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Predictors of the Adoption of Low Carbon Lifestyle

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Abstract

Background: The adoption of low-carbon practices by citizens has become a major priority for governments in reaching GHG emission reduction targets. Individuals are encouraged to adopt a range of behaviours to reduce the negative impact of their lifestyles. Current policy discourses are focused around linear models of behaviour, which assumes that various factors may influence individuals to adopt or reject low-carbon practices. The objective of this study was to better understand these factors by applying a conceptual framework based on Rogers' Theory of Diffusion of Innovation. This study examined a range of low-carbon practices and investigates if a combination of factors affects the adoption of low-carbon lifestyle. The authors queried if there are significant predictors of the level of adoption of low-carbon lifestyles and if personal characteristics moderate the relationships between the predictors and community's adoption of low-carbon lifestyle.

Methods: Criterion samples of community leaders in a low-carbon city were recruited from leaders in residents' association committees in Putrajaya. Data were collected using a questionnaire survey. This study was guided by a grounded theory methodology.

Results: Community leaders identified factors such as resource and support, complexity, policy and regulation, and relative advantage to be directly associated with their adoption of low-carbon lifestyle. These factors were found to be significant predictors of the level of adoption of low-carbon lifestyles. Personal characteristics such as innovator and later adopter characteristics were found to have moderating effects on the relations between adoption of low-carbon and predictor variables.

Conclusion: The study found that community leaders' adoption of low-carbon lifestyle were strongly bound by their perception of attributes of the new lifestyle, however their inner innovativeness contribute significant moderating effects that either enhance or curtail their adoption.

Keywords: Low-carbon lifestyle; Behaviour; Predictors; Innovation; Adoption; Adopter; Community leaders

Introduction

Scientists believe the rapid warming in the last decade is due mostly to human-induced changes to the atmosphere. The Intergovernmental Panel on Climate Change (IPCC) in its 2013 report states that "It is extremely likely [defined as 95-100% certainty] that human influence has been the dominant cause of the observed warming since the mid-20th century. According to the IPCC [1], greenhouse gases in the atmosphere have increased to levels unprecedented in at least the last 800,000 years, reaching a new record high in 2012. The report also states that the period 1990 to 2012 saw a 32% increase in radiative forcing-a measure of the warming effect on the climate, because of increased atmospheric concentrations of greenhouse gases. Anthropogenic GHG emissions are mainly driven by population growth, economic activities, lifestyle, land use patterns, technology and climate policy [2]. The IPCC warned that it is very likely that human induced contribution to warming has led to unprecedented climate change and increasingly extreme weathers. Supporting evidence on the effects of global warming comes from different region and types of phenomena, for example the evidence of accelerated retreat of alpine and continental glaciers [3], heavy rains and floods in northeast China and in the India-Nepal border, severe drought in Angola, Botswana and Namibia, and unprecedented snowfall in Israel, Jordan and Syria [4]. In Malaysia, report shows an increase between 0.1°C to 0.9°C in terms of maximum surface air temperature in parts of the country in a period between 2010 to 2015 [5]. In 2008, it was projected that surface air temperature in the country will increase between 1.5°C to 2°C by 2050, causing extremes in terms of maximum and minimum rainfalls, and frequent extreme weather [6].

Realising the potential catastrophe, countries around the world have rallied to support and take actions. To date some 200 countries have pledged their commitment to reduce CO_2 emissions and proposed various low carbon scenarios which incorporate the idea of low-carbon in all aspects of development. These interventions can be taken at macro level i.e., a nation scale, or at micro level which goes down to the district or community scale. Local-scale actions such as development of low-carbon cities are important in order to implement concrete measures [7]. Exemplary low-carbon cities include London, Munich, Berlin, Leicester, Barcelona, Stockholm, Singapore, and Kyoto. During the 2009 Budget Speech, the Prime Minister of Malaysia has announced the idea for Putrajaya Green City as the country's first low-carbon city. With countermeasures that focus on energy use and waste

management, GHG emission in Putrajaya is estimated to decrease by about 60% from 2007 baseline estimate of 664 kt CO_2 eq to 1,780 kt CO_2 eq in the year 2025 [8]. In the low-carbon city agenda, government policies and non-government organizations actively encourage citizens to take responsibility for environmental issues by adopting low-carbon behaviours in all daily aspects, i.e., low-carbon lifestyle.

Empirical studies, primarily in the economically developed societies, associate individuals' lifestyle choices with energy consumption and waste production, and therefore GHG emissions [9-14]. Schipper et al. [12] showed that understanding the spectrum of human activities would provide a better understanding of future energy use and that the most important factors are those that influence the mix of personal activities. Having established a strong link between lifestyle and climate change, these studies suggest that alterations in the everyday lives of individual people towards a low-carbon lifestyle can effectively tackle the environmental problems relating to global warming. The concept of low-carbon lifestyle generally suggests reducing carbon emission from all aspects of living; in which lifestyle strives to be frugal and recyclable towards zero-wastage. Additionally, low-carbon lifestyle also means practices that protect natural environment, maintain green areas, thus increasing carbon sink. The term low-carbon lifestyle is interchangeably used with the terms 'green lifestyle' and 'pro-environmental behaviour'. However low-carbon lifestyle is considered as a more specific concept with the main focus of reducing carbon footprints and minimizing the effects of daily lifestyle in causing devastating climate change.

Studies of Defra [15], Whitmarsh and O'Neill [16] have identified low and high environmental impact actions, related to four behavioural domains namely: transportation, consumption, water and energy use, and waste management. 'Transportation' actions include buying and using more energy efficient (low-carbon) vehicles, using the car less, and seeking alternatives for short trips, while 'consumption' refers to buying energy-efficient products, eating organic and locally grown food, and adopting a diet with lower environmental impacts. On the other hand, energy and water use refers to better energy/water management and usage, while waste management includes waste segregation and recycling, and wasting less (food). Meanwhile other studies of Dickinson and Dickinson, Barr et al. [17-22] identify these behaviours as habitual activities (energy and water saving or daily travel behaviour), structural or systematic changes (e.g., installing low-energy and water saving devices or opting to switch travel mode for certain journeys) or consumption behaviours within the context of everyday practice (such as purchasing behaviour). Despite the different methods in identifying such actions and behaviours, collectively, these actions strive to reduce household waste generation and energy consumption.

As mentioned above, low-carbon lifestyle is closely related to pro-environmental behaviour and the two concepts are almost always assumed to carry the same meaning. While low-carbon living specifically strives to reduce carbon emission in everyday activities, pro-environmental behaviours are actions that seek to protect the environment at a broader level. Therefore, understanding the underlying motivations to participate in pro-environmental behaviour is important as the basis in identifying the influencing factors in the adoption of low-carbon lifestyle. Research on pro-environmental behaviour covers a wide range of disciplines, including psychology, sociology, and management studies, thus, the vast literatures highlight a diversity of factors including motivations and barriers.

Studies of Defra [15] and Darnton et al. [23], Shove [24,25] suggest that the extent to which people adopt pro-environmental behaviours depends upon a mixture of positive motivators and negative barriers. Defra [15] argues that the practical impact of common motivators is usually compromised by equally common barriers. Furthermore, anything can be a potential motivator or a barrier, and it is not always easy to tell which is which [25], a point acknowledged in Darnton's [23] observation that "some factors identified as barriers to behaviours can also be viewed as drivers to behaviours, if they are applied differently". Nevertheless, most empirical studies [26-33] acknowledge factors that motivate pro-environmental behaviour include knowledge (e.g., how individuals interpret information based on existing beliefs), psychological factors (e.g., values, attitudes and emotions that affect behaviour and sense of responsibility), habits (e.g., routine behaviours that contributes to carbon emissions), structural conditions (e.g., infrastructure-or lack of it) and socio-demographic patterns (e.g., individual circumstances). The influence of socio-economic and cultural factors on individuals' decision to engage in pro-environmental behaviour were also emphasised in many studies [34-37]. These studies suggest that these factors are critical antecedents or determinants of behaviours, and thus may either facilitate or inhibit climate change responses.

As this catalogue suggests, there is no limit to the number of possible influencing factors and no method of establishing their precise role and significant importance over other factors. Blake [38] observed that this feature leaves policy makers free to selectively focus on certain barriers or motivators. Therefore, this research has sought to examine specific internal, external, and demographic factors that motivate or hinder the adoption of low-carbon lifestyle in sample populations to develop notions of predictors for the adoption of low-carbon lifestyle. Using Everett Rogers' Theory of Innovation Diffusion, these factors are examined as innovation attributes and contextual characteristics where low-carbon lifestyle is regarded as an innovation.

According to Rogers [39], innovation is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption". Therefore, innovation can be seen as introduction of a new technology, a policy or a system; a redesign of process or service, or an administrative program; or perhaps a change in behaviour [40]. Rogers' [39] diffusion of innovation framework highlighted five sequential stages in innovation adoption: first, individual gains knowledge of an innovation through social networks, secondly, he forms an attitude towards it, and then decides to adopt or reject it, following which; he implements it and confirms the decision. Diffusion, according to Rogers, is "the process in which an innovation is communicated through certain channels over time among the members of a social system". Consequently, on the basis of the degree to which an individual is relatively early in adopting an innovation, Rogers [41] posited that adopters can be classified into adopter categories. These categories are: innovators, early adopters, early majority, late majority, and laggards. Rogers observed that some potential adopters are more innovative than others, and can be identified as such by their personal characteristics and influence on the perceptions of others i.e., as opinion leaders. These opinion leaders can play the role of change agents to accelerate adoption, especially when potential adopters view such individuals as role models and more knowledgeable. Bandura [42] argues that social interaction and learning motivates people to adopt innovations. Other diffusion author suggests that network effects [43] and herd behaviour [44] play a significant role in accelerating adoption.

