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Low Carbon Behaviours in Office Buildings and the Behaviours' Activation Attributes

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Operational carbon emissions from buildings are well known to be one of the prominent contributors to Greenhouse gases (GHG). One of the solutions to reduce operational carbon emissions of buildings is to have occupants with low carbon behaviour (LCB). However, a number of initiatives and research to lower buildings' carbon emissions have mostly focused on the occupants' behaviour in residential buildings rather than in office buildings. The objectives of this paper are to systematically review the available research on behaviour that could be adopted or adapted as low carbon behaviour in office buildings, to identify the behaviour's activation factors by relating it to the Norm Activation Model (NAM) and to formulate a conceptual framework by highlighting their complex interactions. Literature related to the research was carefully selected according to low carbon behaviour-related keywords. The review results were then categorised by authorship, year published, journal, researched building and location, research method, behaviour change theory used, analysis used and low carbon behaviour and its activation attributes. Forty-two studies have met the authors' inclusion criteria. A LCB conceptual framework was proposed at the end of this paper highlighting the factors antecedent to one's personal norms, intentions and attitudes towards a holistic LCB framework.

Keywords: *Low carbon behaviour, Office building, Behaviour change.*

Introduction

Human activities and economic development with increased energy consumption, high demand of natural resources and land are clearly raising concerns about the environmental issues (Isa et al., 2019; Albahori et al., 2017). Carbon emitted by buildings during the operational stage of a building life cycle is mostly generated from energy use by the occupants (Isa et al., 2019; Isa et al., 2018, Albahori et al., 2017). Dumitru et al. (2016) stated that studies about the sustainable behaviour of people in the office are crucial, because large organisations might highly affect global warming up until 100 years. Thus an act to decrease energy consumption is very important to reduce carbon emissions of buildings (Albahori et al., 2017; Isa et al., 2015). Low carbon behaviour (LCB) is cheap, with less expensive and demanding infrastructure or technology needed, applicable to existing or new buildings and potentially for a sustainable culture adopted by generations of occupants.

The efforts to promote LCB in office buildings are crucial, as it is the biggest energy consumer in the commercial sector globally (Nguyen & Aiello, 2013). Yang and Li (2013) defined LCB as a low carbon way of life which determines how a low carbon society lives. This consists of the behaviour of the energy efficient practice, the purchase of low carbon and environmental-friendly items, and other behaviours that lessen the use of energy and the carbon released. This suggests that LCB covers a wide range of occupants' behaviour from the intention to reduce energy consumption to actually reducing individual energy and product consumption. Unfortunately, the energy saving behaviour has not been given sufficient focus in the building sector, including the green buildings that are usually known as energy efficient buildings. In Malaysia, for instance, the criteria in certifying a green building mostly emphasises the building design and technology rather than the occupant's behaviour (Isa et al., 2018). However, reducing energy consumption and carbon emissions of an office building through technological and design approaches will usually involve huge financial and time constraints (Isa et al., 2015).

Gandhi and Brager (2016) added that research papers on occupants' behaviour in offices or commercial buildings are scarce compared to studies on residential buildings. Low carbon or energy saving behaviour is typically applied at home compared to an office building. In addition, most studies are inclined towards technological solutions compared to behaviour solutions that can be applied to existing and new buildings (Safee et al., 2015; Gandhi & Brager, 2016). Therefore, this systematic review aims at identifying low carbon behaviour items and the related behaviour change theory by systematically reviewing related journals and reports. Three objectives are formulated to achieve the aim, one is conducting an overview of available literature on LCB terms and items, the behaviour change theory, research method, and research findings, the second is synthesising LCB items that could be adapted to, or adopted by, the office building setting and its activation attributes and the third is developing a conceptual framework.

Methodology

Searching Method and Study Selection

A systematic review was applied to this research. This method allows the researcher to find literature that is specifically relevant to the research objectives, which are to identify LCB items and the items' activation factors as well as to formulate a conceptual framework highlighting the factors antecedent to one's personal norms, intentions and attitudes towards a holistic LCB framework for future research. The journal search was conducted through Science Direct, Scopus and Google Scholar databases, limited to journals written in English but inclusive of original and review research papers published between 2007 and 2018. The keywords used for the journal's title and abstract searching were: 'LCB in building'; 'LCB'; 'office building', and 'behavioural change model'. The search was further refined to any journals that are related to LCB, its activation factors, behavioural change model and low carbon indicators. From each journal found, the search engine will recommend additional related journals from the particular journal references. The snowballing journals were included if they were related to LCB and the behaviour change theory. Duplicate articles were removed, and articles were screened for relevance, primarily based on the title and abstract.

