



UNIVERSITI PUTRA MALAYSIA

***A PREDICTIVE MODEL FOR COMMUNITY ADAPTIVE BEHAVIOUR
TOWARDS AIR POLLUTION***

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FPAS 2021 17



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TOWARDS AIR POLLUTION**

By

SYAZWANI BINTI SAHRIR

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

July 2021

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DEDICATION

This thesis is dedicated to my parents (Sahrir Zulkifli and Rusiah Ismail) for their prayers, encouragement, and push for tenacity ring in my ears.

I also dedicate this dissertation to my siblings (Shaffiq, Syahmin, Ahmad, Ayu) and my cutest nephew (Umar) and niece (Humaira), who have supported me throughout the process.

Most of all, thanks to Allah SWT, who continues to make the impossible possible.



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

A PREDICTIVE MODEL FOR COMMUNITY ADAPTIVE BEHAVIOUR TOWARDS AIR POLLUTION

By

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July 2021

Chairman : Professor Ahmad Makmom bin Abdullah, PhD
Faculty : Forestry and Environment

Air pollution emerges due to the inability to adapt to the waste produced due to the high population density and concentration in relatively small areas. Urban air pollution is a major health risk to millions of residents globally and is estimated to cause about 1.3 million deaths annually. More importantly, little is known about the factors that determine a community's adaptive behaviour in response to air pollution, specifically in Malaysia. Therefore, the main purpose of this study is to develop a preliminary predictive model on factors determining the adaptive behaviour among urban Malaysians towards air quality by integrating three theories; Social Adaptation Theory, Protection Motivation Theory, and Psychometric Paradigm. This model development of the new ABR model applied using a deductive theory-generating research approach and a correlational research design. Seven variables were examined, namely values (VAL), attitude (ATT), perceived vulnerability (PVL), perceived severity (PSV), self-efficacy (SEF), response efficacy (REF), and risk perception (RPN). This study also determined the moderating role of education level and health status on the relationship between key predictors and adaptive behaviour. PLS-SEM was applied to capture the causal effect relationship model of these relationships. The study area was Klang Valley, and a multi-stage cluster sampling technique was employed. The respondents (n = 440) answered the face-to-face questionnaire survey.

The findings of testing the model revealed that out of 7 path coefficients (β) in the structural model, 6 paths had statistically significant direct effects on the interrelationships, while one path did not have any significant effect. The paths that showed significant effects were: VAL, PVL, PSV, SEF, REF, and RPN on adaptive behaviour. The path with non-significant effects was the ATT. Furthermore, this study also examined the education level and health status as moderating variables for the model. In addition to the path coefficients (direct effect relationship), the structural model also revealed 3 coefficients with significant moderating effects out of 14 for the interrelationships among the key predictors and the adaptive behaviour investigated in

the study. The moderating effect was observed for education level in the relationship between values and adaptive behaviour. As for health status, two significant relationships were found: the moderating role of health status in the relationship between perceived vulnerability and risk perception with adaptive behaviour. Overall, the structural model explained about 61.5% of the variance in the adaptive behaviour of the community towards urban air quality. In conclusion, this study verifies that values, self-efficacy, perceived severity, response efficacy, risk perception, and perceived vulnerability have a major impact on the adaptive behavioural responses of the community towards urban air pollution. The study contributed significantly to the literature by indicating PMT, SAT, and PPM as the ideal framework to capture the adaptive behavioural responses toward urban air pollution. Additionally, this study suggests that the authority could play a meaningful role in drafting effective guidelines to reduce the impact of air pollution on the public, especially in cities affected by air pollution.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

MODEL RAMALAN BAGI PERILAKU ADAPTASI KOMUNITI TERHADAP PENCEMARAN UDARA

Oleh

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Pencemaran udara terjadi kerana ketidakupayaan dalam menyesuaikan diri dengan sisa buangan yang dihasilkan oleh kepadatan penduduk yang tinggi di kawasan yang sempit. Pencemaran udara di kawasan bandar antara penyebab utama risiko kesihatan yang melibatkan berjuta-juta penduduk bandar di seluruh dunia dan punca terhadap kematian yang dianggarkan sekitar 1.3 juta setiap tahun. Apa yang penting, hanya terdapat sedikit pengetahuan terhadap faktor-faktor penentu yang dapat menentukan perilaku adaptasi komuniti sebagai tindak balas terhadap pencemaran udara, khususnya di Malaysia. Oleh itu, tujuan utama kajian ini adalah untuk mengembangkan model ramalan awal mengenai faktor-faktor yang menentukan perilaku adaptasi di kalangan rakyat Malaysia yang tinggal di bandar terhadap kualiti udara dengan mengintegrasikan tiga teori; Teori Adaptasi Sosial (SAT), Teori Motivasi Perlindungan (PMT), dan Paradigma Psikometrik. Pengembangan model baru ABR ini diaplikasikan menggunakan pendekatan penyelidikan penjaanaan teori deduktif dan reka bentuk penyelidikan korelasi. Dengan menggunakan model ini, kesan bagi faktor penentu pada perilaku adaptasi terhadap pencemaran udara bandar dapat dikaji. Tujuh pemboleh ubah dikaji, iaitu nilai (VAL), sikap (ATT), persepsi terhadap bahaya (PVL), persepsi terhadap keterukan (PSV), keupayaan diri (SEF), keupayaan tindak balas (REF), dan persepsi terhadap risiko (RPN). Kajian ini juga menentukan peranan tahap pendidikan dan status kesihatan sebagai kesan penyederhana terhadap hubungan antara semua faktor penentu dan perilaku adaptasi. PLS-SEM digunakan untuk memperolehi model perhubungan sebab-akibat ini daripada hubungan ini. Kawasan kajian yang terlibat adalah Lembah Klang dan teknik pensampelan rawak berkelompok pelbagai peringkat digunakan. Responden (n = 440) menjawab kaji selidik secara bersemuka.

