EVALUATING THE EFFECTS OF ROAD HUMP DESIGN ON VEHICLE SPEED AT A HIGHER LEARNING INSTITUTION: A CASE STUDY FROM IIUM

BY

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ABSTRACT

Road safety is crucial for the road users on campus as most students and staffs would move about and around in the campus on foot, walking to class or to the office. As such, traffic speed has been observed to be one of the main transports determinants that could harm the safety of the population within the university area. Accordingly, road humps are introduced primarily on the main road in the campus area, as it is effective as a traffic calming measure in reducing speed. Nevertheless, the reduction in traffic speed depends on the design of the road humps. For that, this study investigates the effects of a road hump on the speed of vehicles at the main road of International Islamic University Malaysia (IIUM). 18 road humps along the main road were selected, and the two types of vehicles that has been selected were the car and the motorcycle. The design profiles and spot speed of the vehicles at all road humps were respectively measured using measuring tape and radar guns. It was observed that only 5 out of the 18 road humps fell within the Minister of Works specification category. The speed of cars and motorcycles before, at, and after the road humps were analysed using descriptive analysis and t-test. The analysis included the evaluation of speed pattern, speed reduction, speed characteristics, and speed changes in relation with the different heights of road humps. The outcomes from the study yielded 5km/h to 16km/h reductions of mean speed. The reductions are being observed at Before-At road humps for both the car and motorcycle. Additionally, the t-test analysis had also shown that there was a significant effect of a road hump on the speed of vehicles that passed through the selected road humps. By that, the research hypothesis is accepted where there are differences in mean speed of vehicle at and before the road hump. Lastly, the findings are used to formulate the recommendations in improving the implementations of the road hump in a university setting.

خلاصة البحث

تُعتبر السلامة على الطرق أمرا بالغ الأهمية لمستخدمي الطرق داخل الحرم الجامعي خصوصا لطلاب الجامعة والموظفين فيها يتنقّلون من مكان إلى مكان على الأقدام سواء إلى الفصل أو الإدارة. على هذا النحو، اكتشفت الباحثة أن سرعة حركة المرور هي إحدى المشكلة الرئيسية ذات الصلة بسلامة المجتمع داخل الحرم الجامعي. وتمّت بناء مطبات الطرق على الطريق الرئيسي داخل الحرم الجامعي حيث إنها مقياس فعّال لتهدئة سرعة حركة المرور مع اعتماد على تصميمها. ولذلك، تهدف هذه الدراسة تأثير بناء مطبات الطرق على سرعة حركة المرور على الطريق الرئيسي داخل الجامعة العالمية الإسلامية بماليزيا. وقد تمّت اختيار 18 مطبات الطرق على الطريق الرئيسي داخل الحرم الجامعي، واختيار نوعين من المركبات؛ السيارة والدراجة النارية في إجراء هذه الدراسة. وقامت قياس هذه المركبات المحددة والسرعة الموضعية لها باستخدام شريط قياس ومسدس الرادار في كل مطبات الطرق على الطريق الرئيسي داخل الحرم الجامعي. فلُوحظت 5 من 18 مطبات الطرق هي توافق مع خصائص مميزة من وزارة الأشغال. وبهذا، قامت الباحثة بالتحليل الوصفي واختبار تي (t-test) بيانات عن سرعة السيارات والدراجة النارية في ثلاث حالات، قبل وأثناء وبعد مطبات الطرق، وتضمن في هذا التحليل أيضا تقييم نمط السرعة، وتخفيض السرعة، وخصائص السرعة، وتغيرات السرعة فيما يتعلق بارتفاعات مختلفة من مطبات الطرق. فالنتيجة من هذه الدراسة تخفيضات متوسطة السرعة هي ما بين ٥ كم/الساعة حتى ١٦ كم/الساعة وقد لاحظت الباحثة هذه التخفيضات في قبل-بعد مطبات الطرق لنوعين من المركبات؛ السيارة والدراجة النارية. إضافة إلى ذلك، أظهر التحليل من اختبار تي (t-test) أن هناك تأثيرا واضحا لمطبات الطرق على سرعة حركة المرور التي مرت عبر مطبات الطرق المحددة. ومن هنا، فرضية البحث مقبولة، واستخدمت الدراسة النتائج المحصلة في تحسين تطبيقات مطبات الطرق داخل الحرم الجامعي.