Data Extraction

Selected articles were read to extract the key data and the extraction findings were categorised according to the authorship, year published, journal, researched building and location, research method, the behaviour change theory used, the analysis used, LCB and its activation attributes.

Results

Overview of Findings

Forty-two articles were reviewed and grouped into three categories with the themes of LCB in office buildings (25 articles), LCB in other environment settings (7 articles) and the behavioural change theory (10 articles) (**refer Table 1)**. All articles ranging from the year 2009 to 2018 were reviewed in this paper, with 33 of them published recently from 2013 to 2018. All articles were published in a total of 23 journals. *Energy and Buildings* and *Energy Policy,* each published six articles, followed by *Energy Research & Social Science, Energy Procedia* and *Applied Energy,* each with three articles while *Journal of Cleaner Production, Building and Environment* and *Sustainable Cities and Society* each with two articles. Fifteen other journals published only one article each.

Table 1: *Journal Distribution of the Forty-two Research Papers Reviewed in this Study*

Journal		Behavioural changes theory Articles	LCB in office buildings Articles	LCB in other settings Articles	No of papers
		Authors			
1.	Journal of Economic Psychology	Onwezen et al., 2013	-	-	1
2.	Family and Consumer Sciences Research Journal	Park & Ha, 2014	-	-	1
3.	Energy Research and Social Science	Van Der Werff & Steg, 2015	Dumitru et al., 2016, Dixon et al., 2015	-	-
4.	The Journal of Social Psychology	De Groot & Steg, 2009	-	-	1
5.	British Journal of Social Psychology	Steg & de Groot, 2010	-	-	1
6.	Journal of Environmental Psychology	Han, 2014	-	-	1
7.	International Journal of Hospitality Management	Shin et al., 2018	-	-	1
8.	Journal of Outdoor Recreation and Tourism	Vaske et al., 2015	-	-	1
9.	International Journal of Hospitality Management	Han et al., 2016	-	-	1
10.	Energy Policy	Zhang et al., 2013	Zhang et al., 2013, Jiang et al., 2013, Zierler et al., 2017, Murtagh et al., 2013	Bai & Liu, 2013	6

Journal		Behavioural changes theory Articles	LCB in office buildings Articles	LCB in other settings Articles	No of papers
		Authors			
11.	Energy and Buildings	-	Masoso & Grobler, 2010, Kamilari et al., 2015, Gandhi & Brager, 2016, Bennet & Brien, 2017, Brian et al., 2014	Ruan et al., 2017	6
12.	Applied Energy	-	Nilsson et al., 2015, Lin et al., 2017	Chen et al., 2014	3
13.	Energy Procedia	-	Pan et al., 2017, Pan et al., 2016	Romanach et al., 2017	3
14.	Sustainable Cities and Society	-	Liao et al., 2018	Neo et al., 2017	2
15.	Building and Environment	-	Deuble & de Dear, 2012, Pan et al., 2018	-	-
16.	Journal of Cleaner Production	-	Zhang et al., 2014	Li et al., 2017	2
17.	International Journal of Environmental Science and Development	-	Sakina, et al., 2015	-	1
18.	Waste Management	-	Edjabou et al., 2018	-	1
19.	Chemical Physics Letters	-	Galvin & Terry, 2016	-	1
20.	Energy Economics	-	Ornaghi et al., 2018	-	1
21.	Resources, Conservation and Recycling	-	Proenc & Ghisi, 2010	-	1

Journal		Behavioural changes theory Articles	LCB in office buildings Articles	LCB in other settings Articles	No of papers
		Authors			
22.	ASHRAE Winter Conference	-	Lobato et al., 2011	-	1
23.	Global Environmental Change	-	-	-	1
	Total	**10**	**25**	**7**	**42**