Penemuan kajian ini menunjukkan bahawa daripada 7 nilai koefisien jalur (β) dalam model struktur, 6 jalur mempunyai kesan langsung yang signifikan secara statistik terhadap hubungan, sementara satu jalur tidak mempunyai pengaruh yang signifikan. Jalur yang menunjukkan kesan yang signifikan adalah: VAL, PVL, PSV, SEF, REF, dan

RPN terhadap perilaku adaptasi. Jalur dengan kesan tidak signifikan adalah ATT. Selanjutnya, kajian ini juga mengkaji tahap pendidikan dan status kesihatan sebagai pemboleh ubah penyederhana untuk model ini. Sebagai tambahan kepada koefisien jalur (hubungan kesan langsung), model struktur juga mendedahkan 3 daripada 14 koefisien dengan kesan penyederhanaan yang signifikan, melibatkan hubungan antara satu sama lain antara faktor penentu dan perilaku adaptasi yang dikaji dalam kajian. Kesan penyederhanaan yang diperhatikan untuk tahap pendidikan dalam hubungan adalah antara nilai dan perilaku adaptasi. Bagi status kesihatan sebagai penyederhana dalam model, dua hubungan yang signifikan ditemui: kesan penyederhana bagi status kesihatan dalam hubungan antara persepsi terhadap bahaya dan persepsi risiko dengan perilaku adaptasi. Secara keseluruhan, model struktur untuk kajian ini menjelaskan sekitar 61.5% varians dalam perilaku adaptasi komuniti terhadap kualiti udara bandar. Sebagai kesimpulan, kajian ini mengesahkan bahawa nilai, keupayaan diri, persepsi terhadap keterukan, keupayaan tindak balas, persepsi terhadap risiko, dan persepsi terhadap bahaya mempunyai pengaruh besar terhadap perilaku adaptasi masyarakat terhadap pencemaran udara bandar. Kajian ini memberikan sumbangan yang signifikan terhadap literatur dengan menunjukkan PMT, SAT, dan PPM sebagai kerangka yang ideal untuk menerangkan perilaku adaptasi terhadap pencemaran udara bandar. Selain itu, kajian ini menunjukkan bahawa pihak berkuasa dapat memainkan peranan penting dalam merangka garis panduan yang berkesan untuk mengurangkan kesan pencemaran udara kepada orang ramai, terutama di bandar-bandar yang terjejas.

ACKNOWLEDGEMENTS

With the name of Allah, the Most Compassionate and Most Merciful

All praise and thanks to Almighty Allah, with His blessing giving me the strength and passion, could manage to finish the research until this manuscript be compiled. First and foremost, my deepest thanks to my supervisor, Prof Dr Ahmad Makmom Abdullah (Committee Chairman), who provided guidance and supported me while carrying out this research. The supervision and support that he gave truly helped the progression and smoothness of the study. I would also like to thank Dr Amir Hamzah Sharaai and Dr Zakiah Ponrahono as members of the Supervisory Committee for their constant encouragement and invaluable suggestions that made this research successful. My heartfelt thanks also go to other lecturers for their assistance.

This thesis would not have been possible without the love of family. I am grateful to my parents (Encik Sahrir and Puan Rusiah), siblings (Shaffiq, Syahmin, Zuhdi, Ayu), nephew (Umar), niece (Humaira), and extended family members for their marvellous support during my studies, which has contributed to this great success of mine.

I would like to thank a best friend of mine, all my colleagues (Aini, Aimi, Baizura, Kak Maizatul, Adira, Kak Azyiah, Maisarah, Yakin, Shazreena, Atikah, Anun, Fatiah, Kak Fairuz and others), that had given valuable information, suggestions and guidance in the compilation and preparation of this thesis. Thanks to the staff of faculty and SGS UPM, those who have been contributed by supporting my work and helping me during the thesis progress until it is fully completed. I thank those people whom I have not mentioned here for assisting me through this study. I would also like to thank the UPM and Ministry of Higher Education for giving me the opportunity and space to further my studies through the SLAB scholarship and TAM Scheme.

