



AN ASSESSMENT OF THE EFFECTS OF ROAD
HUMPS ON TRAFFIC SPEED AND NOISE IN THE
RESIDENTIAL AREAS

BY

SITI SYAZWANI BINTI AHMAD SOFI

A thesis submitted in fulfilment of the requirement for the
degree of Master of Science (Built Environment)

Kulliyyah of Architecture and Environmental Design
International Islamic University Malaysia

JULY 2019

ABSTRACT

The installation of road humps in residential areas have calmed residential roads as they seem to have reduced the traffic speed along these roads. However, at drawback of road humps installation is that they cause nuisance due to the noise and vibration produced by the sudden acceleration and deceleration of vehicles. This study evaluates the effects of road humps on traffic speed and noise level in residential areas. The study was conducted for two different sets of road humps in Taman Setiawangsa and Keramat and measurement of the road humps and road profiles were done for each road. The speed of each vehicle and noise levels at selected points were measured by using a radar gun and noise level meters. The sample size for spot speed was determined by using a systematic sampling technique based on the collected 12-hour traffic volume survey done earlier. Satisfaction and perceptions of residents on traffic speed and noise were conducted through face to face interviews with randomly selected residents by using simple random sampling. Data were analysed using descriptive statistics, which described the changes in vehicles speed and noise levels along the selected roads, as well as taking into account the patterns of speed and noise levels. The differences in mean for both speed and noise levels were analysed by using T-test while correlation analysis was used to analyse the relationship between speed and noise level. As for the questionnaire data, descriptive analysis was applied to identify the residents' demographic and socioeconomic background while cross tabulation analysis was used to evaluate the perceptions and satisfaction of the residents. As expected, the results of the speed survey showed that the highest speed recorded was along Jalan Keramat with 28.75 km/h and the lowest was Jalan Setiawangsa 21, 14.35 km/h. Meanwhile, the highest noise level, 72.36 dB was recorded along Jalan Keramat and the lowest, 57.88 dB was recorded along Jalan Setiawangsa 21, affected by road humps characteristics, particularly height and width of the humps, have influenced the speed produced by the vehicles. This showed the significant relationship between traffic speed and noise and verified that the increase in speed resulted in high noise levels. It was found that the relationship between traffic speed and noise level was significant as the noise level was affected by the accelerating and decelerating vehicles, apart from being influenced by the road and hump profiles as well as the types of vehicles involved. The findings on significant changes showed that road humps were effective in reducing speed, but the results on traffic noise produced was on the contrary. As for the questionnaire survey results, most residents were satisfied that road humps functioned well in reducing traffic speed compared to traffic noise. The residents also expressed their dissatisfaction towards traffic speed and noise in their residential areas. However, this study only assessed the effects of road humps on traffic speed and noise levels in residential areas, by comparing different roads and road hump profiles. Further study can be done by considering other factors such as traffic volume. The expected findings can be a basis in solving issues on traffic speed and noise in residential areas including the execution of road humps in new residential developments.