Synthesis of Findings

Low Carbon Behaviour (LCB) Articles

Articles discussing the holistic concept of LCB in office buildings are very limited. From all 25 articles on the LCB in office buildings as shown in **Table 1,** only one article covers the holistic concept of LCB, which is an article written by Jiang et al. in 2013. Meanwhile, out of seven LCB articles on other environment settings, there was only one article covering holistic LCB lifestyles (Whitmarsh et al., 2011). Other LCB articles were only focusing on one scope of LCB such as electricity consumption (Ruan et al. 2017), low carbon consumptions (Chen et al., 2014; Li et al., 2017; Romanach et al., 2011), water consumption (Proenc & Ghisi, 2010) and waste management (Edjabou et al., 2018, Liao et al., 2018). Other articles did not use the term low carbon or LCB but only focused on energy or electricity saving, suggesting that the concept of energy or electricity saving is not highly linked to carbon pollution emitted through the production of electricity, rather focusing only on the wasted energy. Reviewing the types of building studied in LCB articles, 25 articles studied office buildings. Eighteen LCBs in the office building articles did not apply any behaviour theory and thus, cannot explain the behaviour, while five articles applied the theory of planned behaviour (TPB) (Li et al., 2017; Dixon et al., 2015; Zhang et al, 2014; Murtagh et al., 2013; Zierler et al., 2017), one article applied the Norm Activation Model (NAM) (Zhang et al., 2013), and one article applied the Value Belief Norm Theory (Sakina et al., 2015). Referring to **Table 1,** seven articles applied the survey questionnaire for the research method, three articles applied the energy audit method, one article applied the interview method, while other remaining articles applied the mixed methods which are survey with observation, log record with building simulation, interview with survey, focus group with survey and energy audit with intervention and survey questionnaire.

Behaviour Change Articles

From ten of the behaviour change articles reviewed (refer **Table 1)**, six of them used only NAM, while two articles integrated NAM with Theory of Planned Behaviour (TPB) and another two articles each integrated NAM with the Model of Goal Directed Behaviour (MGB), and responsible environmental behaviour (REB). Different behaviour variables were applied in the reviewed articles. Onwezen et al. (2013) applied the Anticipated Emotion of Pride and Guilt (AEG) from NAM and integrated it with attitudes towards environmentally friendly behaviour and perceived behavioural control from TPB (Onwezen et al., 2013). Han et al. (2016) also used AEP and AEG but with all three basic NAM variables which are: ascription of responsibility (AR); awareness of consequences (AC) and personal norms (PN). The researcher also integrated attitude towards the behaviour with the social norm from TPB. Shin et al. (2018) also applied AR, AC and PN and integrated it with attitude, subjective norms and perceived behavioural control from TPB. Park and Ha (2014) applied PN and AC from NAM and integrated them with attitude, perceived behaviour control and subjective norm from TPB. Van Der Werff and Steg (2015) used PA, outcome efficacy (OE) and PN to study energy efficient behaviour. De Groot and Steg (2009) used the three basic NAM variables to study pro-social and pro-environmental behaviour. They also added outcome efficacy (OE) to understand the intention to adopt both the pro-social and pro-environmental behaviour. Vaske et al. (2015) applied AC and AR but they altered PN as the ecological norm salience to study the carbon foot print mitigation on vacation. Han et al. (2016) used AC, AR and PN and combined them with the model of goal directed behaviour (MGB) in explaining cruise travellers' pro-environmental behaviour. The MGB involves a number of variables such as the frequency of past behaviour, behavioural intention and desire with TPB-like variables; subjective norm, perceived behavioural control; attitude toward the behaviour and NAM like variables; positive anticipated emotion and negative anticipated emotion. Lastly, Zhang et al. (2013) applied the three basic NAM variables with the addition of organisational electricity saving climate. All NAM articles studied the pro-environmental behaviour with a self-reported behaviour questionnaire survey as their behaviour data. Seven articles used the structural equation modelling in their data analysis (Shin et al., 2018; Han et al., 2016; Park & Ha, 2014; Vaske et al., 2015; Han, 2014; Zhang et al., 2013; Onwezen et al, 2013); two articles used the regression analysis (Van Der Werff & Steg, 2015; De Groot & Steg, 2009) and one article used the multivariate analysis of variance (MANOVA) (Steg & de Groot (2010).

Discussion

Low Carbon Behaviour (LCB) Attributes

Whitmarsh, Seyfang, and O'Neill (2011) suggested that LCB is an act of decreasing the energy consumption; in other words, energy efficient actions (Whitmarsh, et al., 2011). Yang and Li (2013) defined LCB as a low carbon way of life that forms a low carbon society. This consists of the behaviour of the energy efficient practice, the purchase of low carbon and

environmentally-friendly items, and other behaviours that lessen the use of energy and carbon emissions.