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)

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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.

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This thesis is dedicated to my husband and daughter for their everlasting prayers, motivation, unconditional love, and support.

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TABLE OF CONTENTS

Abstract ii
Abstract In Arabic iii
Approval Page iv
Declaration v
Copyright Page vi
Acknowledgements viii
List Of Tables xi
List Of Figures xiv

CHAPTER ONE: INTRODUCTION 1
1.1 Introduction 1
1.2 Problem Statement 3
1.3 Goal 3
1.4 Research Objectives 4
1.5 Research Hypothesis 4
1.6 Scope of Study 4
1.7 Description of Study Area 5
1.8 Significance of the Study 8
1.9 Limitation of the Study 8
1.10 Structure of the Report 9

CHAPTER TWO: LITERATURE REVIEW 10
2.1 Introduction 10
2.2 Research Gap 10
2.3 Traffic Calming Measures 11
2.3.1 Definition 11
2.3.2 Purpose of Traffic Calming Measure 12
2.3.3 Types of Traffic Calming 13
2.3.4 Traffic Calming in Malaysia 14
2.4 Road Hump 15
2.4.1 Purpose of Road Hump 15
2.4.2 Types of Road Humps 17
2.4.3 Implementations of Road Hump in Malaysia 18
2.4.4 Implementation of Road Hump in the Institutional Area 20
2.5 Speed 21
2.5.1 Definition 21
2.5.2 Spot Speed 21
2.5.3 Excessive Speeding 23
2.6 Effects of Road Hump on Speed 23
2.7 Summary 25

CHAPTER THREE: RESEARCH METHODOLOGY 27
3.1 Introduction 27
3.2 Research Framwork 27

3.3 Primary Data and Data Collection 29
3.3.1 Road Inventory Survey 29
3.3.2 Spot Speed Survey 31
3.3.3 Sample Size 33
3.3.4 Sampling Method 35
3.4 Secondary Data and Data Collection 35
3.5 Method of Data Analysis 36
3.5.1 Descriptive Analysis 36
3.5.2 Paired-Sample T-Test 37
3.6 Summary 38

CHAPTER FOUR: ANALYSIS AND FINDINGS 39
4.1 Introduction 39
4.2 Road Geometrical Design 39
4.3 Design Characteristics of Road Hump 40
4.4 Spot Speed Analysis 44
4.4.1 Speed Pattern of Car 45
4.4.2 Speed Pattern of Motorcycle 53
4.4.3 Summary of Spot Speed For Car and Motorcycle 61
4.4.4 Percentage of Vehicles Traveled Above and Equal or Less than the Speed Limit Of 30km/H 63
4.4.5 Frequency of Car Speed Changes Before-At and At-After the Road Humps 65
4.4.6 Frequency of Motorcycle Speed Changes Before-At and At-After the Road Humps 73
4.4.7 Comparison for Frequency of Car and Motorcycle Speed Changes Before-At and At-After at all Road Humps 81
4.5 Spot Speed Characteristics 84
4.6 Changes in Mean Speed of Vehicles at all Road Humps 90
4.6.1 Car 90
4.6.2 Motorcycle 92
4.7 Testing the Differences in Spot Speed Between selected Road Humps 94
4.8 Discussion 96

CHAPTER FIVE: SUMMARY, RECOMMENDATIONS, AND CONCLUSION 99
5.1 Introduction 99
5.2 Summary Of Findings 99
5.3 Recommendations 102
5.4 Conclusions 103