ملخص البحث

ساهم تركيب حذب الطرق في المناطق السكنية في تهدئة الطرق السكنية حيث يبدو أنه يُقلل من سرعة حركة المرور في الطرق السكنية. ومع ذلك ، فإن من عيوب تركيب حذب الطريق هو تسببه في توليد إزعاج بسبب الضوضاء والاهتزازات الناتجة عن التسارع والتباطؤ المفاجئ للسيارات. تقوم هذه الدراسة بتقييم آثار حذب الطريق على سرعة المرور ومستوى الضوضاء في المناطق السكنية. أجريت الدراسة على مجموعتين مختلفتين من حذب الطرق في تامان سيتياوانجسا وكيرامات، وتم أخذ كل من قياسات حذب وملامح الطرق لكل من المنطقتين. تم استخدام بندقية الرادار ومقياس مستويات الضوضاء لقياس سرعة كل سيارة ومستوى الضوضاء في نقاط محددة. تم تحديد حجم عينة السرعة الفورية باستخدام أسلوب أخذ عينات منهجي يعتمد على مسح حجم حركة المرور الذي تم جمعه لمدة 12 ساعة في وقت مسبق. بعد ذلك ، تم أخذ نسبة الرضا وتصورات السكان حول سرعة المرور والضوضاء من خلال مقابلات معهم وجهاً لوجه وقد تم اختيارهم عشوائياً عن طريق استخدام أسلوب العينة العشوائية البسيطة. تم تحليل البيانات باستخدام إحصائيات وصفية ، والتي وصفت التغيرات في سرعة السيارات ومستويات الضوضاء في الطرق المحددة ، وكذلك أنماط السرعة ومستوى الضوضاء. تم تحليل الاختلافات في المتوسط لكل من السرعة والضوضاء بينما تم استخدام تحليل الارتباط لتحليل العلاقة بين السرعة ومستوى الضوضاء. T باستخدام اختبار أما بالنسبة لبيانات الاستبيان ، فقد تم تطبيق التحليل الوصفي لتحديد الخلفية الديموغرافية والاجتماعية والاقتصادية للسكان، في حين تم استخدام تحليل الجدولة المتقاطعة لتقييم تصورات ونسبة رضا السكان كما كان متوقعاً ، أظهرت نتيجة مسح السرعة أن أعلى سرعة مسجلة كانت في جالان كيرامات بمسافة 28.75 كم / ساعة وأدنى سرعة كانت في جالان سيتياوانجسا 21 ، 14.35 كم / ساعة. وفي الوقت نفسه ، تم تسجيل أعلى مستوى للضوضاء وهو 72.36 ديسيبل في جالان كيرامات وأدنى مستوى وهو 57.88 ديسيبل في جالان سيتياوانجسا 21. ولكن على أية حال، فقد أظهرت النتائج أن مستويات الضوضاء المسجلة في جميع الطرق المحددة تجاوزت الحدود المسموح بها. تأثرت كلتا النتيجتين بخصائص حذب الطريق ، وخاصة ارتفاع وعرض الحذب ، والتي أثرت على السرعة التي تنتجها السيارات، و هذا يدل على العلاقة الملحوظة بين سرعة حركة المرور والضوضاء وأكد على أن الزيادة في السرعة تؤدي إلى ولقد وجدنا أن العلاقة بين سرعة المرور ومستوى الضوضاء كانت مهمة لأن ارتفاع مستوى الضوضاء مستوى الضوضاء قد تأثر بالسيارات المتسارعة والمتباطئة وحدبات وملامح الطرق وكذلك أنواع السيارات.

أظهرت النتائج المتعلقة بالتغيرات المهمة أن حذب الطرق فعّالة في تقليل السرعة، في حين أن نتيجة ضوضاء المرور كانت العكس. بالنسبة لنتائج الاستبيان ، فإن معظم السكان راضون عن عمل حدبات الطرق في تقليل سرعة حركة المرور مقارنةً بضوضاء المرور. كما أعرب السكان عن استيائهم من سرعة المرور والضوضاء ومع ذلك ، قيّمت هذه الدراسة آثار حذب الطرق على سرعة حركة المرور. في مناطقهم السكنية ومستويات الضوضاء في المناطق السكنية من خلال مقارنة حذب الطريق وملاحمه المختلفة. يمكن إجراء مزيد من الدراسات عن طريق اعتبار عوامل أخرى مثل حجم حركة المرور. يمكن أن تكون النتائج المتوقعة أساسًا في حل المشاكل المتعلقة بزيادة سرعة حركة المرور والضوضاء في المناطق السكنية بما في ذلك إجراء حذب الطرق في تطوير السكن الجديد.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science (Built Environment).

.....
Abdul Azeez Kadar Hamsa
Supervisor

.....
Mohd Zin Mohamed
Co-Supervisor

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science (Built Environment).

.....
Syahriah Bachok
Internal Examiner

.....
Munzilah Md Rohani
External Examiner

This thesis was submitted to the Department of Urban and Regional Planning and is accepted as a fulfilment of the requirement for the degree of Master of Science (Built Environment).

.....
Syafiee Shuid
Head, Department of Urban and
Regional Planning

This thesis was submitted to the Kulliyyah of Architecture and Environmental Design and is accepted as a fulfilment of the requirement for the degree of Master of Science (Built Environment).

.....
Abdul Razak Sopian
Dean, Kulliyyah of Architecture
and Environmental Design

DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Siti Syazwani Ahmad Sofi

Signature.....