Electricity Habit

In discussing the energy saving behaviours, a few research papers have highlighted several acts which are beneficial when the electricity appliances are not being used or needed; switching off the lights, setting the computer system to sleep or standby mode to reduce the power use, turning off the overhead light and turning the monitor of the computer (Dixon et al., 2015). Zhang et al. (2013) described a few electricity saving behaviours such as; switching off the lights even though a person is going out for a short period of time or when the sunshine is bright, opening the windows instead of using the air conditioner, setting the temperature as high as possible even though the person feels a little hot, turning the computer power off when it is not being used, lessening the amount of time of the refrigerator door being kept open, making sure that the room is closed when the airconditioner is on, turning off the light when exiting a room when one is the last person.

Heating, Ventilation, Air Condition (HVAC)

Pan et al (2017) and Jiang et al (2013) stated that the window should be closed when the cooling system is operating and the outdoor air utilisation should be maximised to cool down the temperature. The air conditioner temperature setting is subjective to the respective country. Ruan et al. (2017) in their study in Tijuan, China, suggested that air conditioners should be set at 26 degrees to minimise the energy use by the air conditioner and to use the fan as the cooling alternative. Jiang et al. (2013) suggested that the temperature should be set at ≥28 C during summer and ≤15 C during winter, and the air conditioner should not be used or should not be set on standby when the temperature is ideally between 15 and 30 Celsius (Jiang et al., 2013). Ruan et al. (2017) also found that the HVAC consumption behaviour depends on its system and bill charging. Some HVAC are controlled by individuals while some are controlled by an automated integrated systems. The bill charged is also playing a crucial aspect as people tend to be more alert if they pay the bill compared to the company paying the bill (Ruan et al., 2017).

Lighting Consumptions

Jiang et al. (2013) suggested that the lighting is turned off if its function is not significant, using an energy saving bulb and using a lamp suitable for its function such as table lamp for reading instead of a room lamp. However, occupants tend not to behave in a low carbon manner if the behaviour is inconvenient to them. Occupants might also just leave the lighting switched on because of the unreachable location of the lighting from their desks. Occupants also tend to leave lighting and other pieces of equipment switched on all day even though they spend more than 50% of their time away from their desks (Jiang et al., 2013).

Plug Loads Consumption

All electrical appliances that are plugged in to the electrical switch outlet are categorised under plug loads (Gandhi & Brager, 2016). Miscellaneous Electric Loads (MELs) involve the electrical consumption that leaves an electrical footprint (Kamilaris et al., 2015). The Plug loads or MELs items in an office are the desktop computer, laptop, printer, server, UPS, fax machine, scanner and task light (Masoso & Grobler, 2010; Gandhi & Brager, 2016; Kamilaris et al, 2015). The U.S Energy Information Administration (2003) reported that commercial office buildings use 12% of their end use energy for plug loads. In 2006, the percentage of the total building energy consumption for offices' plug loads is reported at 14%. In 2010, the percentage of total US commercial building electric usage for plug loads is about 33%. These reports show that the plug loads' energy usage cannot be taken lightly and its consumption is highly dependent on occupants' behaviour. This is proven in a scenario at an office building in California where the plug load consumption is about 40% from the total energy used in energy efficient buildings that have an effective space and lighting arrangement. In another scenario, plug loads use up to 55% of the total energy consumption in office buildings (Lobato et al., 2011). Gandhi and Brager (2016) discovered that the task light and monitor energy consumption are reduced during lunch hours while the desktop and laptop maintained their consumption level, indicating that occupants leave their work devices switched on. Nilsson, Andersson and Bergstad (2015) and Jiang et al. (2013) suggested several plug loads savings such as turning off the monitor instead of using the standby mode, turning off the computer instead of using the standby mode and using the energy saving mode.

Consumption of Low Carbon Product

The low carbon product is part of the effort towards achieving a low carbon economy. Low carbon products could only work in reducing carbon emission and energy consumption if people choose to consume, use or buy the product. People's behaviour will determine the product supplier's decision to supply low carbon products or not, and this will eventually determine the low carbon economy performance of a country (Chen et al., 2014). Thus, it is crucial to understand factors affecting personal norms, which in turn will determine people's behaviour to consume the low carbon product, or otherwise.

Water Usage

Water is one of the elements that consumes energy, thus emitting carbon in the process as well. Water also consumes energy through its treatment processes. Jiang et al (2013) studied several behaviours related to water such as turning off the tap when it is not used, taking less time in the shower and using a washing machine properly.