Indeed, I am very grateful for being awarded these great people in my life. Without them, I could not finish this study successfully. May Allah SWT accept our efforts and strengthen us in the path of guidance. Thank you all for your support, kindness, and caring.

This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

12MP	Twelfth Malaysia Plan
ABQ	Adaptive Behaviour Questionnaire
ABR	Adaptive Behaviour
API	Air Pollution Index
AQS	Air Quality Standard
ASMA	Alam Sekitar Malaysia Sdn. Bhd.
ATT	Attitude
AVE	Average Variance Extracted
CB-SEM	Covariance-Based Structural Equation Modelling
CCA	Confirmatory Composite Analysis
CFA	Confirmatory Factor Analysis
CMV	Common Method Variance
CO	Carbon monoxide
CVI	Content Validity Index
DOEM	Department of Environment Malaysia
DOSM	Department of Statistics Malaysia
EEA	European Environment Agency
EFA	Exploratory Factor Analysis
enHealth	Environmental Health Standing Committee
ETP	Economic Transformation Programme
GC	Government of Canada
HEI	Health Effects Institute
HTMT	Heterotrait-Monotrait

IAMAT	International Association for Medical Assistance to Travellers
IARC	International Agency for Research on Cancer
MAAQG	Malaysia Ambient Air Quality Guideline
MAQI	Malaysian Air Quality Index
MoHM	Ministry of Health Malaysia
MyWI	Malaysia Well-Being Index
NIEHS	National Institute of Environmental Health Sciences
NO ₂	Nitrogen dioxide
NRE	Natural Resources and Surrounding Nature
O ₃	Ozone
PAHs	Polycyclic aromatic hydrocarbons
PEB	Pro-Environmental Behaviour
PLS-SEM	Partial Least-Squares Structural Equation Modelling
PM	Particulate matter
PMQ	Protection Motivation Questionnaire
PMT	Protection Motivation Theory
PPM	Psychometric Paradigm
PSV	Perceived severity
PVL	Perceived vulnerability
REF	Response efficacy
RMAQG	Recommended Malaysian Air Quality Guidelines
RPN	Risk perception
RPQ	Risk Perception Questionnaire
SAQ	Social Adaptation Questionnaire

SAT	Social Adaptation Theory
SDGs	Sustainable Development Goals
SEF	Self-efficacy
SEM	Structural Equation Modelling
SO ₂	Sulphur dioxide
SOP	Standard Operating Procedure
SPSS	Statistical Package for the Social Sciences
STM	Structural Topic Modelling
TESB	Theory of Environmentally Significant Behaviour
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UN	United Nations
UNEP	United Nations Environment Programme
VAL	Values
VIF	Variance Inflation Factor
VOCs	Volatile organic compounds
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Overview

This introductory chapter briefly explains the introduction and background of the study on air quality and its impact on behaviour and society. This is followed by the problem statements pertaining to gaps from previous studies and how this research fills those gaps. This chapter also enlightens on research questions, objectives, research significance, scope and limitation of the study, the definition of terms, and outline of the research.

1.2 Introduction

Air pollution is one of the world's leading factors that lead to the risk of death and environmental problems. The constant rise in air pollution levels has made it a major threat to global public health and therefore requires the responsible participation of researchers at all levels. Air pollution levels vary widely around the world, and no country can escape it. In such a situation, 9 out of 10 people breathe air containing high pollution levels (World Health Organization (WHO), 2020a). While most empirical studies on air pollution have concentrated on metropolitan areas in developed countries (Dedoussi et al., 2020; Lu & Liu, 2015; Mccarty & Kaza, 2015; Miao et al., 2015; Romero-Lankao et al., 2013; Chuanwang Sun et al., 2018), urbanisation, which has advanced rapidly in developing countries (Manisalidis et al., 2020), may have a more profound effect, so the urban air environment deserves more interest. The rapid, unsustainable lifestyle and unplanned urbanisation in developing countries have rendered them as the focal point of dense urban centres with poor air quality (Ahmed et al., 2017; Fotourehchi, 2016; Mannucci & Franchini, 2017; WHO, 2020b; Zalakeviciute et al., 2019; Zhou et al., 2018). Specifically, exposure to urban air pollution is one of the many environmental and public health concerns currently confronting the world's population. As reported by WHO, based on recent data from a national survey covering more than 4300 cities, more than 80% of the urban population lives in areas that do not comply with air quality guidelines for particulate matter PM_{2.5} (WHO, 2020b). Additionally, urban air pollution remains a major health risk to millions of urban residents globally, and it is estimated to cause about 4.2 million deaths annually (Muindi et al., 2014; WHO, 2020a). This association may be particularly important for rapidly developing economies and densely populated Asian countries, which are increasingly exposed to unhealthy air quality.