Date.....

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

**DECLARATION OF COPYRIGHT AND AFFIRMATION
OF FAIR USE OF UNPUBLISHED RESEARCH**

**AN ASSESSMENT OF THE EFFECTS OF ROAD HUMPS ON
TRAFFIC SPEED AND NOISE IN THE RESIDENTIAL AREAS**

I declare that the copyright holder of this thesis are jointly owned by the student and IIUM.

Copyright © 2019 Siti Syazwani Ahmad Sofi and International Islamic University Malaysia. All rights reserved.

No part of this unpublished research may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of the copyright holder except as provided below

1. Any material contained in or derived from this unpublished research may only be used by others in their writing with due acknowledgement.
2. IIUM or its library will have the right to make and transmit copies (print if electronic) for institutional and academic purpose.
3. The IIUM library will have the right to make, store in a retrieval system and supply copies of this unpublished research if requested by other universities and research libraries.

By signing this form, I acknowledged that I have read and understand the IIUM Intellectual Property Right and Commercialization Policy.

Affirmed by Siti Syazwani Ahmad Sofi.

.....
Signature

.....
Date

This thesis is dedicated to;

My family;

Abah, Mak, Along, Angah,

.

.

And

You.

ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious and The Most Merciful.

Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this thesis. I would first like to thank my supervisor, Assoc. Prof. Dr. Abdul Azeez Kadar Hamsa who granted me the gift of their unwavering belief in my ability to accomplish this goal: thank you for your support and patience. Not forgotten, my appreciation to my co-supervisor, Assoc. Prof. TPr. Dr. Mohd Zin for his support and knowledge regarding this topic.

I would also like to acknowledge Assoc. Prof. TPr. Dr. Syahriah Bachok and Assoc. Prof. Dr. Munzilah Md Rohani as internal and external examiners of this thesis, and I am gratefully indebted to them for very valuable comments on this thesis. My acknowledgement also goes to all office staffs of Postgraduate Office for their co-operations.

Sincere thanks and gratitude especially to my research colleague, Khairun Sarah Radhiah and friends for the kindness, help and advices during my study. Also, thanks to my superior and colleagues for being understanding throughout my study period. Just saying thank you will never repay your kindness.

Finally, I wish to express my appreciation and thanks to my parents and my siblings for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. To those indirectly contributed in this research, your kindness means a lot to me.

Thank you.

LIST OF TABLES

Table 2.1	Road Hump Profiles as by HPU	21
Table 3.1	Road Characteristics Inventory Form	34
Table 3.2	Road Hump Profiles Inventory Form	35
Table 3.4	Recommendation Study Length	39
Table 3.5	Sample Size for Setiawangsa	43
Table 3.6	Sample Size for Keramat	43
Table 3.7	Population for Questionnaire Survey	52
Table 3.8	Proportional Allocation of Housing Sample for Questionnaire	54
Table 3.9	Response Rate from Questionnaire Survey	57
Table 4.1	Summary of Road Dimensions	75
Table 4.2	Summary of Road Humps Profiles	76
Table 5.1	Traffic Speed Characteristics for Jalan Setiawangsa 21	79
Table 5.2	Traffic Speed Characteristics for Persiaran Setiawangsa	80
Table 5.3	Traffic Speed Characteristics for Jalan AU1C/1	81
Table 5.4	Traffic Speed Characteristics for Jalan Keramat	82
Table 5.5	Summary of Findings	83
Table 5.6	Paired Sample Test for Jalan Setiawangsa 21	109
Table 5.7	Paired Sample Test for Persiaran Setiawangsa	110
Table 5.8	Paired Sample Test for Jalan AU1C/1	111
Table 5.9	Paired Sample Test for Jalan Keramat	113
Table 5.10	Traffic Noise Characteristics for Jalan Setiawangsa 21	115
Table 5.11	Traffic Noise Characteristics along Persiaran Setiawangsa	116