Frambach highlights the main attributes that influence innovation adoption decision to include characteristics of the adopting organization, characteristics of the innovation itself, and the availability of information. Later, Rogers [39] demonstrates that the perceived attributes of an innovation offers important explanation of the rate of adoption and that most of the variance in adoption rate (from 49 to 87%) is explained by five attributes: relative advantage, compatibility, complexity, trialability and observability. First, the relative advantage of an innovation is the perception that the innovation is better or worse than similar ideas. Complexity refers to the perception of how difficult it is to comprehend or utilize the innovation. Compatibility is the perception that a particular innovation is similar and congruent with past ideas. Trialability refers to the accessibility of an innovation to an individual for experimentation. Finally, observability refers to how available or visible the innovation is to an individual. Rogers [39] suggests that relative advantage, simplicity, and an innovation's compatibility with a potential adopter's norms, are particularly important and account for considerable variance in explaining adoption decisions. He considers that the other two attributes, observability and trialability, are not as consistently important across innovation types for producing adoption.

Subsequently, other researchers have added perceived risk to Roger's five innovation attributes, as an expected consequences resulting from the innovation [45,46] concluded that overall, what pushes people from 'intention to adopt' to 'actual adoption' is a combination of perceived personal benefits; compatibility with their values, identity and social references; strong social influence and normative beliefs; a sense of control over costs and associated inconveniences attached to switching over; no perceived risk/uncertainty; and good information. In summary, literature in this matter generally indicates that an analysis of individual characteristics, innovation characteristics, and contextual characteristics would give an in depth understanding of the adoption and/or diffusion of an innovation. Based on the literature review, certain questions concerning the relations among individual's perception of innovation attributes, contextual variables and individual's adoption of low-carbon lifestyle remained unanswered. Therefore, the aim of the present study is to assess which innovation attribute and which contextual variable most strongly relate to the adoption of low carbon lifestyle and thus select a combination which is most suitable as predictors to the adoption of low carbon lifestyle. We posit that perceptions of awareness, relative advantage, complexity, resource and support, and policy and regulation are potential predictors for the adoption of low-carbon lifestyle. We also note that next to innovation attributes, an individual's adoption of low-carbon lifestyle can be influenced by contextual variables.

In this study, we put a lens on personal characteristics as contextual variables. Firstly, we examine years of living in the low-carbon city and assume that individuals that have lived in the low-carbon city for a longer period have received more information and are longer exposed to the innovation i.e., low-carbon practices, compared to others that have lived in the city for a shorter period. Secondly, we pay attention to individual's innovativeness which we describe as the individual's openness and relative speed in adopting the new lifestyle. Based on this, we propose 3 categories of adopter: innovator, earlier adopter, and later adopter, and assume that the rate and level of low-carbon lifestyle adoption is higher if the individual if more innovative. Although many researchers have suggested that contextual variables influence the adoption of low-carbon lifestyle, none has investigated these variables for their indirect role particularly as a moderating variable in predictive models. Therefore, in the present study, contextual variables are included in our analyses and we explore whether they moderate the relationship between the independent variables and the adoption of low-carbon lifestyle.

Based on these research aims, the following research question is put forward: Which of the innovation attribute (i.e., awareness, relative advantage, complexity, resource and support, and policy and regulation) are significant predictors for the level of individual's adoption of low-carbon lifestyle, taking contextual variables (i.e., years of living in the low-carbon city, adopter category) into account? The research question is depicted in Figure 1.

Methodology

Location of the study

The study was conducted in Putrajaya, the Federal Administrative Centre of Malaysia. The residential sector in Putrajaya contributes about 23 kt CO_2 eq to the total GHG emission in Putrajaya in 2007, and potentially 11 times higher i.e., 266 kt CO_2 eq with business as usual (BAU) in 2025 [8]. In Putrajaya, the low-carbon lifestyle agenda is promoted to the public through a set of programs under Local Agenda 21 that emphasises on community participation in 3R (Reuse, Reduce and Recycle) programs, community greening activities, and environmental awareness campaigns. The public is also encouraged to use public transportation or non-motorised vehicle such as cycling and walking as a mode of travelling. Putrajaya also promotes local products and low-carbon local foods through a wide range of choices in market places and restaurants. These actions are estimated to potentially contribute to a total of 40% reduction in GHG emission in Putrajaya.

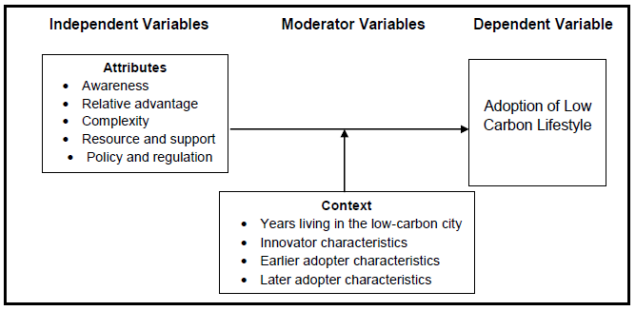

Figure 1: Research question.

Sample

A survey was conducted on leaders of residential communities specifically the chairmen and members of residents' association committees (RACs) in Putrajaya. This group of leaders was chosen as unit of analysis based on several reasons: RACs are the focal point in disseminating the green city agenda to the public and as elected representatives, RACs are the eyes and the ears of the community they represent. Leaders of RACs are most knowledgeable about the community and highly involved, and therefore most responsible for the success of the change effort. Moreover, being closely connected to the community has given RACs leaders vast opportunities to influence the opinions, attitudes, beliefs, motivations, and behaviours of others. The opinions and behaviours of these leaders will greatly contribute to the

community's positive perception and subsequent adoption of low-carbon lifestyle.

A sample size of 402 was selected using a proportionate stratified random sampling technique. The sample were selected from a list of 102 residential association committees (RACs) provided by Putrajaya Corporation (PjC). Based on the estimated population of 1500 RAC leaders (including respective chairmen and committee members), a two-stage sampling was conducted to capture all chairmen and at least 1/3 of the selected RACs. In the second stage of the sampling, a proportionate stratified random sampling technique was used: RACS were stratified into two house types (landed, and apartment) and sampled. This technique was employed to ensure a balanced proportion of the subgroups were included in the study and the representativeness of the results. Hence, the questionnaire was administered to all chairmen of RACs in the first stage and 6 committee members from each of the selected RACs in the second stage (51 RACs).

A total of 304 completed questionnaires were collected from the respondents. Of the 304 respondents, 93 (30.6%) were chairman of Residents' Association Committees (RACs) while another 211 (69.4%) were RACs' committee members. The respondents varied with regards to demographics. The respondents consisted of 283(93.1%) males and 21(6.9%) females. The age of the community leaders ranges from 29 to 70, with a mean of 47.9 (SD = 9.2). The mean length of time living in Putrajaya was 9.29 years, ranging from 3 to 15 years.

Research instrument

In the present study, we developed the Low-carbon Lifestyle Survey (LCLS) through three important phases. The first phase involved a comprehensive review of the literatures on subject matters i.e., low-carbon society, pro-environmental behaviours, and diffusion of innovation. This is vital in establishing a solid theoretical framework to justify the methodology of the present study and also in defining key words and terminologies. The second phase of the instrument development involved using one-to-one interviews and group discussions with community leaders and RACs to establish key issues to be addressed in the study. Three group discussion sessions were conducted in three RACs, each participated by three to four committee members. Insights were also gathered from four interview sessions held with officers in charge of the programs in PjC and an RAC chairman that is elected as community representative in the Putrajaya Green City Council. In this phase, a qualitative data collection and analysis was employed to identify key issues for the design of a subsequent quantitative instrument. Interviews and group discussions provided essential information on low-carbon programs and campaigns carried out in the communities, including information on public reactions as well as the perceptions of success or failure of such programs. A set of questions was used as the interview guidelines. The interviews were recorded and reviewed by the researcher in isolating the variables to be included in the research framework and in the construction of the survey instrument. The statements of the participants were analysed for mentioning of exact key words or its associated descriptions which were scored based on their frequencies. Analyses of the data from the interview sessions showed that five variables were most frequently mentioned i.e., awareness, relative advantage, complexity, resource and support, and policy and regulation. Subsequently, in the third phase, the LCLS survey tool was prepared using the five variables identified from the previous phases.