REFERENCES 104

APPENDIX 1 (CAR) 109
APPENDIX 2 (MOTORCYCLE) 115

LIST OF TABLES

Table 2.1	Types of Traffic Calming and Its Examples	13
Table 2.2	Categories of traffic calming in Malaysia and its examples by HPU	14
Table 2.3	Road hump specifications by Malaysian Ministry of Road Works (2012)	19
Table 3.1	List of Right-of-Way (ROW) on the road	30
Table 3.2	List of design characteristics of selected road hump	30
Table 3.3	Spot speed survey form	32
Table 3.4	Table for determining sample size from a given population	34
Table 4.1	Right-of-way on the selected road humps	40
Table 4.2	Comparison between observed dimensions of selected road humps and M.O.W design specifications	41
Table 4.3	Categorization of road humps according to the heights in comparing with M.O.W specifications	43
Table 4.4	Minimum and maximum spot speed of car before, at, and after the selected road humps	51
Table 4.5	Minimum and maximum spot speed of motorcycle before, at, and after the selected road humps	59
Table 4.6	Comparison of minimum and maximum spot speed before, at and, after the selected road humps between car and motorcycle	61
Table 4.7	Percentage of vehicles travelled above and equal or less than the speed limit (30km/h)	63
Table 4.8	Frequency of car speed changes at all road humps	71
Table 4.9	Frequency of motorcycle speed changes at all road humps	79
Table 4.10	Frequency of car speed changes Before-At and At-After the selected road humps	81
Table 4.11	Frequency of motorcycle speed changes Before-At and At-After the selected road humps	82

Table 4.12	Spot speed characteristics of the vehicles at road hump 1 (Height: 120mm)	84
Table 4.13	Spot speed characteristics of the vehicles at road hump 2 (Height: 30mm)	84
Table 4.14	Spot speed characteristics of the vehicles at road hump 3 (Height: 90mm)	85
Table 4.15	Spot speed characteristics of the vehicles at road hump 4 (Height: 80mm)	85
Table 4.16	Spot speed characteristics of the vehicles at road hump 5 (Height: 94mm)	85
Table 4.17	Spot speed characteristics of the vehicles at road hump 6 (Height: 25mm)	85
Table 4.18	Spot speed characteristics of the vehicles at road hump 7 (Height: 70mm)	85
Table 4.19	Spot speed characteristics of the vehicles at road hump 8 (Height: 110mm)	86
Table 4.20	Spot speed characteristics of the vehicles at road hump 9 (Height: 40mm)	86
Table 4.21	Spot speed characteristics of the vehicles at road hump 10 (Height: 30mm)	86
Table 4.22	Spot speed characteristics of the vehicles at road hump 11 (Height: 80mm)	86
Table 4.23	Spot speed characteristics of the vehicles at road hump 12 (Height: 113mm)	86
Table 4.24	Spot speed characteristics of the vehicles at road hump 13 (Height: 120mm)	87
Table 4.25	Spot speed characteristics of the vehicles at road hump 14 (Height: 50mm)	87
Table 4.26	Spot speed characteristics of the vehicles at road hump 15 (Height: 86mm)	87
Table 4.27	Spot speed characteristics of the vehicles at road hump 16 (Height: 70mm)	87
Table 4.28	Spot speed characteristics of the vehicles at road hump 17 (Height: 60mm)	87

Table 4.29	Spot speed characteristics of the vehicles at road hump 18 (Height: 110mm)	88
Table 4.30	Changes in mean speed of car for each road hump at the selected points	90
Table 4.31	Changes in mean speed of motorcycle for each road hump at the selected points	92
Table 4.32	Paired-sample t-test for before-at points of car at all road humps	94
Table 4.33	Paired-sample t-test for before-at points of motorcycle at all road humps	95

LIST OF FIGURES

Figure 1.1	The locations of selected road humps in IIUM	7
Figure 2.1	Types of road hump	18
Figure 2.2	Road hump dimensions according to guidelines	19
Figure 2.3	Section A-A of road hump	19
Figure 2.4	Elevation of road hump	20
Figure 3.1	Research framework of the study	28
Figure 3.2	Cross-section of the IIUM main road	29
Figure 3.3	Road hump dimension on IIUM main road	29
Figure 3.4	Road hump dimension on the IIUM main road	30
Figure 3.5	Stalker Lidar XS radar gun	31
Figure 3.6	Method of collection for spot speed data in IIUM	33
Figure 4.1	Spot speed pattern of cars at road hump 1	45
Figure 4.2	Spot speed pattern of cars at road hump 2	45
Figure 4.3	Spot speed pattern of cars at road hump 3	45
Figure 4.4	Spot speed pattern of cars at road hump 4	46
Figure 4.5	Spot speed pattern of cars at road hump 5	46
Figure 4.6	Spot speed pattern of cars at road hump 6	46
Figure 4.7	Spot speed pattern of cars at road hump 7	47
Figure 4.8	Spot speed pattern of cars at road hump 8	47
Figure 4.9	Spot speed pattern of cars at road hump 9	47
Figure 4.10	Spot speed pattern of cars at road hump 10	48
Figure 4.11	Spot speed pattern of cars at road hump 11	48
Figure 4.12	Spot speed pattern of cars at road hump 12	48
Figure 4.13	Spot speed pattern of cars at road hump 13	49