Table 5.12	Traffic Noise Characteristics along Jalan AU1C/1	117
Table 5.13	Traffic Noise Characteristics along Jalan Keramat	118
Table 5.14	Paired Samples Statistics for Noise Levels	128
Table 5.15	Paired Samples Statistics Tests for Noise Levels	128
Table 5.16	Paired Samples Statistics for Noise Levels	129
Table 5.17	Paired Samples Tests for Noise Levels	129
Table 5.18	Paired Samples Statistics for Noise Levels	130
Table 5.19	Paired Samples Statistic Tests for Noise Levels	130
Table 5.20	Paired Samples Statistics for Noise Levels	130
Table 5.21	Paired Samples Tests for Noise Levels	130
Table 6.1	Residents' Background	137
Table 6.2	Residential Details	140
Table 6.3	Vehicles Ownership	142
Table 6.4	Satisfaction with Daytime Speeds	144
Table 6.5	Satisfaction with Nighttime Speeds	146
Table 6.6	Satisfaction with Daytime Noise	148
Table 6.7	Satisfaction with Nighttime Noise	150
Table 6.8	RH can reduce vehicle speed	152
Table 6.9	RH can reduce traffic noise	153

LIST OF FIGURES

Figure 1.1	Study Area	2
Figure 1.2	Taman Setiawangsa	9
Figure 1.3	Kampung Datuk Keramat	10
Figure 1.4	Taman Keramat	11
Figure 2.1	Traffic Calming in Malaysia	18
Figure 3.1	Research Approach	30
Figure 3.2	Road Characteristics	31
Figure 3.3	Road Hump Profiles	32
Figure 3.4	Traffic Counter	36
Figure 3.5	Traffic Volume Survey Form	37
Figure 3.6	Location of Spot Speed Study	38
Figure 3.7	Radar Gun (Stalker Lidar XS)	38
Figure 3.8	Traffic Speed Survey Form	39
Figure 3.9	Location of Enumerators	40
Figure 3.10	Noise Level Metre (Cirrus Research)	46
Figure 3.11	Location of Noise Level Metre	47
Figure 3.12	Location of Noise Level Metre	48
Figure 3.13	Sample Size for Setiawangsa	53
Figure 3.14	Sample Size for Keramat	53
Figure 3.15	Simple Random Sampling	55
Figure 3.16	Jalan Setiawangsa 21	55
Figure 3.17	Persiaran Setiawangsa	56

Figure 3.18	Jalan AU1C/1	56
Figure 3.19	Jalan Keramat	57
Figure 3.20	Triangulation Method	59
Figure 4.1	Location of Study Area	60
Figure 4.2	Cross-section of Jalan Setiawangsa 21	61
Figure 4.3	Point 3 (Road Hump 1)	62
Figure 4.4	Point 5 (Road Hump 2)	62
Figure 4.5	Location of Study Area	63
Figure 4.6	Cross-section of Persiaran Setiawangsa	64
Figure 4.7	Point 3 (Road Hump 1)	65
Figure 4.8	Point 5(Road Hump 2)	65
Figure 4.9	Location of Study Area	66
Figure 4.10	Cross-section of Jalan AU1C/1	67
Figure 4.11	Point 3 (Road Hump 1)	68
Figure 4.12	Point 5 (Road Hump 2)	68
Figure 4.13	Location of Study Area	69
Figure 4.14	Cross-section of Jalan Keramat	70
Figure 4.15	Point 3 (Road Hump 1)	71
Figure 4.16	Point 5 (Road Hump 2)	71
Figure 4.17	Cross - section of Road Humps	72
Figure 4.18	Cross-section of Road Humps	73
Figure 4.19	Cross-section of Road Humps	74
Figure 4.20	Cross-section of Road Humps	75
Figure 5.1	Cars Speed Distribution at Road Hump 1 and 2 (Entering)	84
Figure 5.2	Cars Speed Distribution at Road Hump 1 and 2 (Exiting)	84