Rationally, people should imagine the degree of risk and the possibility of an association between air pollution and health risk that may arise if they are living in the cities. Compared to other types of risks such as natural hazards, individual exposure to air pollution is immeasurably linked to how they are exposed to it (Chen et al., 2018;

Jiuchang Wei et al., 2017). Thus, in this scenario, people may adapt to reduce the negative impacts of the potential risk and to take advantage of new opportunities (Ban et al., 2017; Ebert & Welsch, 2011; Government of Canada (GC), 2015). Basically, adaptation can be described as the balance reached between the subject and the environment (Terziev & Stoyanov, 2019). Collectively, people have a tremendous influence on air quality, so how they adapt and respond behaviourally will reduce the impact of pollution. However, far less is known regarding the factors influencing people's adaptation towards air pollution. How people adapt and behave in the face of the effects, especially those who live in urban areas with poor air quality, is much less understood. Therefore, this issue is an important topic to study, especially because the world cannot avoid exposure to air pollution; it can only deal with it, and how people adapt to air pollution will determine the state of the environment.

1.3 Background of study

As a developing country, Malaysia has undergone a dramatic transformation from a dependency on agriculture and commodity exports into a more diversified and open economy, particularly after 1981 (Koen et al., 2017; Saadatian et al., 2011). The transformation of Malaysia's economy from agriculture-based to the modern industry has caused increased environmental issues. Malaysia aims to become a developed country in 2020, in line with the global mission of Sustainable Development Goals (SDGs 17), so the country must ensure healthy air quality meets the standards of a developed country (Ujang et al., 2013). Goal 11 by the United Nations (2020) states: "...By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management". Nevertheless, as Cook (2016) stated, it is unfortunate that countries, such as Malaysia, have achieved considerable levels of development but have overlooked the effects of such development on the environment and the people. Air pollution has now become one of the primary environmental issues in Malaysia due to the growing number of motor vehicles, increased industrial activities (stationary), and transboundary pollution from neighbouring countries (Azid et al., 2013; Cook, 2016; Mabahwi et al., 2015; Vos et al., 2013).

Malaysia experienced the worse transboundary haze episode in 2005 due to massive land and forest fires in neighbouring countries, namely, Indonesia (Department of Environment Malaysia (DOEM), 2017; Othman et al., 2014). The activity generates transboundary smoke haze, an annual phenomenon that degrades the local air quality and is presumably the major source of ambient PM_{2.5} in Malaysia (Fujii et al., 2016; Othman et al., 2014). Additionally, the most recent haze in 2019 was the worst yet, with unhealthy air pollution levels resulting in extensive illnesses in many areas of Malaysia (DOEM, 2019). Air pollution easily spreads out beyond the boundary of a megacity to wider surrounding areas (Geelen et al., 2013; Marlier et al., 2016; Rahman et al., 2015). Thus, air quality is now a regional issue. Several studies indicate that air pollution has brought about two important concerns: the effect on human health and the effect on the environment (Ghorani-Azam et al., 2016; Hassan et al., 2016; Sass et al., 2017). Several community initiatives to reduce air pollution include avoiding exposure to haze, staying indoors, and wearing facemasks in appropriate circumstances. Hence, macro-level

environmental policies and solution-based approaches are necessary with some involvement from the community.

Note that air quality is the key aspect of city life and sustains the process of urban growth and development (Marlier et al., 2016; Steeneveld et al., 2016). Most air quality studies focused on urban areas, especially Klang Valley, Malaysia (Abdul Rashid et al., 2014; Rahman et al., 2015; Zakaria et al., 2018; Zulkepli et al., 2019), as this area has a significant population number, and transportation, industrial and urban activities. These activities are prevalent in dense urban centres with poor air quality and increased public health risks. Klang Valley, one of the popular economic zones in Malaysia, has experienced a great decline in air quality levels due to urbanisation (Azmi et al., 2010; Mohamad et al., 2015). Azid et al. (2015) also reported the same finding showing the high levels of atmospheric pollutants in the Southern region of Peninsular Malaysia. This pollution is attributed to the rapid industrial development and urbanisation in this region over the years. The rigid separation of employment, commercial, housing, and recreational areas has forced the population to rely on road-based transport, which further contributes to greenhouse gas emissions and high levels of urban air pollution (Mabahwi et al., 2015; Shakir et al., 2017), in turn, slowly degrading the quality of the urban living environment.