Figure 4.14	Spot speed pattern of cars at road hump 14	49
Figure 4.15	Spot speed pattern of cars at road hump 15	49
Figure 4.16	Spot speed pattern of cars at road hump 16	50
Figure 4.17	Spot speed pattern of cars at road hump 17	50
Figure 4.18	Spot speed pattern of cars at road hump 18	50
Figure 4.19	Spot speed pattern of motorcycles at road hump 1	53
Figure 4.20	Spot speed pattern of motorcycles at road hump 2	53
Figure 4.21	Spot speed pattern of motorcycles at road hump 3	53
Figure 4.22	Spot speed pattern of motorcycles at road hump 4	54
Figure 4.23	Spot speed pattern of motorcycles at road hump 5	54
Figure 4.24	Spot speed pattern of motorcycles at road hump 6	54
Figure 4.25	Spot speed pattern of motorcycles at road hump 7	55
Figure 4.26	Spot speed pattern of motorcycles at road hump 8	55
Figure 4.27	Spot speed pattern of motorcycles at road hump 9	55
Figure 4.28	Spot speed pattern of motorcycles at road hump 10	56
Figure 4.29	Spot speed pattern of motorcycles at road hump 11	56
Figure 4.30	Spot speed pattern of motorcycles at road hump 12	56
Figure 4.31	Spot speed pattern of motorcycles at road hump 13	57
Figure 4.32	Spot speed pattern of motorcycles at road hump 14	57
Figure 4.33	Spot speed pattern of motorcycles at road hump 15	57
Figure 4.34	Spot speed pattern of motorcycles at road hump 16	58
Figure 4.35	Spot speed pattern of motorcycles at road hump 17	58
Figure 4.36	Spot speed pattern of motorcycles at road hump 18	58
Figure 4.37	Frequency of car speed changes at road hump 1	65
Figure 4.38	Frequency of car speed changes at road hump 2	65
Figure 4.39	Frequency of car speed changes at road hump 3	66
Figure 4.40	Frequency of car speed changes at road hump 4	66

Figure 4.41	Frequency of car speed changes at road hump 5	66
Figure 4.42	Frequency of car speed changes at road hump 6	67
Figure 4.43	Frequency of car speed changes at road hump 7	67
Figure 4.44	Frequency of car speed changes at road hump 8	67
Figure 4.45	Frequency of car speed changes at road hump 9	68
Figure 4.46	Frequency of car speed changes at road hump 10	68
Figure 4.47	Frequency of car speed changes at road hump 11	68
Figure 4.48	Frequency of car speed changes at road hump 12	69
Figure 4.49	Frequency of car speed changes at road hump 13	69
Figure 4.50	Frequency of car speed changes at road hump 14	69
Figure 4.51	Frequency of car speed changes at road hump 15	70
Figure 4.52	Frequency of car speed changes at road hump 16	70
Figure 4.53	Frequency of car speed changes at road hump 17	70
Figure 4.54	Frequency of car speed changes at road hump 18	71
Figure 4.55	Frequency of motorcycle speed changes at road hump 1	73
Figure 4.56	Frequency of motorcycle speed changes at road hump 2	73
Figure 4.57	Frequency of motorcycle speed changes at road hump 3	74
Figure 4.58	Frequency of motorcycle speed changes at road hump 4	74
Figure 4.59	Frequency of motorcycle speed changes at road hump 5	74
Figure 4.60	Frequency of motorcycle speed changes at road hump 6	75
Figure 4.61	Frequency of motorcycle speed changes at road hump 7	75
Figure 4.62	Frequency of motorcycle speed changes at road hump 8	75
Figure 4.63	Frequency of motorcycle speed changes at road hump 9	76
Figure 4.64	Frequency of motorcycle speed changes at road hump 10	76
Figure 4.65	Frequency of motorcycle speed changes at road hump 11	76
Figure 4.66	Frequency of motorcycle speed changes at road hump 12	77
Figure 4.67	Frequency of motorcycle speed changes at road hump 13	77