Figure 5.3	Motorcycles Speed Distribution at Road Hump 1 and 2 (Entering)	85
Figure 5.4	Motorcycles Speed Distribution at Road Hump 1 and 2 (Exiting)	85
Figure 5.5	Medium and Heavy Vehicles Speed Distribution at Road Hump 1 and 2 (Entering)	86
Figure 5.6	Medium and Heavy Vehicles Speed Distribution at Road Hump 1 and 2 (Exiting)	86
Figure 5.7	Cars Speed Distribution at Road Hump 1 and 2 (Entering)	87
Figure 5.8	Cars Speed Distribution at Road Hump 1 and 2 (Exiting)	87
Figure 5.9	Motorcycles Speed Distribution at Road Hump 1 and 2 (Entering)	88
Figure 5.10	Motorcycles Speed Distribution at Road Hump 1 and 2 (Exiting)	88
Figure 5.11	Medium and Heavy Vehicles Speed Distribution at Road Hump 1 and 2 (Entering)	89
Figure 5.12	Medium and Heavy Vehicles Speed Distribution at Road Hump 1 and 2 (Exiting)	89
Figure 5.13	Cars Speed Distribution at Road Hump 1 and 2 (Entering)	90
Figure 5.14	Cars Speed Distribution at Road Hump 1 and 2 (Exiting)	90
Figure 5.15	Motorcycles Speed Distribution at Road Hump 1 and 2 (Entering)	91
Figure 5.16	Motorcycles Speed Distribution at Road Hump 1 and 2 (Exiting)	91
Figure 5.17	Medium and Heavy Vehicles Speed Distribution at Road Hump 1 and 2 (Entering)	92
Figure 5.18	Medium and Heavy Vehicles Speed Distribution at Road Hump 1 and 2 (Exiting)	92
Figure 5.19	Cars Speed Distribution at Road Hump 1 and 2 (Entering)	93
Figure 5.20	Cars Speed Distribution at Road Hump 1 and 2 (Exiting)	93
Figure 5.21	Motorcycles Speed Distribution at Road Hump 1 and 2 (Entering).	94
Figure 5.22	Motorcycles Speed Distribution at Road Hump 1 and 2 (Exiting)	94
Figure 5.23	Medium and Heavy Vehicles Speed Distribution at Road Hump 1 and 2 (Entering)	95

Figure 5.24	Medium and Heavy Vehicles Speed Distribution at Road Hump 1 and 2 (Exiting)	95
Figure 5.25	Percentage of Changes in Speed along Jalan Setiawangsa 21	97
Figure 5.26	Percentage of Changes in Speed along Persiaran Setiawangsa	97
Figure 5.27	Percentage of Changes in Speed along Jalan AU1C/1	98
Figure 5.28	Percentage of Changes in Speed along Jalan Keramat	99
Figure 5.29	Frequency of Vehicles Changing Speed Before and After Road Hump 1	100
Figure 5.30	Frequency of Vehicles Changing Speed Before and After Road Hump 2	100
Figure 5.31	Frequency of Vehicles Changing Speed Before and After Road Hump 1	101
Figure 5.32	Frequency of Vehicles Changing Speed Before and After Road Hump 2	101
Figure 5.33	Frequency of Vehicles Changing Speed Before and After Road Hump 1	102
Figure 5.34	Frequency of Vehicles Changing Speed Before and After Road Hump 2	103
Figure 5.35	Frequency of Vehicles Changing Speed Before and After Road Hump 1	103
Figure 5.36	Frequency of Vehicles Changing Speed Before and After Road Hump 2	104
Figure 5.37	Frequency of Vehicles Changing Speed Before and After Road Hump 1	105
Figure 5.38	Frequency of Vehicles Changing Speed Before and After Road Hump 2	105
Figure 5.39	Frequency of Vehicles Changing Speed Before and After Road Hump 1	106
Figure 5.40	Frequency of Vehicles Changing Speed Before and After Road Hump 2	106