Moreover, higher numbers of motor vehicles, industries, and other activities in the city result in increased amounts of nitrogen dioxide (NO₂), ozone (O₃), particulate matter (PM₁₀) formation, and carbon monoxide (CO) emission (Shakir et al., 2017). Urban mobility is considered the main contributor (70%–75%) of urban air pollution (Chin et al., 2019). At the same time, projected population increases in urban areas in the coming decade emphasise the importance of identifying the source, variations, and effects of air pollution. Primarily, urban air pollution is produced by the inability of the general public and the environment to adapt to the level of waste produced due to the high population density and high concentration in relatively small areas (Mabahwi et al., 2015). The severity of air pollution in urban areas has always been an issue, but the behaviour of the general community towards this event is still unclear (Ban et al., 2017; Huang et al., 2017). Studies on air pollution in Malaysia have mainly focused on atmospheric aspects of pollution, particularly emphasising on quantifying the level and nature of pollutants (Althuwaynee et al., 2020; Azid et al., 2015; Fujii et al., 2016; Ghadimzadeh et al., 2015; Isiyaka & Azid, 2015; Mabahwi et al., 2015; Othman et al., 2014; Rahman et al., 2015; Ujang et al., 2013; Wahid et al., 2013; Wan Mahiyuddin et al., 2013). However, there is little information available on the social aspect of pollution, with few studies investigating the behaviour of the community towards air pollution. Adaptation is not simply about avoiding the harms of pollution; the victims must also be prepared to accept significant changes to their lives in the ascertainable future (Nagle, 2011). This problem has not been studied extensively in the literature despite the fact that people should adapt to air pollution to handle any possible worst-case scenarios.

People seem to adapt to positive and negative changes in their lives by changing their standards, goals, and expectations, and thus people can change their behaviour to reduce environmental impacts (Gifford & Nilsson, 2014). Basically, several research works

have stated that individual behavioural modification in response to serious air pollution issues could help reduce individual exposure and protect human health (Giles et al., 2011; Laumbach et al., 2015). In addition, people's behaviour and action regarding preventive measures depend on the way they perceive environmental stimuli (Ban et al., 2017). Thus, it is crucial for policymakers to acknowledge people's behavioural changes so as to protect public health via adaptive measures. With a better understanding of individual behavioural responses towards poor air quality, the negative effects of air pollution can be reduced.

In 2011, DOE Malaysia announced its five strategies under the "Clean Air Action Plan", which set a series of strict targets for emission control and promotes actions to develop cleaner industrial infrastructure, reduce emissions from vehicles, prevent haze from open-burning and forest fires, improve self-efficacy, as well as strengthen community engagement awareness towards air pollution (DOEM, 2013). Despite increasing recognition of the severity of air pollution over time, spontaneous awareness of air pollution is still low among the community, even if they live in heavily polluted areas (Oltra et al., 2017; Oltra & Sala, 2014). While waiting for controls to take effect to improve ambient air quality, urban Malaysian citizens have commenced small-scale personal protective behaviours to reduce the risks of adverse health effects from air pollution, such as wearing protective masks and reducing outdoor activities (De Pretto et al., 2015; Wong et al., 2017). Therefore, case studies should be conducted to determine the connection between community adaptation behaviour and air quality. Such a study will shed light on the community's adaptive behavioural changes to reduce the impact of air pollution.

1.4 Problem Statements

As a consequence of modern industrial society, urban air pollution has become a significant risk. Air pollution results from various urbanisation processes driven by different socio-economic activities, which also affects the travel and daily behaviour of the community (Hodgson & Hitchings, 2018). From this perspective, air pollution primarily affects those in densely populated areas, where road emissions contribute the most to air quality degradation (Manisalidis et al., 2020). Effective air pollution control requires the participation of all members of the community. The community can play several roles to avoid pollution from these sources, including shifting from motorised to active travel, being aware of local air pollution levels, minimising personal exposure to air pollution, and engaging in moderate outdoor physical activity when air pollution levels are high (Carlsten et al., 2020; Giles et al., 2011). Therefore, community activity modification, such as varying the duration, intensity, and location of physical activity, can help reduce air pollution exposure. As a result, the public must be empowered with guidelines and strategies for mitigating the effects of air pollution. However, there is an unmet need for community ways to limit their exposure to harmful levels of air pollution. Given the importance of the community's success in reducing exposure to polluted air and related health impacts, this study first addressed the lack of understanding of community adaptive behavioural responses to air pollution and factors driving these responses among urban residents.

Adaptation takes a broad conceptual approach to the relationship between this behaviour and air quality and the relationship between them. By understanding the factors driving the behaviour changes in air quality, the practical recommendations should be useful for advising the general public on individual-level interventions to reduce air pollution exposure and mitigate health risks. Although there is widespread acknowledgement due to the extensive research that has been done on specific behavioural responses, such as enhancing indoor air quality protection (Haverinen-Shaughnessy et al., 2015; Li et al., 2015; Mohd Nor Rawi et al., 2015; Settimo & D'Alessandro, 2014), effects of air pollution on daily normal behaviour (outdoor activities) (Hu et al., 2017; Lang-Yona et al., 2016; Laumbach et al., 2015), location choice behaviour (Lu, Zhang, & Rahman, 2017), or changing travel behaviour (Adams et al., 2016; Davison et al., 2014; Haddad & de Nazelle, 2018; Kramnaimuang et al., 2013; Sá et al., 2017; Shekarrizfard et al., 2017; Xia et al., 2015; Zailani et al., 2016), there is still limited research on how communities adapt to the risk of air pollution in this country. This work is the first such study.