Below we outline the content of the LCLS and the scales used for the purposes of the present study: The first section of the LCLS collects demographic information i.e., age, gender, educational level, type of house, years living in Putrajaya, and rate the respondent's innovativeness (i.e., innovator, earlier adopter or later adopter). In the present study, innovativeness was measured by the respondents' response to twelve statements on how quickly they adopt low-carbon lifestyle. Questions in this section utilized a continuous four-point Likert scale that do not include any neutral answers, ranging from strongly disagree to strongly agree (1 = strongly disagree to 4 = strongly agree). Meanwhile, the second section was designed to assess the respondents' low-carbon lifestyle. In this section, a total of 25 statements were employed to assess respondents' low-carbon practices inside and outside the home. Respondents were asked to report how often they performed practices under the five low-carbon lifestyle dimensions i.e., waste segregating and recycling, efficient usage of electricity, efficient usage of fuel, prioritizing environment-friendly products, and frugal usage of water. The questionnaire utilized a discrete five point (1-5) Likert scale ranging from 'never' to 'all the time' (1 = never; 2 = once a while (less than once a month); 3 = sometimes (once or twice a month); 4 = frequently (several times per week); 5 = all the time. The third section of LCLS focuses on assessing the respondents' perceptions of innovation attributes i.e., awareness, relative advantage, complexity, resource and support, policy and regulation. The respondents were asked to indicate their agreement on the 27 statements given using a continuous four-point Likert scale ranging from strongly disagree to strongly agree (1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree). The instrument was subjected to two field-test and examined for reliability before it was utilized in the actual survey. The Cronbach's alpha ranged from the lowest 0.70 for 'efficient usage of electricity' to the highest 0.91 for 'innovator characteristics' which indicated the reliability of that the instrument.

Data Analysis

The data were analysed using a series of statistical analyses which include descriptive statistics, correlation statistics, and multiple regression and moderated multiple regression analyses. Prior to the application of statistical procedures, an exploratory data analysis (EDA) was applied to check for conformation with the basic assumptions in terms of normality and also to ascertain that there was no issue of multicollinearity. We produce a correlation matrix for the attribute and contextual variables to gain initial insight into how our research variables are related. To quantify the contributions of the independent variables towards the variance in the adoption of low-carbon lifestyle, a multiple linear regression analysis was used. Multiple regression is the simultaneous combination of multiple factors to assess how and to what extent they affect a certain outcome. The result of the regression is an equation that represents the best prediction of a dependent variable from several independent variables. We employed ENTER method of regression in which all independent variables were regressed on the criterion variable i.e., the adoption of low-carbon lifestyle, to identify the significant predictors of community's adoption of low carbon lifestyles.

We then applied moderated multiple regression analyses (MMR) to find out the moderating effect of contextual variables on the relations between innovation attributes (e.g., awareness, relative advantage, complexity, resource and support, policy and regulation) and the adoption of low-carbon lifestyle. The existence of a moderating effect

implies that the relationship between Y and a predictor X is moderated by a function of another variable Z, labelled as a moderator [47]. In moderated regressions, the effects of several independent variables were held statistically "constant" while the interaction effects of an independent variable and a moderating variable were examined [48].

The test of the moderating effect consists of assessing whether regression coefficient associated with the product term (of the independent and moderator variables) is different from zero in the population and this test is conducted by computing a t-test statistic [49]. By computing an F-statistics, we examined whether inclusion of the product term in the regression improves the ability to predict the criterion. A hypothesized moderator effect is supported if the interaction increases the variance explained by the predictors [50]. Hence, the interaction effects were examined by looking at the significant F value and significant changes in the R^2 [49]. According to Allison [51], the best measure of the importance of interaction is simply the increment to R^2 with the inclusion of the product term. In this study, F-change significant was used to infer that an interaction effect exists while a change of R^2 measured the strength of the effect. The level of significant normally used in the field of social science research is between 0.05 and 0.01 [52]. For the purpose of this study, 0.05 significance level was adopted in the testing of the entire hypotheses. In the MMR analyses, predictor variables (X and Z) were examined in their centered form while Y was utilized in its original uncentered form. This strategy of centering yields two straightforward, meaningful interpretations of each first-order regression coefficient of predictors entered into the regression equation: (1) effects of the individual predictors at the mean of the mean of the sample, and (2) average effects of each individual predictors across the range of the other variables. Doing so also eliminates nonessential multicollinearity between first-order predictors and predictors that carry their interaction with other predictors [53].

Results

Descriptive statistics

An examination of community leaders' responses on subscales with a range from 1 to 5, revealed that community leaders' adopt low-carbon lifestyle at a moderate level (M = 2.83).

Dimension of Low-carbon Lifestyle	Mean	Standard Deviation
Waste segregating and recycling	2.83	0.69
Prioritizing environment friendly product	2.68	0.67
Efficient usage of electricity	3.34	0.63
Frugal usage of water	2.41	0.62
Efficient usage of fuel	2.71	0.64

Table 1: Dimensions of the adoption of low-carbon lifestyle scores.

Table 1 indicates the breakdown of community leaders' adoption of low-carbon lifestyle based on the five low-carbon dimension scores.

Among the five low-carbon lifestyle dimensions, efficient electricity usage was the most adopted by the community leaders (M = 3.34, SD = 0.63), followed by waste segregating and recycling (M = 2.83, SD = 0.69). Efficient usage of fuel (M = 2.71, SD = 0.64) ranked the third most adopted low-carbon dimension while prioritising environment-friendly products ranked fourth (M = 2.68, SD = 0.67). Frugal usage of water was ranked the least adopted by the committee leaders (M = 2.41, SD = 0.62). Table 2 further presents the descriptive statistics for the study variables.

The results of our study indicated that, based on the means on subscales with a range from 1 to 4, community leaders feel that they have moderate (M = 3.00) level of awareness about low-carbon lifestyle. The analyses also found that, based on subscales with a range from 1 to 4, community leaders perceive moderate relative advantage of low-carbon practices (M = 3.00) and moderate level of complexity in low-carbon practices (M = 2.39). Additionally, based on the examination of the means of the subscales with a range of 1 to 4, the mean scores were moderate for resource and support (M = 2.49) and policy and regulation (M = 2.23) indicating that the community leaders perceive that there was moderate level of resource and support and moderate level of policy and regulation for low-carbon practices.

Meanwhile, the analyses of the means scores for the contextual variables revealed that, compared to the midpoint (i.e., 2.5) of the scales with a range from 1 to 4, community leaders perceive that have moderate level of innovator characteristics (M = 2.27), moderate level of earlier adopter characteristics (M = 3.09) and low level of later adopter characteristics (M = 2.04). This implies that community leaders are prominently earlier adopters.

Correlation analyses

An examination of the correlations, as displayed in Table 2, suggests that there is positive significant correlation between four innovation attributes and community leaders' adoption of low-carbon lifestyle, except for complexity which have negative significant correlation with the adoption of low-carbon lifestyle.

The magnitude showed the range of correlation coefficient from 0.55 to 0.82. According to Guildford's Rule of Thumb, the r value of 0.4 to 0.7 indicates a moderate positive linear relationship, while r value of 0.70 - 0.90 indicates a strong linear relationship.

The results indicate that there is strong linear relationship between adoption of resource and support ($r = 0.82$, $p = 0.00$), and also between adoption of low-carbon lifestyle and complexity ($r = -0.70$, $p = 0.00$). This suggests that the adoption of low-carbon lifestyle is highly correlated with the availability of resource and support and also with its perceived complexity. Meanwhile, the analyses also suggest moderate linear relations between the adoption of low carbon lifestyle and the other three innovation attributes (i.e., relative advantage, $r = 0.67$, $p = 0.00$; policy and regulation, $r = 0.65$, $p = 0.00$; awareness, $r = 0.55$, $p = 0.00$).

The examination of the correlations between contextual variables and the adoption of low-carbon lifestyle failed to find strong evidence that the adoption of low-carbon lifestyle relates to the years living in the low-carbon city. This suggests that the duration of time exposed to the new lifestyle does not necessarily determine the level of its adoption by community leaders.

However, the analyses revealed significant relationships between adopter characteristics i.e., innovator ($r = 0.67$, $p = 0.00$), earlier adopter ($r = 0.67$ $p = 0.00$), and later adopter ($r = -0.76$, $p = 0.00$), with community's adoption of low-carbon lifestyle.

This suggests that community leaders with high level of innovativeness are likely to demonstrate higher level of low-carbon lifestyle.

Variable		M	SD	1	2	3	4	5	6	7	8	9	10
Dependent variable	1. Adoption of low-carbon lifestyle	2.83	0.51	1									
Innovation attributes	2. Awareness	3.03	0.34	.548**	1								
Context	3. Relative advantage	3	0.35	.666**	.502**	1							
	4. Complexity	2.39	0.4	-.698**	-.389**	-.521**	1						
	5. Resource and support	2.49	0.46	.817**	.597**	.578**	-.609**	1					
	6. Policy and regulation	2.23	0.38	.654**	.442**	.432**	-.498**	.584**	1				
	7. Years living in Putrajaya	9.15	3.54	0.106	0.03	0.052	-0.046	0.073	0.03	1			
Innovativeness	8. Innovator	2.27	0.46	.670**	.472**	.479**	-.478**	.586**	.428**	.118*	1		
	9. Earlier adopter	3.09	0.39	.673**	.482**	.496**	-.541**	.620**	.517**	0.041	.563**	1	
	10. Later adopter	2.04	0.41	-.761**	-.475**	-.498**	.507**	-.618**	-.561**	-.116*	-.619**	-.610**	1
Note: Values with different superscripts are significantly different.													

Table 2: Means, standard deviations and correlations of the community leaders' scores for the study variables.