Figure 4.68	Frequency of motorcycle speed changes at road hump 14	77
Figure 4.69	Frequency of motorcycle speed changes at road hump 15	78
Figure 4.70	Frequency of motorcycle speed changes at road hump 16	78
Figure 4.71	Frequency of motorcycle speed changes at road hump 17	78
Figure 4.72	Frequency of motorcycle speed changes at road hump 18	79
Figure 4.73	Comparison of changes in average car speed with the height of all road humps	90
Figure 4.74	Comparison of changes in average motorcycle speed with the height of all road humps	92

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Road transport in Malaysia is constantly growing to catch up with the growth of population, urbanization and economy. As for that, the numbers of registered vehicle keep on increasing aligned with the expanding economy. Unfortunately, it leads to the increase of traffic volume as well as the accident rate inside Malaysia. It is related to the study by Mohd Shariff (2016) where the rate of accident increase linearly with the increasing numbers of registered vehicle (as cited by Zainala et al., 2018). Department of Statistics Malaysia (2017) highlighted a number of 521,466 cases of road accidents were reported in 2016 compared to 462,423 in 2012. It increases for about 59,043 cases for the past years. Speeding was the main cause of the increase in accident rate (Fonseca & Okumura, 2010).

As the speed increases, the injury severity in crashes also increases (Institute of Road Safety Research, 2012). The statement narrates that excessive speeding consequently leads to major accidents. It is a cumbersome situation if the scenario of significant accident arises within an institutional area as the safety of users is a priority. Moreover, it eventually declines the conducive and pleasant learning environment of the university. In triggering the issue, traffic calming measure, especially road hump, was introduced practically on campus.

Road hump necessities have been renowned by several types of research as an effective traffic calming measure. It is being addressed whereby analysis of fatal and injury accident data on the road sections with vertical traffic calming measures showed the significant decrease of fatal and injury accidents after installation of these measures.

The number of fatal and injury accidents decreased by 60%, the number of people injured reduced by 63%, the number of people killed reduced by 82% (Jateikienė et al., 2016). Huang and Cynecki (2000) also noted that traffic calming is a viable solution for the deterioration of living conditions caused by increased vehicle speed by giving the impression that the road is not meant for high-speed traffic.

The speed of moving vehicles very much hinges on the design characteristics of the road humps. It echoed the findings by Johnson & Nedzesky (2004), which mentioned speed humps and the speed cushions all generated average speeds that were approximately ten mph and 85th percentile speed that were less than 15 mph.

Currently, in International Islamic University Malaysia (IIUM), the existing condition of vehicle speed in the campus is observed to be higher than the speed limit of 30km/h even when there are several road humps located on the main road. It significantly affects the safety of pedestrian and other road users on-campus. Hence, the purpose of this study is to evaluate the effects of road humps on the speed of moving vehicles along the major circular road of International Islamic University Malaysia (IIUM). Different locations and profiles of road humps are chosen, and it will be later compared with each other. The outcomes will be used to recommend the practical design of road humps to improve the learning environment in the campus.

1.2 PROBLEM STATEMENT

Speeding is one of the issue that contributed to the increase of accident as mentioned by Yeo et al. (2020). As a mitigation measure, road humps that act as traffic calming measure are installed at the main circular road of IIUM to address the issue. The moving vehicles are now being forced to slow down or decrease the speed while approaching the road humps. However, the road humps with diverse design profiles, which are being determined by the width, length, and height, have promoted a change in driving behaviour of the drivers when impending these road humps as stated by Werner (2015).

Consequently, it is observed that specific road humps which are placed at a different part of the main road have successfully reduced the speed of the moving vehicle. Nevertheless, there are also road humps which persuaded lesser or almost no effect on the vehicle speed. Thus, it demands the importance of knowing the changes in vehicle movement, especially in terms of speed when approaching road humps with different design characteristics to know the optimum design profile for the road humps installation in the university setting.

1.3 GOAL

The goal of this research is to evaluate the effects of different design profiles of road humps on vehicle speed in the IIUM campus area.