Waste Management - Reduce, Reuse and Recycle

Recycling is a process of separating and reusing items instead of disposing of them (Park & Ha, 2014). Bai et al. (2013) included a specific item, which is the chopstick. The use of disposable chopsticks should be reduced in the effort to reduce the product wastage. Other disposable materials should also be avoided to reduce waste production. Jiang et al (2013) also recommended recycling bottles and papers. Jiang et al (2013) and Nilsson et al. (2015) suggested reducing the use of the paper by printing on both sides of the paper. Nilsson et al. (2015) also added reading from the monitor as a strategy to reduce paper usage.

Table 2 summarises 67 LCB items that could be adopted in office buildings. The items were categorised into four main categories, namely efficient electricity behaviour, efficient water behaviour, efficient waste management and low carbon product consumption. However, the items listed should be modified according to each building due to the complexity of the organisational climate of a building and its occupants.

Table 2: *Low Carbon Behaviour in Office Buildings*

ELECTRICITY EFFICIENT BEHAVIOUR	
Lighting	
1.	Switch off the lights in the office when they are not in use
2.	Switch off the lights when going out even for a short time
3.	Switch off the lights when the sunlight is bright enough
4.	Switch off unused and rarely used lights, such as in the store room, toilet, meeting room, pantry and Muslim prayer room
5.	Switch off unused outdoor lights, such as in the corridor, lobby, and side walk except for security and other purposes
6.	Open curtains in an office room to allow sunlight to light the room
7.	Dim the living room lights while watching television or videos
Air Conditioner	
8.	Switch off air conditioner in a meeting room after use
9.	Switch off split units if you leave the room for more than two hours
10.	Switch on the air conditioner early if the temperature is expected to increase, to reduce the load on the air conditioner
11.	Set the temperature as high as possible even if you feel only a little hot
12.	Set the temperature as advised, which is 24 Celsius
13.	Actively manage indoor temperatures by opening and closing windows
14.	Make sure doors are closed shut, reducing gap between doors and doors' frames
15.	Check source of an air leak to avoid hot and humid air entering the building
16.	Reduce the operating system time
17.	Do not block the air flow of the unit with curtains or furniture
18.	Shade windows to reduce heat absorption

Ceiling or Wall Fan	
19.	Switch off the fan when it is not needed
20.	Make sure the back of the fan is not blocked because airflow obstruction will degrade performance or cause it to operate with excessive burdens
Refrigerator	
21.	Shorten the duration of refrigerator door opening
22.	Adjust the freezer temperature according to the load
23.	Set freezer temperature at -18 Celsius
24.	Set refrigerator temperature at 5 Celsius
25.	Make sure the door gasket works well
26.	Arrange and ensure there are gaps between foods for ventilation
27.	Clean refrigerator on a regular basis
28.	Avoid frequent opening or deliberately letting the refrigerator door open
Elevator	
29.	Only use the elevator when moving up to far upper level
Computer	
30.	Switch off the computer when not in use for more than one hour
31.	Set energy management features such as setting computer to sleep mode if it is unused for several minutes and activate power saving function
32.	Use computer with LCD monitor instead of CRT monitor
33.	Use laptop instead of desktop computer
34.	Turn off the computer monitors
35.	Avoid leaving computer in standby mode or sleep mode
Printer, Scanner And Photocopier Machine	
36.	Switch off printer and photocopier machine after office hours
37.	Set printer and photocopier machine to save mode and off to energy efficient setting
38.	Use print preview feature to ensure style and layout before printing
39.	Adjust appropriate margin and font size for optimum paper use
Television and Radio	
40.	Switch off television when not in use
41.	Avoid leaving the appliances in standby mode
Microwave/ Oven	
42.	Check the door gasket and door hinges, if worn and broken, contact customer service to repair or replace it immediately
43.	Avoid heating the oven before cooking
44.	Check dishes through glass door to make sure the oven door is always closed
45.	Defrost frozen food in advance before cooking
46.	Plan to cook several dishes at once to save electricity
47.	Avoid using the microwave oven when it is empty as this can damage the magnetron
48.	Shorten the cooking time

WATER EFFICIENT BEHAVIOUR	
49.	Turn off water taps when not in use
50.	Turn off the water when brushing teeth
51.	Turn off the water when shaving
52.	Take showers that last twelve minutes or less
53.	Replace the daily bath with a shower
54.	Report leaking taps
55.	Tighten leaking taps
56.	Avoid flushing tissue or other waste in the toilet bowl
WASTE MANAGEMENT EFFICIENT BEHAVIOUR	
57.	Avoid using disposable cutlery, plates, bowls and cups
58.	Print on both sides of paper
59.	Recycle paper, plastic bottles and other materials
60.	Reduce paper, bottles and other material usage
61.	Reduce waste production
62.	Sort and segregate waste at source
63.	Segregate electronic waste from others
64.	Trade recycle materials into cash
65.	Compost organic waste
PRODUCT CONSUMPTION EFFICIENT BEHAVIOUR	
66.	Buy environmentally friendly products
67.	Buy and use energy efficient electrical appliances with 4 or 5 Star MEPS Rating