Variables	Un-std Coefficient[b]	Std Coefficient[b]	t	p
(constant)	1.736		5.882	0
Awareness	-0.054	-0.036	-1.195	0.233
Relative advantage	0.227	0.155	5.033	0
Complexity	-0.217	-0.17	-5.362	0
Resource and support	0.375	0.336	8.779	0
Policy and regulation	0.158	0.116	3.747	0
Years living in the low-carbon city	0.003	0.02	0.857	0.392
Innovator characteristics	0.118	0.106	3.278	0.001
Earlier adopter characteristics	0.053	0.041	1.211	0.227
Later adopter characteristics	-0.316	-0.249	-7.148	0
F statistic	174.044			
Adjusted R^2	0.837			
R^2	0.842			
Proportion of variance explained (%)	84.2			

Table 3: Model estimates of the analyses of community leaders' adoption of low-carbon lifestyle.

Given the magnitude of these correlations, the data was examined for potential multicollinearity problems. All tolerance values were found to be greater than 0.1 and VIF values are below 10, indicating that multicollinearity among the investigated variables is not a problem in this study.

Multiple regression analyses

As shown in Table 3, the results revealed that only six variables were found to be significant predictors of community's adoption of low carbon lifestyles. The six predictor variables with their respective t and p value, were relative advantage (t = 5.033, p = 0.000), complexity (t = -5.362, p= 0.000), resource and support (t = 8.779, p = 0.000), policy and regulation (p = 3.747, p= 0.000), innovator characteristics (t = 3.278, p = 0.001), and later adopter characteristics (t = -7.148, p = 0.000). Awareness (t = -1.195, p = 0.233), years living in the low-carbon city (t = 0.857, p = 0.392), and earlier adopter characteristics (t = 1.211, p = 0.227) were excluded because they did not contribute in significance to the variance of adoption of low-carbon lifestyle.

The standardized regression coefficients were also analysed to determine the relative importance of the predictors in predicting community's adoption of low-carbon lifestyle, as presented in Table 3. For comparative purposes, it is important to use the standardized coefficients as the values of the different variables have been converted to the same scale. Both the dependent and independent variable were standardized to have a mean of 0 and a standard deviation of 1.

When an independent variable gives a high beta coefficient, it indicates that the variable is highly important in contributing to the criterion variable. Based on the values reported in Table 3, the highest beta coefficient was 0.336 which was derived from resource and support. This suggests that resource and support was the strongest contributor to the equation.

This variable was followed by later adopter characteristics (β = -0.249), complexity (β = -0.170), relative advantage (β = 0.155), and policy and regulation (β = 0.116).

Innovator characteristic has the lowest effect with a beta coefficient of 0.106 as compared to the other five variables.

Therefore, the final estimated model for the adoption of low-carbon lifestyle in standard score is as shown below:

$Y = 1.736 + 0.336X_1 - 0.249X_2 - 0.170X_3 + 0.155X_4 + 0.116X_5 + 0.106X_6 + e$

Where:

Y = Adoption of low-carbon lifestyle

X_1 = Resource and support scores

X_2 = Later adopter characteristics scores

X_3 = Complexity scores

X_4 = Relative advantage scores

X_5 = Policy and regulation scores

X_6 = Innovator characteristics scores

e = Random error

Table 3 also indicates the coefficient of determination (R^2) that is the value that indicated the percentage of total variation of the dependent variable explained by the independent variables. Therefore, as shown in Table 2, the total amount of variance of the criterion variable that was predictable from the six predictor variables was 84.2% and the adjusted R^2 was 83.7%. Therefore, the overall regression model was successful in explaining approximately 83.7% of the adjusted variance in community's adoption of low-carbon lifestyle.

Moderated multiple regression analyses

Moderated Multiple Regression (MMR) analyses were employed to determine whether contextual variables moderate the relationships between each of the predictors with the level of community's adoption of low-carbon lifestyle'. Only two contextual variables were examined i.e., innovator characteristics, and later adopter characteristics while innovator characteristic and years living in Putrajaya were excluded as findings in the previous multiple regression analyses revealed that both do not contribute in significance to the variance of community leaders' adoption of low-carbon lifestyle. Results of the analyses are provided in Tables 4 and 5, respectively for innovator and later adopter characteristics.

The examination of the MMR revealed that the inclusion of relative advantage-innovator characteristic interaction did not result in a significant increase in R^2 change value and the F statistic was not significant (R^2 change = 0.003, F change = 1.910, p = 0.168).

Similarly, no significant increase was found with the inclusion of resource and support-innovator interaction (R^2 change = 0.000, F change = 0.024, p = 0.877).

Therefore, this suggests that there is no strong evidence that innovator characteristic has a moderating effect on the relationship between relative advantage and the adoption of low-carbon lifestyle nor between resource and support and adoption of low-carbon lifestyle.

Meanwhile, the examination found significant increase in R^2 change value and significant F statistic when each of the other three interactions were included i.e., complexity-innovator (R^2 change = 0.012, F change = 10.141, p = 0.002); policy and regulation-innovator (R^2 change = 0.014, F change = 10.903, p = 0.001); later adopter-innovator (R^2 change = 0.009, F change = 8.044, p = 0.005).

This indicates that innovator characteristic moderates adoption of low-carbon lifestyle's relations with complexity, policy and regulation, and later adopter characteristic.

To further illustrate, regression equations were formulated and simple regression lines were then generated for three levels of the moderating variable i.e., one standard deviation below the mean (Z_L = -0.46), at the mean (Z_M = 0) and one standard deviation above the mean (Z_H = 0.46). The graphical results are presented in Figures 2a-2c.

As shown in Table 4, R^2 value with only complexity and innovator characteristic but without their interaction as predictors is 0.634, however, the inclusion of the interaction increases R^2 value to 0.646.

Thus, the interaction accounts for 1.2% of the variance in the criterion, over and above the main effects, F change = 0.012, $p < 0.01$.

While this is "only" 1.2% of the variance accounted for, the buffering effect is evident, as shown in Figure 2a.

Dependent	Independent	R	R^2	R^2 Change	b	F change	p
Step 1: Main effect							
Adoption	Relative advantage	0.777	0.603	0.16	2.83	121.671	0
Step 2: Interaction							
Adoption	Relative advantage	0.778	0.606	0.003	2.84	1.91	0.168
	Relative advantage × Innovator						
Step 1: Main effect							
Adoption	Complexity	0.796	0.634	0.147	2.83	120.666	0
Step 2: Interaction							
Adoption	Complexity	0.804	0.646	0.012	2.803	10.141	0.002
	Complexity × Innovator						
Step 1: Main effect							
Adoption	Resource and support	0.851	0.724	0.056	2.83	60.527	0

Step 2: Interaction							
Adoption	Resource and support	0.851	0.724	0	2.831	0.024	0.877
	Innovator						
	Resource and support × Innovator						
Step 1: Main effect							
Adoption	Policy and regulation	0.783	0.614	0.187	2.83	145.585	0
	Innovator						
Step 2: Interaction							
Adoption	Policy and regulation	0.792	0.627	0.014	2.809	10.903	0.001
	Innovator						
	Policy and regulation × Innovator						
Step 1: Main effect							
Adoption	Later adopter	0.802	0.643	0.064	2.83	54.318	0
Step 2: Interaction							
Adoption	Later adopter	0.808	0.652	0.009	2.807	8.044	0.005
	Later adopter × Innovator						

Table 4: Moderating effects of innovator characteristics.

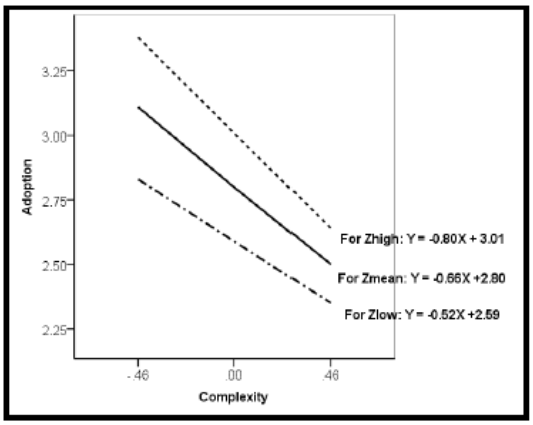

Figure 2a: Simple slope analyses for community's adoption of low-carbon lifestyle on complexity, policy and regulation, and later adopter characteristics for three levels of innovator characteristics.

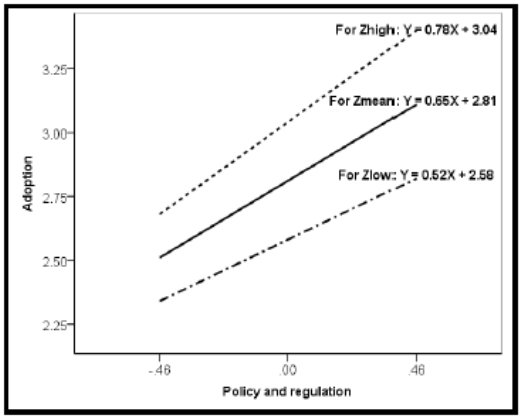

Figure 2b: Simple slope analyses for community's adoption of low-carbon lifestyle on complexity, policy and regulation, and later adopter characteristics for three levels of innovator characteristics.