Ban et al. (2017) stated that to establish effective mitigation measures, identifying the factors underlying different community responses must be identified. Given the detrimental effects of air pollution, strategies are required to assist the public in reducing their daily exposure. Above all, little is currently known regarding the factors driving changes in community adaptation and response to air pollution, specifically within Malaysia and particularly among urban residents, who are frequently exposed to air pollution. In the literature, subjective behaviour, which varies among groups and individuals, is the significant factor shaping the public's perception of air quality (Pantavou et al., 2017). Adaptive behaviour, in response to severe air pollution, could help decrease individual disclosure of air pollution and protect public health (Ban et al., 2017). The evidence indicates that the development of new interventional and prevention frameworks that are not only focused on community-level regulations but also on individual-level perspectives is necessary and may potentially offer a new solution to the air pollution problem (Araban et al., 2017). This study addresses the lack of studies on the factors that possibly impact community adaptation towards air pollution, although it is important to encourage people to lower their exposure to air pollution.

Moreover, community involvement in environmental issues is crucial for policy formulation and implementation (Rahman, 2011). Accordingly, community complaints regarding environmental issues in Malaysia is a significant indicator of the quality of life (Siddiquee, 2013). Their constructive complaint to the DOEM manifests public participation involvements in environmental management planning and policy formulation. In one example, about 4,467 cases of public were logged in 2012 regarding air pollution (DOEM, 2012). Monitoring, environmental management plan, and public disclosure of urban air quality are vital to developing sustainable urban environmental management. Presently, Malaysian government officials at central and local levels have addressed guidelines for individual behavioural modifications regarding continuous haze episodes. These guidelines have been advertised during haze episodes, to reduce the emissions from vehicles, stop open burning, and strengthen community engagement and awareness, with the aim of encouraging citizens to reduce exposure to poor air quality (DOEM, 2017). However, the content of these guidelines is vague and mostly addresses

outdoor behavioural modification. As such, there is a lack of detailed guidelines to adapt behaviour towards improving air quality and lower transport emissions, limiting air pollution. With a government solution to the haze crisis remaining elusive (De Pretto et al., 2015), studies on community perception and behaviour in response to the phenomenon are urgently needed. To provide more substantial evidence of effective behavioural interventions for appropriate response and mitigation measures, it is critical to improving the current understanding of the overall mechanisms influencing individual behaviour to improve awareness of air quality standards.

Although previous studies have listed various factors affecting the individual-level response to haze episodes, such as the psychosocial perceptions of air pollution (Chin et al., 2019; Liao et al., 2015; Liobikiene & Juknys, 2016), environmental concerns, and knowledge about environmental issues (Pothitou et al., 2016; Sarker et al., 2018), the effects of the interactions among multiple factors have not been studied as much (Ban et al., 2017). Therefore, per Oltra and Sala (2014), there is a need to study the community's coping or protection behaviour regarding air pollution. Studies have not investigated people's behaviour and perception of air pollution because the issue is linked to various mechanisms in the economy and society at large. Thus, as Yang and Shi (2017) mentioned, the study of psychological and behavioural responses to air pollution is theoretically and practically significant.

Previous studies (Ru et al., 2019; Shi, Wang, et al., 2017; Terziev & Stoyanov, 2019) have attempted to determine a theory that bests explain adaptive behaviour. However, these studies reported inconsistent and inconclusive results, with most using variables from existing or modified theoretical sources that focus on one aspect of behaviour (Chin et al., 2019; Price et al., 2018). Accordingly, adaptive behaviour is still an emerging construct that has not been conceptualised or measured in-depth (Spreat et al., 2012). For example, the Protection Motivation Theory (PMT) has been identified as the most widely applied model to explain adaptation towards risk. Nevertheless, the theory explains how people protect themselves from risk (Babcicky & Seebauer, 2018; Cismaru et al., 2011; Keshavarz & Karami, 2016; Koerth et al., 2013), but it does not consider the social cognition and moral aspect of behaviour. Meanwhile, the Social Adaptation Theory (SAT) is vague and has no independent definition (Price et al., 2018; Terziev & Stoyanov, 2019), so its applicability is still debatable.