Behaviour Change Model and LCB Activation Attributes
Norm Activation Model (NAM)

NAM is one of the many social psychological theories used to understand and predict pro-social behaviour (Van Der Werff & Steg, 2015). The past research had been validated by the present work where NAM's variables are dominant in clarifying a variety of pro-social intentions, especially in the social and environmental settings (De Groot, & Steg, 2009). De Groot and Steg (2009) named three categories of NAM which are personal norm (PN), awareness of consequences (AC) and ascription of responsibility (AR). NAM, however, is usually modified according to the research scope of the study and the subject. For example, Han (2014) added four additional variables to NAM which are anticipated feeling of pride, anticipated feeling of guilt, attitude toward the behaviour and social norms. As a result, the research acquires more accurate results.

Pro-environmental behaviour is always a combination of pro-social motives and self-interest. The combination of several variables will eventually lead to research to make it more complete and stronger in predicting behaviour (Onwezen et al., 2013). According to Onwezen et al. (2013), NAM was developed to elucidate altruistic behaviour. They further elaborated that

environmentally friendly behaviour is regarded as an explicit kind of altruistic behaviour. De Groot and Steg (2009) stated that it is important for people to know the effects of behaviour before having the feeling of accountability to act on this behaviour or recognise that their contribution might be helpful. Consecutively, accountability feelings enhance the moral obligation to perform pro-socially, and these feelings or obligations would spark pro-social behavioural intentions (De Groot & Steg, 2009). De Groot and Steg (2009) added that NAM was used to examine different kinds of individual pro-social behaviour. They said that one type of pro-social behaviour is the workers' electricity-saving behaviour in a company. Hence, NAM is an appropriate theory to examine this kind of behaviour among the workers, or in other words, LCB.

Theory of Planned Behaviour (TPB)

One of the popular additions to NAM theory is the TPB. For this research, social norms or organisational climate is added to understand the behaviour of occupants of organisations in buildings. A social norm is how a person perceives the social weight to act or not in certain behaviour. This norm eventually affects one's personal norm which will guide one's behaviour to act pro-environmentally or not. NAM focuses on the individual morality and its impact on individual pro-social behaviour. It omits the social environment in which it is very crucial on the perception and behaviour of the individuals. In other words, workers are the people who are involved in an institution and this has a significant effect on their perception and behaviour (Zhang et al., 2014). Thus, it is important for this research to integrate other relevant factors in predicting LCB of occupants in office buildings. The integrated theory is also proven to have better predicting abilities for some research.

NAM as Mediator Model

De Groot and Steg (2009) conducted five experiments of NAM and they found that NAM works well as the mediator model. The research concluded that pro-social or environmental behaviour would need people to be aware of the negative consequences of their actions and to feel responsible for their actions to behave pro-socially and pro-environmentally (De Groot, & Steg, 2009). Thus, the lack of AC and AR resulted in the lack of PN to act pro-socially and pro-environmentally (De Groot, & Steg, 2009). A mediator model looks theoretically probable because it is hard to feel accountable for acting pro-socially or for thinking about the efficacy of probable actions without knowing if not acting pro-socially is a predicament. Consequently, if a person does not feel responsible for the problems or its solution, it is very unlikely that he will act in accordance to PN. Hence, at first, problem awareness and responsibility play a vital role in the development of PN, and PN will affect pro-social intentions in accordance with these norms only if these conditions are met.

Self-Reported Behaviour

Nilsson, Andersson, and Bergstad (2015) found in their research that pre and post-intervention of self-reported behaviour is more reliable compared to the observation when they measure changes in people's behaviour due to people bringing their laptops or computers home which left the observation null (Nilsson et al., 2015). Results from reviewed NAM articles also concluded that self-reported behaviour is widely used in NAM research. However, in explaining complex LCB, other methods would enhance the reliability and validity of self-reported behaviour, such as interview and observation. Most of the LCB and NAM studies contain case studies. NAM attributes are then formed from these previous research works. A numbers of additional variables will be integrated with the basic NAM in order to have a stronger predictive measure. However, all available variables will be matched with the research scope, which is low carbon behaviour in office buildings.