The simple slopes of the regression lines increases from -0.52 to -0.66 to -0.80 as innovator characteristicincreases from -0.46 to 0.46.

Meanwhile, the intercept increases from 2.59 to 2.80 to 3.01 as innovator characteristic increases.

This confirms the moderating role of innovator characteristics in the relationship between community's adoption of low-carbon lifestyle and complexity.

Our examination on policy and regulation-innovator characteristic interaction found R^2 value increases from 0.783 to 0.792 with the inclusion of the interaction and this account for 1.4% of the variance in the criterion, over and above the main effects.

As shown in Figure 2b, the simple slopes of the regression lines increases from 0.52 to 0.65 to 0.78 as innovator characteristic increases from -0.46 to 0.46, while the intercept increases from 2.58 to 2.81 to 3.04. The t-test of the simple slopes confirms that there is significant difference of each slope from zero; hence, there is strong evidence that

the increase in the adoption of low-carbon lifestyle with policy and regulation was heightened by the leaders' innovator characteristics.

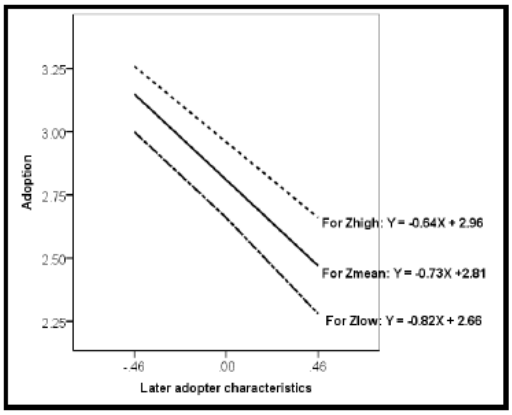

Figure 2c: Simple slope analyses for community's adoption of low-carbon lifestyle on complexity, policy and regulation, and later adopter characteristics for three levels of innovator characteristics.

Figure 2c illustrates how adoption of low-carbon lifestyle declines with later adopter characteristics. The adoption of low-carbon lifestyle, in contrast, increases with innovator characteristic. The graph indicates that community's adoption of low-carbon lifestyle was higher in high innovator characteristic as compared to low innovator characteristic. The inclusion of innovator-later adopter interaction weakens the direct impact of later adopter characteristic; that is, the decline in the adoption of low-carbon lifestyle with later adopter characteristic was buffered by the individual's innovativeness in adopting the new lifestyle.

The simple slopes of the regression lines decreases from -0.82 to -0.73 to -0.64 as innovator characteristic increases from -0.46 to 0.46, while the intercept increases from 2.66 to 2.81 to 2.96. The t -test confirmed the negative regression of Y on X at ZH, ZM and ZL; there is strong evidence that the decline in the adoption of low-carbon lifestyle with later adopter characteristic was lessened by the person's innovator characteristic. This findings showed strong evidence that innovator characteristic has a moderating effect on the relationship between the adoption of low-carbon lifestyle and policy and regulation.

Meanwhile, the examination of MMR on the moderating effects of later adopter characteristic (Table 5) revealed significant increase in R^2 change value and significant F statistic for complexity (R^2 change = 0.020, F change = 21.955, p = 0.00), policy and regulation (R^2 change = 0.006, F change = 24.625, p = 0.00), and innovator characteristic (R^2 change = 0.009, F change = 8.044, p = 0.005) indicating that there is strong evidence that later adopter characteristic moderates the relations between community leaders' adoption of low-carbon lifestyle and complexity, policy and regulation, and innovator characteristic. The graphical results are presented in Figures 3a-3c.

Figure 3a shows that the adoption of low-carbon lifestyle decreases with perceived complexity. The adoption of low-carbon lifestyle also decreases with later characteristics. The simple slopes of the regression lines decreases from -0.74 to -0.56 to -0.38 aslater adopter characteristic increases from -0.46 to 0.46. Meanwhile, the intercept decreases from 3.08 to 2.79 to 2.51 as later adopter characteristics increases.

The t-test confirmed the negative regression of Y on X at Z_H, Z_M and Z_L, which implies that there is strong evidence that the decline in the adoption of low-carbon lifestyle with complexity was aggravated by the person's later adopter characteristic. Thus, there is strong evidence of moderating effects of later adopter characteristic on the relationship between adoption of low-carbon lifestyle and complexity.

Meanwhile, Figure 3b shows that adoption of low-carbon lifestyle increases with perceived policy and regulation. In contrast, the adoption of low-carbon lifestyle declines with later adopter characteristic. The graph shows steeper slope for low later adopter characteristic compared to high later adopter characteristic.

The simple slopes of the regression lines decreases from 0.69 to 0.51 to 0.34 as later adopter characteristic increases from -0.46 to 0.46 while the intercept decreases from 3.09 to 2.79 to 2.5.

Dependent	Independent	R	R^2	R^2 change	b	F change	p
Step 1: Main effect							
Adoption	Relative advantage	0.829	0.687	0.244	2.83	235.447	0
	Later adopter						
Step 2: Interaction							
Adoption	Relative advantage						
	Later adopter	0.829	0.688	0	2.826	0.211	0.646
	Relative advantage x Later adopter						
Step 1: Main effect							
Adoption	Complexity	0.842	0.71	0.222	2.83	230.532	0
	Later adopter						
Step 2: Interaction							

Adoption	Complexity						
	Later adopter	0.854	0.73	0.02	2.793	21.955	0
	Complexity × Later adopter						
Step 1: Main effect							
Adoption	Resource and support	0.88	0.774	0.106	2.83	140.5	0
	Later adopter						
Step 2: Interaction							
Adoption	Resource and support						
	Later adopter	0.881	0.776	0.002	2.818	2.531	0.113
	Resource and support × Later adopter						
Step 1: Main effect							
Adoption	Policy and regulation	0.808	0.654	0.227	2.83	196.87	0
	Later adopter						
Step 2: Interaction							
Adoption	Policy and regulation						
	Later adopter	0.825	0.68	0.026	2.793	24.625	0
	Policy and regulation × Later adopter						
Step 1: Main effect							
Adoption	Innovator	0.802	0.643	0.194	2.83	163.347	0
	Later adopter						
Step 2: Interaction							
Adoption	Innovator						
	Later adopter	0.808	0.652	0.009	2.807	8.044	0.005
	Innovator × Later adopter						

Table 5: Moderating effects of later adopter characteristics.

The t -test of each simple slope against zero confirms the positive regression of Y on X at Z_H, Z_M and Z_L; there is evidence of increase in the adoption of low-carbon lifestyle with policy and regulation when there is low later adopter characteristic.

Meanwhile, Figure 3c indicates that community's adoption of low-carbon lifestyle is higher in low later adopter characteristic as compared to high later adopter characteristic. The graph shows steeper slope for low later adopter characteristic as compared to high later adopter characteristic.

The simple slopes of the regression lines decreases from 0.40 to 0.32 to 0.24 as later adopter characteristic increases from -0.46 to 0.46. Meanwhile, the intercept also decreases from 3.10 to 2.81 to 2.51.

This suggests that the increase in adoption of low-carbon lifestyle with innovator characteristics is buffered by later adopter characteristics; that is the more resistant the person is towards the green lifestyle, the less dramatic the increase in adoption with innovator characteristics.

The t-test indicates the significance of each slope from zero; there is evidence that the increase in the adoption of low-carbon lifestyle with innovator was buffered by the person's later adopter characteristic.

These findings confirmed the moderating effect of later adopter characteristic in the relationship between innovator characteristics scores and community's adoption of low-carbon lifestyle.

In summary, results from moderated multiple regression analyses indicated that there is strong evidence that later adopter characteristic moderates the relationships between certain predictor variables i.e., complexity, policy and regulation, and innovator characteristic, with the criterion variable i.e., community's adoption of low-carbon lifestyle.

However, the analyses failed to find significant evidence that later adopter characteristic moderates the relation between community leaders' adoption of low-carbon lifestyle and relative advantage, nor its relation with resource and support.

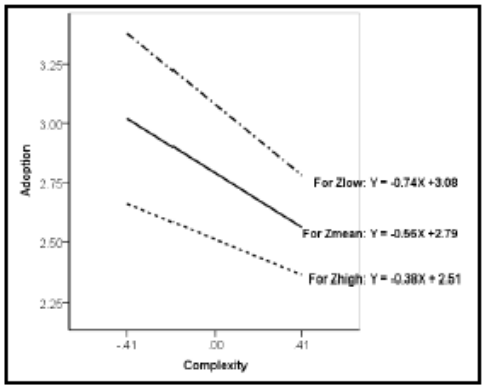

Figure 3a: Simple slope analyses for community's adoption of low-carbon lifestyle on complexity, policy and regulation, and innovator characteristics for three levels of later adopter characteristics.

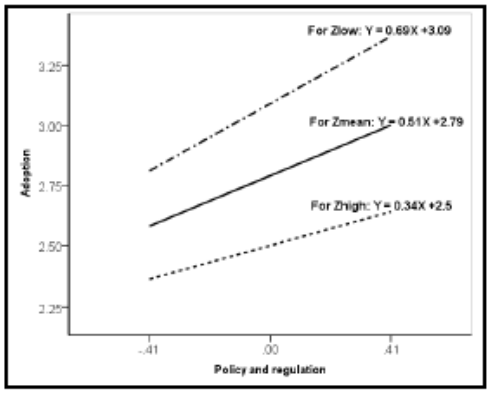

Figure 3b: Simple slope analyses for community's adoption of low-carbon lifestyle on complexity, policy and regulation, and innovator characteristics for three levels of later adopter characteristics.