In sum, there is a lack of works that have employed empirically validated theories to examine the key factors influencing a community's adaptive behaviour to air pollution. Therefore, there is a research gap in this field. A predictive model should thus be developed to enhance understanding of community adaptation, particularly towards urban air pollution. This study will benefit relevant organisations and help them create effective behavioural interventions and guidelines for appropriate mitigation measures. Thus, more insights into socio-psychological factors influencing the behavioural modification of the community to air pollution will provide a more in-depth explanation of how to achieve a sustainable society and consequently address air quality problems in the country.

1.5 Research Questions

Three research questions are addressed in this research:

1. What is the level of the key predictors of adaptive behaviour in a community towards urban air quality?
2. What are the significant direct effects of cognitive functions (values and attitudes), threat appraisal (perceived vulnerability and perceived severity), coping appraisal (self-efficacy and response efficacy) and risk perception on adaptive behaviour towards urban air quality?
3. What are the moderating effects of education level and health status on the key predictors of adaptive behaviour towards urban air quality?

1.6 Research Objectives

This research aims to develop a predictive model for determining the adaptive behaviour among urban Malaysians towards urban air quality to establish effective behavioural interventions.

General objectives

The general objective of this study is to evaluate factors determining the current adaptive behaviour towards urban air quality and to develop a predictive model based on the factors driving these responses.

1.6.1 Specific objectives

The specific objectives of this study are:

1. To describe the level of the key predictors of adaptive behaviour in a community towards urban air quality.
2. To evaluate the direct effects of the cognitive functions (values and attitudes), the threat appraisal (perceived vulnerability and perceived severity), the coping appraisal (self-efficacy and response efficacy), and risk perception on adaptive behaviour among the community towards urban air quality.
3. To examine the role of education level and health status as moderating effects on the relationship between key predictors and adaptive behaviour to urban air quality.
4. To develop a preliminary model of predictor factors that influencing adaptive behaviour among the community towards urban air quality.

1.7 Significance of the study

This study makes several significant contributions to the existing literature and has policy implications:

1.7.1 Theoretical

The community behavioural response towards air pollution could indicate the social dimensions and circumstances under which people understand pollution (Huang et al., 2017). Moreover, effective risk communication and public engagement could also strengthen public awareness about health risks, increase trust in the government, and reduce people's anxiety regarding air pollution (Geelen et al., 2013). To date, it has been very difficult to find quantitative or qualitative studies that have examined the relationship between social adaptation and urban air quality. In terms of theoretical contribution, the present study developed a predictive model consisting of constructs from discrete but complementary PMT, SAT, and Psychometric Paradigm (PPM) (risk perception) of the community based on previous literature.

Therefore, the proposed predictive model provides a comprehensive explanation and enhances understanding of factors that determine the adaptive behavioural responses towards urban air quality. Combining variables from different PMT, SAT, and PPM theories bridges the gap between these theories and several academic fields, including air pollution management. The theory, in this context, reflects the accumulated understanding of the dynamics of change moderators and the a priori assumptions about the concept of human behaviour and what affects that behaviour. This study contributes to the current body of knowledge by providing information on the effects of air pollution on the urban community through their adaptive behavioural responses.

1.7.2 Practical

As for practical implications, the research contributes useful information for developing and implementing guidelines for protecting the community against the effects of air pollution. Currently, there is a lack of more targeted and detailed action guidelines on improving public behaviour to better the air quality and reduce the health impact on the community (Ban et al., 2017). It is crucial to improve the current understanding of the socio-psychological factors influencing behaviour to provide significant evidence on effective behavioural interventions and guidelines such as standard operating procedure (SOP) to improve the practicality of public adaptation according to the guidelines. This study also provides environmental researchers with baseline knowledge, particularly on the community perception and expectation of air quality and its benefits for implementing procedures for self-protection, especially towards public health.

Moreover, this study helps researchers better understand human responses to air pollutions and the routes to achieving a sustainable society. Thus, by identifying the key predictors of the current behaviour of the community to adapt to urban air pollution, this research contributes to developing the foundations for an effective and sustainable society. The proposed predictive model is expected to help researchers and practitioners in the environmental management field improve their understanding of the behavioural adaptation to air pollution in Malaysia and the social factors underlying this phenomenon.

1.8 Scope and Limitation of the Study

The scope of this study is the identification of factors determining a community's behaviour to adapt to urban air pollution in Klang Valley, Malaysia. This study aims to examine the key predictors of behaviour to adapt to urban air quality. This research only covers seven dimensions (values, attitudes, perceived vulnerability, perceived severity, self-efficacy, response efficacy, and risk perception) and the influence of each dimension on the community's behaviour in adapting towards urban air quality. In addition, this study obtained the answers of respondents randomly selected from districts in Klang Valley, Malaysia. As this study only focuses on urban air quality, Klang Valley was deemed the best area to represent the air quality on an urban scale.