Conceptual Framework

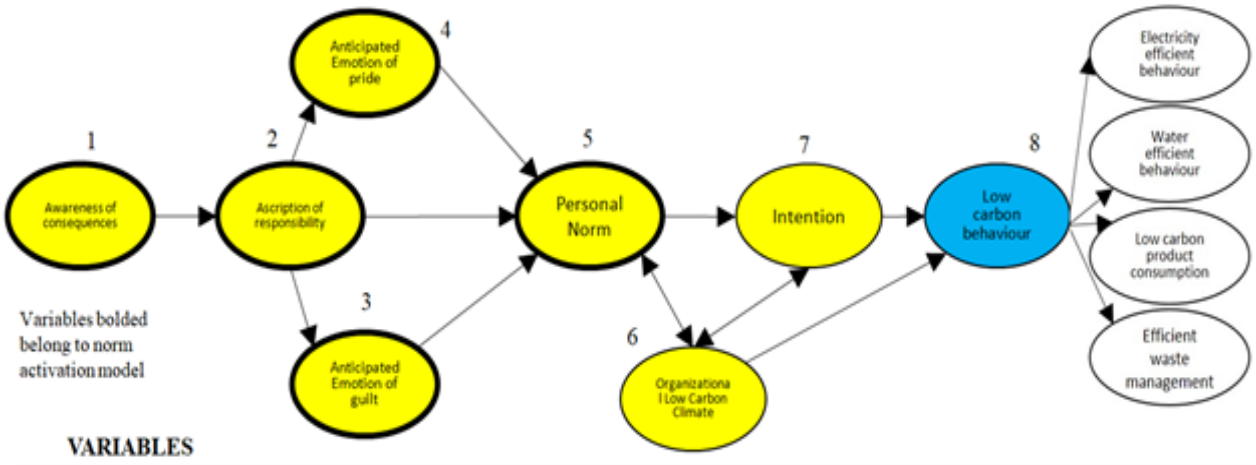
To summarise the main findings from this review and guide further research in this area, a conceptual framework was formulated, linking the LCB and its activation attributes **(Figure 1)**. There are four main LCB dependent variables focusing on electricity consumption, water consumption, waste management and low carbon consumption that have been categorised. To understand the LCB in depth, behaviour change attributes have been integrated into the LCB framework. Variables from the behaviour theory, which are awareness of consequences, anticipated emotion of pride and guilt, ascription of responsibility and personal norm were placed as factors antecedent to the organisational low carbon climate, an intention which becomes the activation attributes of LCB. Each variable is discussed further in the following sections.

Awareness of Consequences (AC)

De Groot and Steg (2009) explained that AC is people's awareness of the negative consequences of their actions to others or the environment by not acting pro-socially or pro-environmentally (De Groot & Steg, 2009). Park and Ha (2014) claimed that the awareness of the consequences embodies one's inclination to associate his own behaviour to other people's wellbeing. They felt that it is hard for an individual to feel a strong commitment to carry out certain behaviours without being conscious of the effects of his behaviour. When users are equipped with the knowledge about the needs for the environment and acknowledge that recycling is a method to curb environmental problems, they are prone to personally feel inclined to execute recycling. The development of the ascription of responsibility can be promoted through the awareness of the consequences. Park and Ha (2014) further explained the statement by saying that people will develop ascription of responsibility when they have experienced negative consequences and they are prone to impose the negative consequences

to themselves. Workers will also develop ascription of responsibility when they are aware of the negative consequences. If the workers are aware of the negative consequences of electricity consumption in the long run, they are prone to develop the moral obligation to save the electricity. On the other hand, if the workers are not aware of the negative effects of electricity consumption, they are not prone to develop PN to save the electricity (Zhang et al., 2013).

Figure 1. *Conceptual Framework*



	VARIABLES	
1	Awareness of consequences	People awareness of the negative consequences of their action to others for not acting pro-socially or pro-environmentally (De Groot and Steg, 2009)
2	Ascription of responsibility	People's feeling responsible for the negative impact to other people or environment by not acting pro-socially or pro-environmentally (De Groot and Steg, 2009)
3	Anticipated Emotion of pride	People anticipated feeling of pride even before they act because of the positive mentality toward a certain behaviour (Onzewen et al., 2013)
4	Anticipated Emotion of guilt	People anticipated feeling of guilt even before they act because of negative mentality towards certain behaviour (Groot and Steg, 2009).
5	Personal Norm (PN)	PN is a person action of doing or avoiding certain behaviour from his or her moral obligation point of view (Schwartz & Howard, 1981).
6	Organizational Low Carbon Climate	Workers' perception that LCB is encouraged and supported in the organization (Zhang, Wang and Zhou, 2013)
7	Intention	People intention to perform LCB Ajzen (1991)
8	Low Carbon Behaviour (LCB)	LCB is an act to decrease energy consumption and carbon emission (Whitmarsh, Seyfang, and O'Neill, 2011)