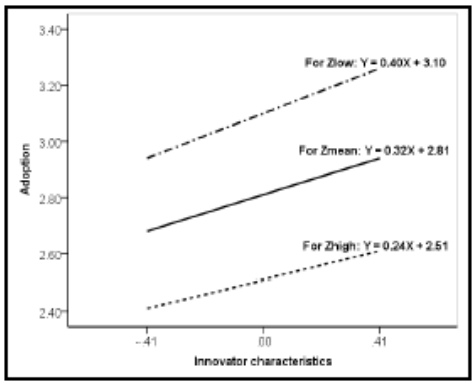

Figure 3c: Simple slope analyses for community's adoption of low-carbon lifestyle on complexity, policy and regulation, and innovator characteristics for three levels of later adopter characteristics.

Discussion

It appears that as an innovation, low-carbon lifestyle has the potential for full adoption within the residential community in Putrajaya. However, it has to be approached from an adopter-based perspective in which serious considerations are given to its perceived attributes to ensure success of diffusion and adoption by the community. While the programs target all levels of the community, agencies must first focus on the leaders who will be the communication channels or agents tasked to sell the idea. The results of this study indicated that about 85% of the RACs leaders in Putrajaya have reported moderate to high level of low-carbon lifestyle. Hence, community leaders should be encouraged to form and lead teams in promoting low-carbon lifestyle in their communities. The study highlights the role of community leaders as opinion leaders that can help influence potential adopters in their communities. Their nearness to the grass roots and to potential adopters gives them the advantage in expediting and enhancing the community's adoption of low-carbon lifestyle. This study suggests that these opinion leaders be recruited to help in dissemination efforts. The leaders should be encouraged to know more about the programs, talk about them with their peers, family, and friends, and to know where to send followers for more information.

The results of this study indicate that awareness does relate to the adoption of low-carbon lifestyle, which corroborates findings from previous studies Hawthorne and Alabnaster [54] Omran et al. [55] and Ramayah et al. [56,57] that suggest that the more the individuals are aware of environmental issues the more likely they are to be involved in pro-environmental behaviours. Moreover, various studies of Hines et al. [26], Inglehart et al. [58] and Olli et al. [59] have shown that the consistency of a person's attitude towards environment is affected by his/her awareness, for example, those who have more knowledge about climate change tend to take more positive actions to counter it [60]. Next, our results showed that there was a substantial positive linear relationship between relative advantage and community's adoption of low-carbon lifestyle. This is consistent with the fact that individual choices are often based on what they perceived as better or more beneficial particularly which will give them an advantage in certain situations. The importance of relative advantage is in line with previous findings which explained that individuals base their choice and decision on the desirability of the perceived usefulness [61-63]. Hence, the results suggests that choosing a more sustainable behaviour or changing towards a more environmental friendly living is more likely if people are aware of the benefits of the new behaviour. Similarly, people will change their behaviour if they are sure that a new way of behaving will prevent problems [64].

However, we found that there is a substantial negative linear relationship between complexity and community's adoption of low-carbon lifestyle. This is in line with previous studies of Salonen et al. [65] that posit that complexity is a barrier to the adoption of pro-environmental behaviour or sustainable living. The inverse relationship between perceived complexity and the intention to adopt corroborates findings by Barr and Gilg who found that behavioural intention to recycle is greatly influenced by the psychological factors relating to the logistical ease and convenience of the practice, and also with Ramayah et al. [56] in their study on individuals' intention to purchase green products. Furthermore, findings from this study concurs with Azilah in a study of recycling practices in Iskandar Malaysia, who found that the main reason for not recycling was lack of time (65%), followed by lack of material to recycle (24.7%), laziness (5.59%), lack of space

(2.59%) and no one to handle the task (2.6%). Our result also confirms findings by Dearing et al. [66] who stressed that innovation must be highly accessible but with low in cost in order to most persuasively demonstrate its worth. Hence, results from this study imply that the perceived difficulty and complication in implementing a pro-environmental behaviour has a negative effect on a pro-environmental behaviour.

Results of the present study also confirmed that there is a marked positive linear relationship between resource and support and community's adoption of low-carbon lifestyle. This finding supports Barnett et al. [67] that concluded that to change towards sustainable lifestyle; people must feel that they have the opportunities and resources to make a difference in their daily lives. The present study also concurs with Maller and Horne [68] which argued that individuals themselves are not necessarily problematic, but the way resources are provided to them facilitates or scripts certain practices over others. Thus, the role of governments is to provide the capacity and capabilities for its citizens to make the better choice [69]. Hence, this study confirms findings from previous studies that the availability of support system such adequate recycling centers and effective public transportation system [65], as well as sufficient guidance, are important in empowering citizens to change to sustainable lifestyle. Additionally, the findings from the present study showed that at present, there is an absence of low-carbon champions or role models to serve as an example in the community. Various studies of Welsch et al. [70] have indicated the role of reference group of role models as factors that influence pro-environmental behaviours. Moreover, studies of Burkhardt et al. and Lu et al. [71,72] have shown that support from influential others has an important impact on what action a potential adopter chooses to take because individuals adapt their attitudes, behaviors and beliefs to their social context. The literature explains that due to the uncertainties and potential consequences posed by an innovation, potential adopters will therefore, tend to interact and consult with the social network on their adoption decisions by informational and normative social influences. Information passed through individuals' social networks influences their perception of an innovation [73,74].

Next, our results indicate that there is a substantial positive linear relationship between policy and regulation, and community's adoption of low-carbon lifestyle. Overall, authors [18,19] have stressed that sustainable lifestyle cannot be attained, unless coordinated by policy interventions, incentive design, regulation and cooperative effort. The findings of the present study concur with previous studies that governmental interventions in the form of policy and regulation are necessary in encouraging low-carbon practices and sustainable choices [75]. While other studies may argue that governmental guidance will limit the freedom of citizens and always creates resistance, our findings indicate that a clear policy and regulation is in fact what is needed by the public to facilitate their change towards a greener living [76].

We also found significant relationships between adopter characteristics particularly innovator and later adopter characteristics with community's adoption of low-carbon lifestyle. Our findings suggest that individuals with high innovator characteristics or high level of innovativeness are likely to demonstrate higher level of low-carbon lifestyle. This concurs with Rogers [39,46] who described innovators as willing to experience new ideas and prepared to cope with unprofitable and unsuccessful innovations, and a certain level of uncertainty about the innovation. Thus, innovator are always the earliest to try out and adopt new innovations. On the other hand, later adopters are more sceptical about innovations and change agents [39,46,77]. They first want to make sure that an innovation works before they adopt and tend to decide after looking at whether the innovation is successfully adopted by other members of the social system. Due to these characteristics, later adopters take relatively longer time to adopt an innovation.

We further examined the variables to produce an equation model that can estimate the adoption of low-carbon lifestyle. Based on our examination, six variables were found to be significant predictors of community leaders' adoption of low carbon lifestyles i.e., relative advantage, complexity, resource and support, policy and regulation, innovator characteristic, and later adopter characteristic. Apart from highlighting the direct relations, we also studied two contextual variables (i.e., innovator and later adopter characteristics) for moderating effects on the relationship between predictor variables and the criterion variable. We conclude that both innovator and later adopter characteristics have moderating effects on the relationship between the criterion variable and certain predictor variables. Firstly, our results suggest that while adoption of low-carbon lifestyle declines with perceived complexity, and, in contrast, increases with innovator characteristics, the interaction between complexity-innovator characteristic produces additional effects. Our finding indicates that the decline in adoption in relations to the increase in complexity is buffered by the leaders' innovativeness in resolving the difficulties; that is, the more innovative the person is, the less dramatic the decline in the adoption of low-carbon lifestyle. Next, our examination on policy and regulation-innovator interaction found that the increase in the adoption of low-carbon lifestyle in order to abide by the new regulations is enhanced by the leader's innovativeness; that is, the more innovative the leader is, the more marked the increase in adoption with policy and regulation. Thirdly, our results indicate that the interaction between later adopter characteristics and innovator characteristic weakens the impact of later adopter characteristics; that is, the decline in the adoption of low-carbon lifestyle with the increase of later adopter characteristic was buffered by the individual's innovativeness in adopting the new lifestyle. As a whole, these three findings confirmed the moderating effect of that innovator characteristic on the relationship between the adoption of low-carbon lifestyle and predictor variables.

