 | 77.4 | 74.4 | 69.2 | 63.2 | 53.3 | 73.6 | Shouting |
| Apartment 2 | 21 (Heavy) | 81.2 | 77.1 | 74.1 | 68.7 | 61.3 | 50.7 | 73.3 | Shouting |
| Apartment 3 | 26 (Heavy) | 84.5 | 76.2 | 78.0 | 72.3 | 69.2 | 70.2 | 75.5 | Shouting |
| Apartment 4 | 8 (Intense) | 83.6 | 71.5 | 66.2 | 60.8 | 54.6 | 47.1 | 66.1 | Raised |
| Apartment 5 | 9 (Intense) | 69.9 | 72.2 | 68.8 | 64.6 | 58.9 | 53.9 | 68.5 | Very Loud |

As mentioned in subjective findings, both of the gender ranked communication problem as the most influential activities were disturbed by the rain noise. Table 5 (b) contains the detail of calculated Speech Interference Level (SIL). Commonly, background noise levels in a building significantly contributed to the quality of speech communication.

The higher background noise in a building the more voice has to be raised in order to satisfy the acceptable speech communication between individuals. In order to evaluate the effect of background noise in relation to speech communication, speech Interference level (SIL) is calculated (Table 6). SIL is based on averaging the 500, 1000 and 2000Hz levels and describe in dB. Once the SIL is calculated, the ideals distance between speaker and the listener can be determined.

Table 6 contains the average noise level at frequency range of 500Hz, 1 kHz and 2 kHz for Apartment 1, 2, 3, 4 and 5 are 73.6dB, 73.3 dB, 75.5dB, 66.1dB and 68.5dB respectively. If the distance between the speaker and the listeners is 1 meter, the speakers either have to speak in raised voice or to speak very loud. Therefore, in order to have a clear conversation between speaker and listener according to the background noise as shown in Table 5b the distance will have to be more than 1.5 meters.

Table 6. Speech Interference Level. Sources; Pearson et al (1977)

| Distance (m) | Background Noise Levels (dB) | | | | | |
|---|---|---|---|---|---|---|
| | Whisper | Low | Normal | Raised | Very loud | Shouting |
| 0.25 | 41 | 56 | 67 | 73 | 79 | 85 |
| 0.50 | 36 | 50 | 61 | 67 | 73 | 79 |
| 0.75 | 32 | 47 | 57 | 63 | 69 | 75 |
| **1.00** | **29** | **44** | **55** | **61** | **67** | **73** |
| 1.50 | 26 | 41 | 51 | 57 | 63 | 69 |
| 2 | - | 38 | 49 | 56 | 61 | 67 |
| 3 | - | - | 45 | 51 | 57 | 63 |
| 4 | - | - | 43 | 49 | 55 | 61 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | - | - | 41 | 47 | 53 | 59 |
| 6 | - | - | 39 | 45 | 51 | 57 |

## 6.0 Conclusion

Obviously, there are gender differences on how they perceived value of indoor environment especially noise issues. In fact, level of noise sensitivity between genders also differs even though the findings are varied amongst researchers. When mention about noise issues most of the findings merely focuses on the psychological and sociological effects and only a few sentences or parts describe the gender in general

From the findings, both of the measurements are related to each other. Based on the subjective responses, sounds generated by the rain underneath metal deck roof system at building apartment significantly trigger negative reaction in students' activities especially conversation activities. On top of that, the t-test findings explicit those female students are more aware towards rain noise problem compared to the opposite gender.

These findings are supported by the results obtained from the real time rain noise measurements where noise level at (1/1) single octave frequency range level indicates that the higher level of rain noise were recorded at low frequency which is more than 70dB as shown in Table 5b. Basically, female is more sensitive to the noise range at low frequency compared to the opposite gender (Warring, 1983).

Moreover, most of the respondents' (both of the gender) concurred that they are annoyed and disturbed when it rains. This supported by the results as shown in Table 5a where most of the building apartments understudied were recorded the maximum level of noise Leq more than 70dB. Audible range of noise level inside a building is in the range of 55 to 60 dB (Bronzaft et al, 2010). If it goes higher than that, it might influence the quality of acoustic comfort in an indoor environment.

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