Figure 5.41	Frequency of Vehicles Changing Speed Before and After Road Hump 1	107
Figure 5.42	Frequency of Vehicles Changing Speed Before and After Road Hump 2	108
Figure 5.43	Frequency of Vehicles Changing Speed Before and After Road Hump 1	108
Figure 5.44	Frequency of Vehicles Changing Speed Before and After Road Hump 2	109
Figure 5.45	Noise Level at P3	120
Figure 5.46	Noise Level at P5	120
Figure 5.47	Noise Level at Road Hump 1 (P3)	121
Figure 5.48	Noise Level at Road Hump 2 (P5)	121
Figure 5.49	Noise Level at Road Hump 1 (P3)	122
Figure 5.50	Noise Level at Road Hump 2 (P5)	122
Figure 5.51	Noise Level at Road Hump 1 (P3)	123
Figure 5.52	Noise Level at Road Hump 2 (P5)	123
Figure 5.53	Noise Level Change (LAeq) at Hump 1	124
Figure 5.54	Noise Level Change (LAeq) at Hump 2	124
Figure 5.55	Noise Level Change (LAeq) at Hump 1	125
Figure 5.56	Noise Level Change (LAeq) at Hump 2	125
Figure 5.57	Noise Level Change (LAeq) at Hump 1	126
Figure 5.58	Noise Level Change (LAeq) at Hump 2	126
Figure 5.59	Noise Level Change (LAeq) at Hump 1	127
Figure 5.60	Noise Level Change (LAeq) at Hump 2	128
Figure 5.61	Average Speed vs. LAeq Noise Level (Entering)	131
Figure 5.62	Average Speed vs. LAeq Noise Level (Exiting)	132
Figure 5.63	Average Speed vs. LAeq Noise Level (Entering)	132

Figure 5.64	Average Speed vs. LAeq Noise Level (Exiting)	133
Figure 5.65	Average Speed vs. LAeq Noise Level (Entering)	133
Figure 5.66	Average Speed vs. LAeq Noise Level (Exiting)	134
Figure 5.67	Average Speed vs. LAeq Noise Level (Entering)	135
Figure 5.68	Average Speed vs. LAeq Noise Level (Exiting)	135
Figure 6.1	Gender	138
Figure 6.2	Marital Status	138
Figure 6.3	Respondents' Age Group	139
Figure 6.4	Respondents' Employment Status	140
Figure 6.5	Period of Stay (House)	141
Figure 6.6	Period of Stay (Residential Area)	141
Figure 6.7	Motorcycle Ownership	142
Figure 6.8	Car Ownership	143
Figure 6.9	4WD / MPV Ownership	143
Figure 6.10	Satisfaction with Daytime Speeds	146
Figure 6.11	Satisfaction with Nighttime Speeds	147
Figure 6.12	Satisfaction with Daytime Noise	149
Figure 6.13	Satisfaction with Nighttime Noise	151
Figure 6.14	RH can reduce vehicle speed	153
Figure 6.15	RH can reduce traffic noise	155
Figure 7.1	Road Marking and Warning Sign	160
Figure 7.2	Warning Sign in Front of Residential Area	161
Figure 7.3	Visible Marking on Road Hump	161
Figure 7.4	Road Hump Maintenance Works	162

Figure 7.5	Trees as Buffer	163
Figure 7.6	Pedestrians Walkway	163

TABLE OF CONTENTS

Abstract	ii
Abstract in Arabic	iii
Approval Page.....	v
Declaration	vi
Copyright	vii
Dedication	viii
Acknowledgements.....	ix
List of Tables	xvi
List of Figures	xviii
CHAPTER ONE : INTRODUCTION.....	1
1.1 Research Overview	1
1.2 Problem Statement	3
1.1.1 Excessive speed along residential areas.....	3
1.1.2 High noise level in residential areas	3
1.1.3 Lack of proven road humps design standards.....	4
1.3 Research Aim	4
1.4 Research Objectives	4
1.5 Research Questions	5
1.6 Significance of Study	5
1.7 Scope of Study	6
1.7.1 Selection of study areas	6
1.7.2 Road hump design characteristics.....	7
1.7.3 Spot speed survey samples.....	7
1.7.4 Data collected.....	7
1.8 Limitation of Study	8
1.8.1 Equipment	8
1.8.2 Response rate	8
1.8.3 Behaviour	8
1.9 Study Area Background	9
1.9.1 Setiawangsa.....	9
1.9.2 Keramat.....	10
1.10 Structure of Thesis Report	12
1.11 Chapter Summary.....	13
CHAPTER TWO : RESEARCH OVERVIEW	14
2.1 Introduction	14
2.2 Traffic Calming	14
2.2.1 History of Traffic Calming	14
2.2.2 Definition of Traffic Calming.....	15
2.2.3 Purposes of Traffic Calming.....	16