Similarly, our findings also indicate that later adopter characteristic moderates the relationship between the adoption of low-carbon lifestyle and specific predictor variables. Based on our examinations on the moderating effects of later adopter characteristic, we found that there is strong evidence that the decline in the adoption of low-carbon lifestyle with increase complexity is aggravated by the person's later adopter characteristic, i.e., negative perception and resistance to adopt the new lifestyle. Our results also revealed that the increase in adoption of low-carbon lifestyle with policy and enforcement depends on the quick reaction and acceptance of the newly-introduced lifestyle. However, the increase in adoption is reduced by later adopter characteristics; that is the more resistant the person is towards the green lifestyle, the less dramatic the increase in adoption of low-carbon lifestyle with the increase in policy and enforcement. Finally, our results also showed that while adoption of low-carbon lifestyle increases with innovator characteristic, the interaction between a leader's innovator and later adopter characteristics buffered the increase in adoption of low-carbon lifestyle. In summary, results from this study indicated that there is strong evidence that later adopter characteristic moderates the relationships between certain predictor variables i.e., complexity, policy and enforcement, and innovator

characteristic with the criterion variable i.e., community leaders' adoption of low-carbon lifestyle. This is perhaps due to the fact that leaders with strong later adopter characteristic tend to view low-carbon practices in an overly negative perspective. Therefore, tasks that are seemingly simple or that do not require much effort may be perceived as complicated and troublesome for these individuals. This concurred with arguments in adopter-based theories [78], which argued that the decision to adopt or reject an innovation is mostly influenced by factors unrelated to technical superiority. The differences between innovator, earlier adopters and later adopter groups has been highlighted in Rogers [79], particularly in terms of socioeconomic status, personality variables, and communication behaviours, which usually are positively related to innovativeness [80-90]. Rogers suggests that, "the individuals or other units in a system who most need the benefits of a new idea (the less educated, less wealthy, and the like) are generally the last to adopt an innovation" [46].

Conclusion

The results from this study demonstrate that changing people's behaviour toward a low-carbon direction is certainly difficult for many reasons. One is that individuals are either not interested, or are not able to make changes due to various constraints. The findings of this study suggest that individuals may hold positive perceptions of low-carbon practices, but this does not necessarily mean that they will adopt such practices. The lack of opportunities, skills or resources may be a hindrance to their adoption. This suggests that while having adequate resources, appropriate skills and opportunities to adopt low-carbon lifestyle contribute towards positive perception; what is more important is that the community must be convince to not perceive that the low-carbon practices will incur extra costs, inconvenience, take up too much time and effort, or are too complicated. Thus, low-carbon lifestyle schemes should be designed with convenience in mind, while incurring near-zero cost and minimal effort, time, and space. Clear instructions should be also provided on how to adopt the new lifestyle while their benefits must be communicated frequently.

The current research findings highlight the needs for local authorities to select and design a range of low-carbon lifestyle promotional programs that can be adopted by their locality. Furthermore, problem-solving efforts in diffusing this new lifestyle should not be unidimensional. For example, merely changing regulations or providing facilities do not address some of the deep-rooted personal barriers, such as habits or negative perceptions. Providing facilities does not automatically imply that the facilities will be used. Hence, establishing meaningful dialogues within the communities, between citizens and government agencies, and involving other related bodies is important in solving the many and inter-related issues. Frequent community engagements and open communications may help in cultivating ownership and curtail fervent resistance to the low-carbon city agenda.

The main contribution of this study is in its theoretical implication to research and practices. First, the findings from this study support the utilization of Rogers' diffusion of innovation framework to a set of new behaviours i.e., low-carbon lifestyle, that the local authority attempt to diffuse into the community. To the best of the researcher's knowledge, this is one of the few studies to apply Rogers' theoretical model to low-carbon lifestyle literature.

The findings of the present study contribute to a better understanding of factors that influence the adoption of a low-carbon lifestyle. Specifically, the present study introduced and tested a conceptual model which proposes that the adoption of low-carbon lifestyle critically depends on individuals' evaluation of the new lifestyle based on perceived attributes. What is striking in our results is that, apart from the direct relationships between these attributes and the adoption of low-carbon lifestyle, indirect relationship in the form of moderating effects by the individuals' innovativeness were also detected. By taking this into consideration, this study provides a clearer picture of the adoption process and factors that are considered by individuals before deciding to adopt. This information will be useful to local authorities and the various agencies to design and redesign interventions and communication messages about them.

This study has several limitations. Firstly, in the framework employed for measuring low-carbon lifestyle, it is impossible to identify the point at which a specific behaviour becomes 'high carbon' and even less so the extent to which the adoption of a whole set of behaviours makes a lifestyle 'low-carbon'. Another key limitation to the task of modeling a framework for low-carbon lifestyle is that the behaviours making up a lifestyle are numerous, even nearly infinite; thus it is impossible to examine all behaviours. However, it should be noted that the behaviours studied here are classified under four main domains of everyday practices: consumption, water and energy use, waste management, and transportation. This classification is to ensure that the groups of behaviours for low-carbon lifestyle are provided as inclusive as possible.

Thirdly, this study concerned only the adoption stage of the new lifestyle. The adoption of low-carbon lifestyle by the community leaders is the first stage in the diffusion process but is no guarantee of successful implementation. Further research on factors influencing implementation and institutionalization stages seems necessary to stimulate effective interventions. Fourth, the study focuses only on the level of the adoption of low-carbon lifestyle but did not examine the rate of the adoption. More research particularly studies that analyze the adoption rate is important to fully understand the diffusion of the new lifestyle in the community. Fifth, the study utilized a cross sectional design, specifically using descriptive-correctional research design where the data were collected at a single point of time. Therefore, the results of this study would not be able to confirm the directions of causality implied in the research model. Hence, future studies should be carried out using a longitudinal research design to test the model as a whole.

Acknowledgement

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References

1. IPCC (2013) Summary for policymakers. In: Stocker TF, Qin D, Plattner GK, Tignor M, Allen SK, et al. (eds.), Climate Change 2013-The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, USA.
2. IPCC (2014) Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland p: 151.
3. Pittock AB (2005) Are scientists underestimating climate change. AGU Publications 87: 340.

4. WMO (2015) WMO statement on the status of the global climate in 2014. World Meteorological Organization.
5. DOS (2015) Compendium of Environmental Statistics. Putrajaya-Department of Statistics p: 200.
6. MNRE (2008) Malaysia's Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). Putrajaya: Ministry of Natural Resources and Environment Malaysia p: 115.
7. Gomi K, Shimada K, Matsuoka Y (2010) A low-carbon scenario creation method for a local-scale economy and its application in Kyoto city. Energy Policy 38: 4783-4796.
8. Ho CH, Matzuoka H, Azman ZA, Omairi H, Fujiwara H, et al. (2012) Putrajaya Green City 2025: Baseline and preliminary study (Revised Edition). Putrajaya Corporation.
9. Cramer JC, Hacketts B, Craig PP, Vine E, Levine M, et al. (1984) Structural-behavioral determinants of residential energy use: summer electricity use in Davis. Energy 9: 207-216.
10. Lutzenhiser L, Hackett B (1993) Social stratification and environmental degradation: understanding household CO2 Production. Social Problems 40: 50-73.
11. Mazur A, Rosa E (1974) Energy and life-style: Cross-national comparison of energy consumption and quality of life indicators. Science 186: 607-610.
12. Schipper L, Bartlett S, Hawk D, Vine E (1989) Linking lifestyle and energy use: A matter of time. Annual Review of Energy 14: 273-318.
13. Mazur A (2011) Does increasing energy or electricity consumption improve quality of life in industrial nations. Energy Policy 39: 2568-2572.
14. Sanquist TF, Orr H, Shui B, Bittner AC (2012) Lifestyle factors in U.S. residential electricity consumption. Energy Policy 42: 354-364.
15. Defra (2008) A framework for pro-environmental behaviours. Department for Environment, Food and Rural Affairs, London.
16. Whitmarsh L, O'Neill S (2010) Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. Journal of Environmental Psychology 30: 305-314.
17. Dickinson JE, Dickinson JA (2006) Local Transport and Social Representations: Challenging the Assumptions for Sustainable Tourism. Journal of Sustainable Tourism 14: 192-208.
18. Barr S, Gilg, AW (2006) Sustainable lifestyles: framing environmental action in and around the home. Geoforum 37: 906-920.
19. Barr S, Gilg, AW (2007) A conceptual framework for understanding and analyzing attitudes: Towards environmental behavior. Swedish Society for Anthropology and Geography 89: 361-379.
20. Barr S, Gilg, AW, Ford NJ (2001) A conceptual framework for understanding and analyzing attitudes towards household waste-management. Environment and Planning A 33: 2025-2048.
21. Barr S, Shaw G, Coles T (2011) Times for (Un)sustainability? Challenges and opportunities for developing behaviour change policy. A case-study of consumers at home and away. Global Environmental Change 21: 1234-1244.
22. Barr S, Gilg AW, Shaw G (2011) Helping People Make Better Choices: Exploring the behaviour change agenda for environmental sustainability. Applied Geography 31: 712-720.
23. Darnton A (2004) Driving public behaviours for sustainable lifestyle. Reports and summary to the Department for Environment. Food and Rural Affairs (DEFRA), London.
24. Darnton A, Verplanken B, White P, Whitmarsh L (2011) Habits, routines and sustainable lifestyles: A summary report to the Department for Environment. Food and Rural Affairs (DEFRA), London.
25. Shove E (2010) Beyond the ABC: climate change policy and theories of social change. Environment and Planning 42: 1273-1285.
26. Hines JM, Hungerford HR, Tomera AN (1987) Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. The Journal of Environmental Education 18: 1-8.
27. Stern PC (2000) Toward a coherent theory of environmentally significant behavior. Journal of Social Issues 56: 407-424.
28. Kollmuss A, Agyeman J (2002) Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior. Environmental Education Research 8: 239-260.
29. Sanne C (2002) Willing consumers locked-in? Policies for a sustainable consumption. Ecological Economics 42: 273-287
30. McDonald S, Oates C (2003) Reasons for non-participation in a kerbside recycling scheme. Resources, Conservation and Recycling 39: 369-385.
31. Tonglet M, Phillips PS, Read AD (2004) Using the Theory of Planned Behaviour to investigate the determinants of recycling behaviour: A case study from Brixworth, UK. Resources, Conservation and Recycling 41: 191-214.
32. Haq G, Whitelegg J, Cinderby S, Owen A (2008) The use of personalised social marketing to foster voluntary behavioural change for sustainable travel and lifestyles. Local Environment: The International Journal of Justice and Sustainability 13: 549-569.
33. Jesson J (2009) Household waste recycling behavior: A market segmentation model. Social Marketing Quarterly 15: 25-38.
34. Lutzenhiser L (1992) A cultural model of household energy consumption. Energy 17: 47-60.
35. Whitelegg J (1993) Time pollution. The Ecologist 23: 132-134.
36. Whitelegg J, Haq G (2003) The global transport problem: Same issues but a different place. The Earthscan Reader.
37. Emery AD, Griffiths AJ, Williams KP (2003) An in-depth study of the effects of socio-economic conditions on household waste recycling practices. Waste Management and Research 21: 180-90.
38. Blake J (1999) Overcoming the 'value-action gap' in environmental policy: Tensions between national policy and local experience. Local Environment: The International Journal of Justice and Sustainability 4: 257-278.
39. Rogers EM (1995) Diffusion of innovations (4th edn.). Free Press, New York.
40. Damanpour F, Gopalakrishnan S (1998) Theories of organizational structure and innovation adoption: The role of environmental change. Journal of Engineering and Technology Management 15: 1-24.
41. Rogers EM (1983) Diffusion of innovations (3th edn.). Free Press, New York.
42. Bandura A (1986) Social foundations of thoughts and action: A social cognitive theory. Prentice-Hall: Englewood Cliffs, New Jersey.
43. Bikhchandani S, Hirshleifer D, Welch I (1992) A theory of fads, fashion, custom, and cultural change as information cascades. Journal of Political Economy 100: 992-1026.
44. Banerjee AV (1992) A simple model of herd behaviour. Quarterly Journal of Economics 107: 797-817.
45. Labay DG, Kinnear TC (1981) Exploring the consumer decision process in the adoption of solar energy systems. Journal of Consumer Research 8: 271-278.
46. Rogers EM (2003) Diffusion of innovations (5th edn.). Free Press, New York.
47. Zedeck S (1971) Problems with the use of "moderator" variables. Psychological Bulletin 76: 295-310.
48. Tabachnick F (2001) Using multivariate statistics, Pearson Fifth Edition.
49. Aguinis H (2004) Regression analysis for categorical moderators. The Guildford Press, London.
50. Cohen J, Cohen P (1983) Applied Multiple Regression/ correlation analysis for behavioral sciences (2nd edn.). Hillsdale New Jersey.
51. Allison PD (1977) Testing for interaction in multiple regression. American Journal of Sociology 83: 144-153.
52. Ary D, Jacobs LC, Razavieh (1996) An introduction to research in education (5th edn.). Harcourt Brace College Publishers, New York.
53. Cohen J, Cohen P, West SG, Aiken LS (2003) Applied Multiple Regression/ correlation analysis for the behavioral sciences (3rd Edn.). Lawrence Erlbaum Associates, New Jersey.