Ascription of Responsibilities (AR)

According to De Groot and Steg (2009), AR is people's feeling responsible for the negative impact to other people or to the environment by not acting pro-socially or pro-environmentally (De Groot, & Steg, 2009). However, low carbon behaviour is part of the pro-environmental behaviour that did not directly benefit people as the pro-social behaviour does. Meanwhile, Park and Ha (2014) described the ascription of responsibility as one's private feeling whether

one is accountable for the results of the behaviour (Park & Ha, 2014). Some workers who have the awareness of the negative consequences of electricity use might develop the ascription of responsibility for not doing electricity saving in the company. Personal norms to save electricity in the company is built once the workers have developed the ascription of responsibility in saving the electricity. Workers will have a moral obligation as they have acknowledged their responsibility of the negative consequences of not saving the electricity (Zhang et al., 2013).

Anticipated Feeling of Pride and Guilt

According to Onwezen et al. (2013), a person will anticipate the emotion that they will feel even before they behave or act. This anticipated feeling of pride will guide the personal norm to act because of the positive mentality towards certain behaviour (Onwezen et al., 2013). As the opposite of feeling proud, the anticipated feeling of guilt will stop a person from doing a certain act because according to his or her personal norm, doing that certain act will make them feel guilty (De Groot & Steg, 2009).

Personal Norm (PN)

PN is a person's action of doing or avoiding certain behaviour from his or her moral obligation's point of view. Han (2014) said that the significant impact of personal norms on intention formation was recognised among the study variables. The outcome entails that a person's moral obligation for pro-environmental behaviour comes from a few factors such as the awareness of consequences, ascription of responsibility and anticipated feelings. These factors are pivotal to attain a deeper level of understanding of conventional travellers' green intentions (Han, 2014; Safee et al, 2015). Park and Ha (2014) defined personal norms as one's self-postulation for a definite behaviour that comes from norms and values with regard to the behaviour. A person's personal norm influences his pro-social behaviour positively. They further explained that a person will be inspired to get involved in the pro-social behaviours if only he experiences a feeling of moral obligation to act pro-socially (Park, & Ha, 2014). As mentioned by Zhang, Wang and Zhou (2013), a person's ascription of responsibility and awareness of consequences will activate his personal norm. A person will develop a high personal norm when he feels the negative consequences for not acting pro-socially.

Organisational Climate

NAM only focuses on the individual morality and its impact on individual pro-social behaviour. Workers are the people who are involved in an institution and this has a significant effect on their perception and behaviour (Zhang et al., 2014). Organisational climate is pivotal in determining workers' perceptions and behaviours because it deals with the organisation's practices and procedures (Zhang et al., 2014). The social context in an organisation can be

captured through an organisational climate. Zhang et al. (2014) claimed that organisational electricity-saving climate takes place when the workers perceive that electricity saving is encouraged and supported in the organisation. The authors further elaborated that workers tend to practice electricity saving to meet the organisational expectations as they have the electricity-saving climate. They said that the higher the level of electricity saving, the more external pressure there is to save electricity by the workers. This is because negative consequences such as criticisms might be faced by the workers if they violate the behaviour patterns that are accepted publicly; saving the electricity. The electricity saving climate shapes the personal norms of the workers. A sense of guilt for not saving the electricity is what the workers feel as they breach the organisational climate. Hence, the electricity saving climate is an important factor in building the workers' personal norm in saving the electricity.

Conclusion

The government and policy makers' efforts to understand how people behave and the strategies in promoting low carbon behaviour are undeniably important. The significant impact of people's behaviour toward carbon emissions could be one of the key areas in policy and guideline making. Therefore, this research is significant in ensuring that the occupants of buildings who actually need and consume the energy which later produces the operational carbon emissions, would behave in a low carbon behaviour manner. The low carbon behaviour in the office could also potentially activate occupants' personal norms to be more aware of their behaviour, thus promoting a better low carbon and environmental behaviour not only in the building environment but also in other environments.

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