2.3	Traffic Calming Measures In Malaysia.....	17
2.4	Road Humps As Traffic Calming Measures	19
2.4.1	Positive Impacts of Road Humps as Traffic Calming Measures	19
2.4.2	Negative Impacts of Road Humps as Traffic Calming Measures	20
2.5	Road Hump Design Profiles.....	20
2.5.1	Height, Width and Length.....	21
2.5.2	Spacing and Location.....	21
2.6	Effects of Road Hump on Traffic Speed and Noise in Residential Area and Public Persepctives.....	23
2.6.1	Traffic Speed.....	23
2.6.2	Traffic Noise	24
2.6.3	Public Perspectives	26
2.7	Chapter Summary.....	27

CHAPTER THREE : RESEARCH METHODOLOGY

3.1	Introduction	28
3.2	Research Framework.....	28
3.2.1	Preliminary Understanding of Research Problems	28
3.2.2	Theoretical Research.....	28
3.2.3	Data Analysis and Findings	29
3.2.4	Suggestions and Recommendations.....	29
3.3	Road Characteristics and Road Hump Profiles.....	31
3.3.1	Data Required	31
3.3.2	Data Collection	33
3.3.3	Method of Analysis.....	35
3.4	Traffic Volume.....	35
3.4.1	Data Required	35
3.4.2	Data Collection	36
3.5	Traffic Speed.....	37
3.5.1	Data Required	37
3.5.2	Data Collection	38
3.5.3	Method of Analysis.....	44
3.6	Traffic Noise	45
3.6.1	Data Required	45
3.6.2	Data Collection	46
3.6.3	Method of Analysis.....	48
3.7	Residents' Perceptions and Satisfaction.....	49
3.7.1	Data Required	49
3.7.2	Data Collection	52
3.7.3	Method of Analysis.....	58
3.7.4	Triangulation Method	59
3.8	Chapter Summary.....	59

CHAPTER FOUR : ROAD CHARACTERISTICS AND ROAD HUMPS PROFILES.....

4.1	Introduction	60
4.2	Road Characteristics.....	60
4.2.1	Jalan Setiawangsa 21	60

4.2.2	Persiaran Setiawangsa.....	62
4.2.3	Jalan AU1C/1.....	65
4.2.4	Jalan Keramat.....	68
4.3	Road Humps Profiles	71
4.3.1	Jalan Setiawangsa 21	71
4.3.2	Persiaran Setiawangsa.....	72
4.3.3	Jalan AU1C/1.....	73
4.3.4	Jalan Keramat.....	74
4.4	Chapter Summary.....	75

CHAPTER FIVE : TRAFFIC SPEED AND NOISE LEVEL ALONG THE RESIDENTIAL ROADS..... 78

5.1	Introduction	78
5.2	Speed Characteristics	78
5.2.1	Jalan Setiawangsa 21	78
5.2.2	Persiaran Setiawangsa.....	79
5.2.3	Jalan AU1C/1.....	80
5.2.4	Jalan Keramat.....	81
5.2.5	Summary of Findings.....	82
5.3	Speed Distribution.....	84
5.3.1	Jalan Setiawangsa 21	84
5.3.2	Persiaran Setiawangsa.....	87
5.3.3	Jalan AU1C/1.....	90
5.3.4	Jalan Keramat.....	93
5.3.5	Summary of Findings.....	96
5.4	Changes in Speed	96
5.4.1	Jalan Setiawangsa 21	96
5.4.2	Persiaran Setiawangsa.....	97
5.4.3	Jalan AU1C/1.....	98
5.4.4	Jalan Keramat.....	98
5.5	Vehicles Changing Speed Every 5km/h.....	99
5.5.1	Jalan Setiawangsa 21	99
5.5.2	Persiaran Setiawangsa.....	102
5.5.3	Jalan AU1C/1.....	104
5.5.4	Jalan Keramat.....	107
5.6	Testing The Difference in Vehicles Speed.....	109
5.6.1	Jalan Setiawangsa 21	109
5.6.2	Persiaran Setiawangsa.....	110
5.6.3	Jalan AU1C/1.....	111
5.6.4	Jalan Keramat.....	112
5.6.5	Summary of Findings.....	114
5.7	Noise Characteristics.....	115
5.7.1	Jalan Setiawangsa 21	115
5.7.2	Persiaran Setiawangsa.....	116
5.7.3	Jalan AU1C/1.....	117
5.7.4	Jalan Keramat.....	118
5.7.5	Summary of Findings.....	119
5.8	Noise Level Readings at Road Humps.....	119
5.8.1	Jalan Setiawangsa 21	119