54. Hawthorne M, Alabaster T (1999) Citizen 2000: development of a model of environmental citizenship. Global Environmental Change 9: 25-43.
55. Omran A, Mahmood A, Abdul Aziz H, Robinson GM (2009) Investigating households attitude toward recycling of solid waste in Malaysia: A case study. International Journal of Environment and Resources 3: 275-288.
56. Ramayah T, Wai J, Osman M (2010) Green product purchase intention: Some insights from a developing country. Resources, Conservation and Recycling 54: 1419-1427.
57. Ramayah T, Wai J, Shuwen Lim S (2012) Sustaining the environment through recycling: An empirical study. Journal of Environmental Management 102: 141-147.
58. Inglehart R (1995) Public support for environmental protection. The impact of objective problems and subjective values in 43 societies. Political Science and Politics 28: 57-71.
59. Olli E, Grendstad G, Wollebaek D (2001) Correlates of environmental behaviors: bringing back social context. Environment and Behavior 33: 181-208.
60. Patchen M (2010) What shapes public reactions to climate change? Overview of research and policy implications. Analyses of Social Issues and Public Policy 10: 47-68.
61. Davis FD (1989) Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly 13: 319–340.
62. Triandis H (1980) Values, Attitudes, and Interpersonal Behavior, Nebraska Symposium on Motivation, 1979: Beliefs, Attitudes, and Values. University of Nebraska Press, Lincoln pp: 195-259.
63. Karahanna E, Straub DW (1999) Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs. MIS Quarterly 23: 183-214.
64. Weinreich N (1999) Hands-on social marketing: A step-by-step guide. Sage, London.
65. Salonen AO, Ahlberg M (2013) Obstacles to sustainable living in the Helsinki Metropolitan Area. Sustainable Cities and Society 8: 48-55.
66. Dearing JW (2009) Applying Diffusion of Innovation Theory to intervention development. Research on Social Work Practice 19: 503-518.
67. Barnett C, Cloke P, Clarke N, Malpass A (2011) Globalizing responsibility: The political rationalities of ethical consumption. Wiley-Blackwell, Oxford.
68. Maller CJ, Horne RE (2011) Living lightly: How does climate change feature in residential home improvements and what are the implications for policy. Urban Policy and Research 29: 59-72.
69. Jackson T (2005) Live better by consuming less? Is there a "double dividend" in sustainable consumption. Journal of Industrial Ecology 9: 19-36.
70. Welsch H, Kühling J (2009) Determinants of pro-environmental consumption: The role of reference groups and routine behavior. Ecological Economics 69: 166-176.
71. Burkhardt ME, Brass DJ (1990) Changing patterns or patterns of change: the effects of a change in technology on social network structure and power. Administrative Science Quarterly 35: 104-127.
72. Lu J, Yao JE, Yu CS (2005) Personal innovativeness, social influences and adoption of wireless Internet services via mobile technology. Journal of Strategic Information Systems 14: 245-268.
73. Schmitz J, Fulk J (1991) Organizational colleagues, media richness, and electronic mail: A test of the social influence model of technology use. Communication Research 18: 487-523.
74. Kohles JC, Bligh MC, Carsten MK (2013) The vision integration process: Applying Rogers' diffusion of innovations theory to leader-follower communications. Leadership 9: 466-485.
75. Roy J, Pal S (2009) Lifestyles and climate change: link awaiting activation. Current Opinion in Environmental Sustainability 1: 192-200.
76. Eilam O, Suleiman R (2004) Cooperative, pure, and selfish trusting: Their distinctive effects on the reaction of trust recipients. European Journal of Social Psychology 34: 729-738.
77. Bhate S, Lawler K (1997) Environmentally friendly products: factors that influence their adoption. Technovation 17: 457-465.
78. Tessmer M (1990) Environmental analysis: A neglected stage of instructional design. Educational Technology Research and Development 38: 55-64.
79. Rogers EM (2002) Diffusion of preventive innovations. Addictive Behaviors 27: 989-993.
80. Barr S (2003) Strategies for sustainability: citizens and responsible environmental behavior. Area 35: 227-240.
81. Barr S (2004) Are we all environmentalists now? Rhetoric and reality in environmental action. Geoforum 35: 231-249.
82. Coakes SJ, Steed L (2009) SPSS: Analysis without anguish using SPSS version 14.0 for Windows. John Wiley and Sons, Inc. New York.
83. Frambach RT, Agarwal MK, Nijssen EJ (2002) Beyond the adoption/non-adoption dichotomy: The impact of innovation characteristics on potential adopters' transition through adoption process stages. Research Memorandum.
84. Haggman SK (2009) Functional actors and perceptions of innovation attributes: influence on innovation adoption. European Journal of Innovation Management 12: 386-407.
85. Heiskanen E, Johnson M, Robinson S, Vadovics E, Saastamoinen M (2010) Low-carbon communities as a context for individual behavioural change. Energy Policy 38: 7586-7595.
86. Kaufmann HR, Panni MFAK, Orphanidou Y (2012) Factors affecting consumers' green purchasing behavior: An integrated conceptual framework. Amfiteatru Economic 14: 50-69.
87. Mooi EA, Frambach RT (2012) Encouraging innovation in business relationships: A research note. Journal of Business Research 65: 1025-1030.
88. Ozaki R (2011) Adopting Sustainable Innovation: What makes consumers sign up to green electricity. Business Strategy and the Environment 20: 1-17.
89. Pickett-Baker J, Ozaki R (2008) Pro-environmental products: marketing influence on consumer purchase decision. Journal of Consumer Marketing 25: 281-293.
90. Rogers EM (2004) A prospective and retrospective look at the Diffusion Model. Journal of Health Communication: International Perspectives 9: 13-19.