1.4 RESEARCH OBJECTIVES

i. To ascertain the design profiles of the road and the design characteristics of the selected road humps in the campus area;

ii. To analyse the speed pattern, speed characteristics, and speed changes of vehicles with regard to the different heights of road humps;

iii. To test the differences of mean speed before and at the selected road humps;

iv. To recommend measures in improving the effectiveness of road humps in reducing the speed of vehicles in an institutional environment.

1.5 RESEARCH HYPOTHESIS

There are differences in mean speed of vehicle at and before the road hump.

1.6 SCOPE OF STUDY

The main elements that will be covered to accomplish the goal and objectives are listed under this scope of the study. This research focused on evaluating the effectiveness of the selected road humps in lowering the speed of vehicles along the main road of the institutional area. IIUM's main circle road is chosen for this study as the selected road humps are implemented on the road. Generally, 18 available road humps on the main road were chosen for this study. There was only circular (round-top) type of road humps can be found inside the campus. The design profiles such as the height, width and length of each road hump are compared with the existing guidelines. The vehicles chosen for the study are car and motorcycle, as it is observed to be the dominant type of vehicles available in the campus area.

1.7 DESCRIPTION OF STUDY AREA

Road humps are being used as a safety measure in the International Islamic University of Malaysia (IIUM) to regulate moving traffic within the allowable speed limits (30km/h) within the institutional environment. The campus is in Gombak, Selangor. It occupies 710 acres of land, 10 km from Kuala Lumpur. The total built-up area inside the university is about 727,279 m^2, as reported by IIUM Development Division in 2013. The primary access is through Jalan Gombak and Middle Ring Road 2 (MRR2). It is within easy reach of public transport.

The increase in car registered vehicles (staffs and students) at IIUM Gombak rose from 8895 in 2015 to 8915 in 2016 (0.22% increase) while motorcycles rose from 4189 in 2015 to 4386 in 2016 (4.5% increase) according to IIUM Traffic Unit in 2016. However, there are no data available regarding the rate of accidents happened inside the campus. If not adequately controlled, the increasing number of vehicles may cause adverse effects on the institution's teaching and learning environment especially on the safety aspect.

Inside the university, the road network framework is based on the design of a ring roadway. The main road connects vital functional areas such as academia, administration, and central facilities. The main road continues along the circle with a single carriageway made of two lanes (one-way traffic).

The International Islamic University of Malaysia (IIUM) is one of the country's academic institution which imposes the use of road humps as safety measures to control the moving traffic within the speed limit of 30km/h. This research focuses on a one-way major road on the IIUM campus equipped with road humps. The main institutional road comprises of 18 road humps with different design profiles. Figure 1.1 illustrated the location for each selected road humps.

Road hump 1 (RH1) is located near the main entrance of the IIUM campus. It is implemented before a junction that leads to a car parking area at the Rectory building. Road hump 2 (RH2) is implemented before a junction to a car park area at the IIUM Cultural Centre (ICC) building which was previously called as Cultural Activity Centre (CAC). While road hump 3 (RH3) is located before a curve road near the Kulliyyah of Architecture and Environmental Design (KAED).

Road hump 4 (RH4) was placed before the junction that leads to the Kulliyyah of Information and Communication Technology (KICT). Road hump 5 (RH5) is located after the junction and on an uphill road. Road hump 6 (RH6) is implemented before a bus stop in front of the Kulliyyah of Engineering (KOE). Moreover, road hump 7 (RH7) is located after the bus stop and the junction that leads to the IIUM Health and Wellness Care. Whilst road hump 8 (RH8) is placed before the junction that leads to the Female Sport Complex of IIUM. Road hump 9 (RH9) is located after a bus stop near Mahallah Nusaibah and before the junction to Kulliyyah of Islamic and Revealed Knowledge and Human Sciences (KIRKHS).

Next, road hump 10 (RH10) is placed on the main road that is next to the main library of IIUM. Road hump 11 (RH11) is located before the junction to Mahallah Salahuddin. Whereas road hump 12 (RH12) is placed before the junction to the main building of Ahmad Ibrahim Kulliyyah of Laws (AIKOL). Road humps 13 (RH13), 14 (RH14), and 15 (RH15) are located before the junction to three different car park areas at Kulliyyah of Economics and Management Sciences (KENMS). Moreover, road hump 16 (RH16) is placed at a junction before a junction to the main library of IIUM. While road hump 17 (RH17) is located before the bus stop near Mahallah Safiyyah. Last but not least, road hump 18 (RH18) is placed before a roundabout near the main gate of IIUM.