It would have been challenging to collect data from the community population and examine and interpret large quantities of data within the time limits and with the minimal financial resources available for this research. Additionally, several discussions on social adaptation address individual psychological adaptation and individual biological adaptation; however, this study researcher only focused on social-psychological adaptation. Moreover, the study is designed to examine a specific group of people. Thus, generalisations should be made only for groups with similar characteristics.

1.9 Operational Definitions of terms

Certain factors influence the community behavioural response to urban air quality. These dimensions include values (VAL), attitude (ATT), perceived vulnerability (PVL), perceived severity (PSV), self-efficacy (SEF), response efficacy (REF), and risk perception (RPN). This section operationally defines these dimensions in more detail.

1.9.1 Adaptive behaviour

From a social context, a person who has adaptive behaviour can negotiate social situations and engage in self-care to meet their own needs and apply skills based on his development level (Perfect et al., 2013; Terziev & Stoyanov, 2019). It can also be defined as the effectiveness and degree of an individual's ability to meet social responsibilities and independence (Price et al., 2018). All these processes indicate

learning and coping over time. In the context of this study, adaptive behaviour can be divided into three behavioural changes, namely concern behaviour, normal daily behaviour, and additional protective behaviour towards air pollution.

1.9.2 Values

There is great variation in how values are defined. Values, in this context, refer to the core aspects of the self. It is a form of 'basic truths about reality, evaluations, or preferences (Felixdóttir, 2017; Liobikiene & Juknys, 2016). Additionally, it can also be defined as a standard ethical behavioural norm and can be taken as antecedents (González-Rodríguez et al., 2019). In this study, only ten basic values that reflect a continuum of related behaviour are focused on self-direction, stimulation, hedonism, achievement, power, safety, conformity, tradition, benevolence, and universalism based on Schwartz (2012). In this study, values refer to the desired goals that serve as guiding principles in the respondents' life to cope with air pollution.

1.9.3 Attitudes

Attitude can be defined as the degree to which an individual has a favourable or unfavourable assessment or appraisal of a particular behaviour (Shi, Wang, & Zhao, 2017). Additionally, attitude is an adaptation abstraction, or generalisations, about functioning in an environment (Wan et al., 2017). In this context, attitude focuses on the feeling and assessment to reduce and protect oneself from air pollution.

1.9.4 Perceived Vulnerability

Perceived vulnerability can be defined as the degree to which a system is susceptible to and unable to cope with the adverse effects of a threat (Yoon et al., 2012). It is the extent to which one perceives, is vulnerable to, and is likely to be affected by the threat (Kim et al., 2012; Lane et al., 2019). In this study, perceived vulnerability is an assessment of how susceptible one is to the threat of air pollution.

1.9.5 Perceived Severity

Perceived severity measures an unwanted outcome that refers to a person's feelings about the seriousness of a negative event (Oltra & Sala, 2018). Additionally, the perceived severity of a threat means the degree of seriousness of the possible harms perceived by an individual (Janmaimool, 2017). It is the magnitude of the consequences to an individual if the threat succeeds (Hellen, 2017). In this study, perceived severity is defined as a measure of an individual's feelings on negative utility towards air pollution.

1.9.6 Self-Efficacy

Self-efficacy is the extent to which a person is capable of performing a recommended coping behaviour (Morowatisharifabad et al., 2018). In addition to the above, a person's beliefs about how efficacious their behaviour is in achieving the desired outcomes are commonly referred to as self-efficacy beliefs (Doran et al., 2015). Within this framework, self-efficacy is an assessment of one's abilities to effectively carry out the adaptation behaviour and whether one can perform an action to protect urban air quality.

1.9.7 Response Efficacy

Response efficacy is the belief that a recommended coping response will be effective in protecting the self or others from a threat (Raineart & Christensen, 2017). It relates to the perceived effectiveness of the respondents' behavioural recommendations. Furthermore, it can be defined as the extent to which a person believes he could adopt a recommended coping behaviour (Janmaimool, 2017). In this context, this study evaluates the extent to which the respondents believe that their protective action will reduce the risk of air pollution.

1.9.8 Risk Perception

Risk perception is the quantitative judgements about the current and desired riskiness of hazards and the desired regulation (Ban et al., 2017). It is an individual preference with respect to different risks. It can be specified as specific characteristics of air pollution that influence how it is perceived, related to the subject of perception and its social relations (Oltra & Sala, 2014). The risk perception can be divided into seven perception factors, such as knowledge, familiarity, concern, severity, dread, controllability, and acceptance towards risk (air pollution and health risk), based on Slovic (1987).

1.10 Outline of thesis

This thesis is organised into five chapters. This chapter introduces the research background, the research question, the research objectives, the research scope, and the significance and contribution of the study. Chapter 2 discusses the literature review to better understand the issues and research trends on air pollution and social adaptation. Chapter 3 presents details about the research methodology and procedures. Chapter 4 elaborates on and discusses the research findings. The recommendations for future work and conclusions of the study are discussed in Chapter 5.

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