5.8.2	Persiaran Setiawangsa.....	120
5.8.3	Jalan AU1C/1.....	122
5.8.4	Jalan Keramat.....	123
5.9	Changes in Noise Level	124
5.9.1	Jalan Setiawangsa 21	124
5.9.2	Persiaran Setiawangsa.....	125
5.9.3	Jalan AU1C/1.....	126
5.9.4	Jalan Keramat.....	127
5.10	Testing the Difference in Noise Level at Road Humps.....	128
5.10.1	Jalan Setiawangsa 21	128
5.10.2	Persiaran Setiawangsa.....	129
5.10.3	Jalan AU1C/1.....	129
5.10.4	Jalan Keramat.....	130
5.10.5	Summary of Findings.....	131
5.11	Relationship Between Traffic Speed and Noise Level.....	131
5.11.1	Jalan Setiawangsa 21	131
5.11.2	Persiaran Setiawangsa.....	132
5.11.3	Jalan AU1C/1.....	133
5.11.4	Jalan Keramat.....	134
5.11.5	Summary of Findings.....	136
5.12	Chapter Summary.....	136

**CHAPTER SIX : RESIDENTS' DEMOGRAPHICS AND SATISFACTIONS ON
EXISTING TRAFFIC SPEED AND NOISE**

6.1	Introduction.....	137
6.2	Residents' Demographics.....	137
6.2.1	Residents' Background	137
6.2.2	Residential Details	140
6.2.3	Vehicles Ownership	142
6.2.4	Summary of Findings.....	143
6.3	Satisfactions With Existing Traffic Speed and Noise Condition	144
6.3.1	Area*Satisfaction with Daytime Speeds.....	144
6.3.2	Area*Satisfaction with Nighttime Speeds	146
6.3.3	Area*Satisfaction with Daytime Noise.....	148
6.3.4	Area*Satisfaction with Nighttime Noise	150
6.3.5	Area * Road Humps can Reduce Traffic Speed	152
6.3.6	Area * Road Humps can Reduce Traffic Noise.....	153
6.3.7	Summary of Findings.....	155
6.4	Chapter Summary.....	156

CHAPTER SEVEN : RECOMMENDATIONS AND CONCLUSION.....	157
7.1 Introduction	157
7.2 Summary of Findings	157
7.3 Recommendations	160
7.3.1 Installing proper signage or marking of the road humps	160
7.3.2 Monitoring and maintaining the road humps' conditions.....	161
7.3.3 Installing road humps from kerb to kerb.....	162
7.3.4 Using landscape as a buffer zone.....	163
7.4 CONCLUSIONS.....	164
REFERENCES	165
APPENDIX I	171
APPENDIX II	172
APPENDIX III	188
APPENDIX IV	189
APPENDIX V	190
APPENDIX VI	202
APPENDIX VII.....	204

CHAPTER ONE

INTRODUCTION

1.1 RESEARCH OVERVIEW

The societal development specifically in terms of living comfort and economic progress can be determined by the road traffic. Hamsa et.al. (2006) believed that the living environment in many residential areas has been deteriorating due to the increase in traffic volume, which resulted in generating noise pollution that affected the residents. Noise pollution has always been a major environmental cause for human (Sulaiman et. al, 2018). Besides, exposure to noise can cause health problems, disturbance and annoyance among the residents particularly those who live along or near the roadside. The loud noise from the speeding vehicles has interrupted the residents especially in the middle of the night.

In addressing to the above concerns, motorized vehicles need special treatment or control to have a safe and pleasant environment. The regulation on the speed limit does not seem to affect the drivers. Therefore, of all the traffic calming measures that have been established, road humps were introduced as a solution to reduce the speed of the vehicles as well as noise level (Schlabach, 1997), which also agreed by (Roess et al, 2004; Huang and Cynecki, 2000).

However, as cited by Yaacob (2013), the drawbacks of the traffic calming measures according to Transport for London (TfL) is that it causes discomfort to two-wheeled vehicles, drivers and passengers of buses, increases journey time for bus and delay to the emergency vehicles as well as generates nuisance due to the noise and