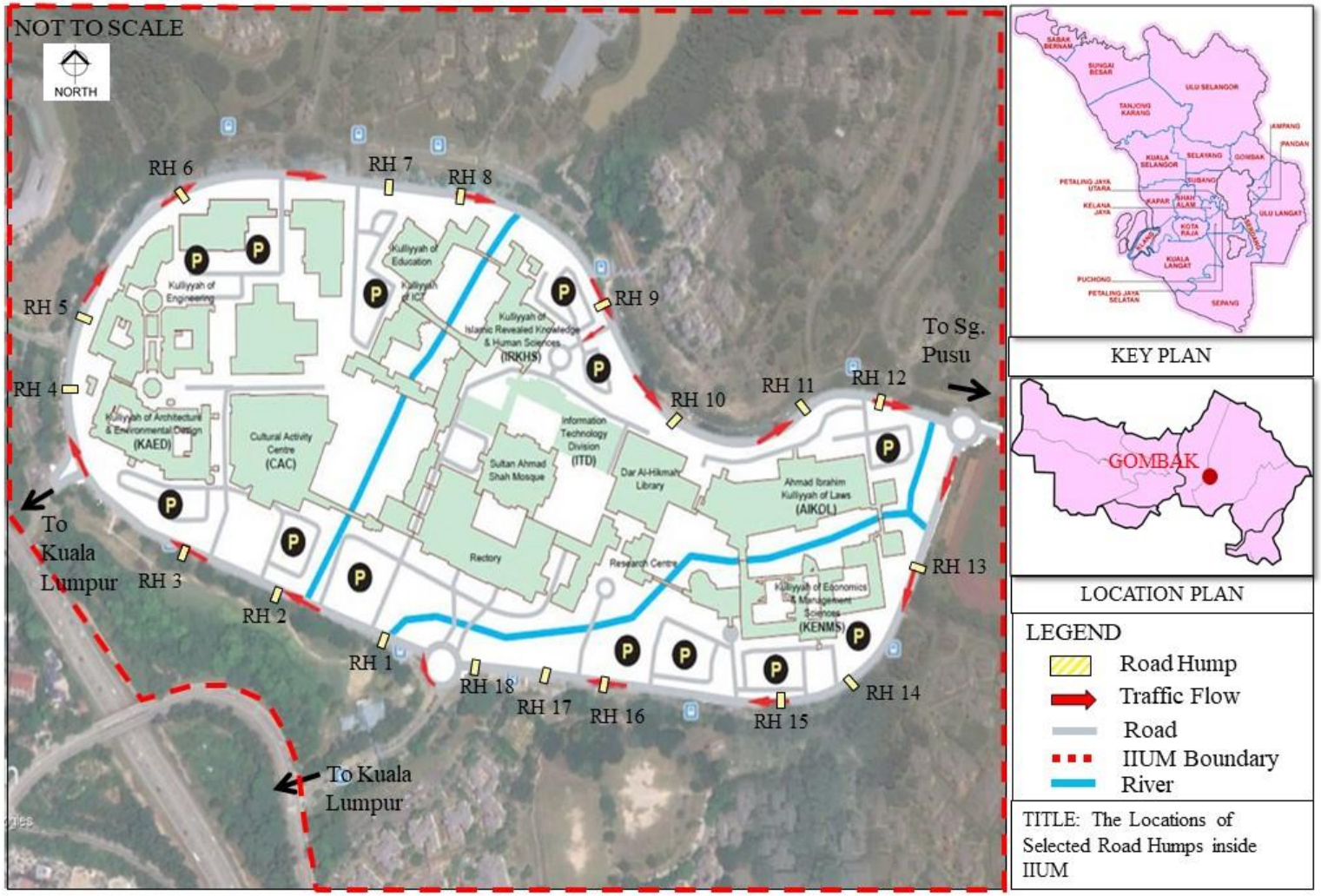

Figure 1.1: The locations of selected road humps in IIUM