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Making Sense of Energy-Saving Behaviour: A Theoretical Framework on Strategies for Behaviour Change Intervention

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Abstract

The global construction industry is expected to experience an average growth of 3.6% annually in construction outputs throughout 2018 to 2022. The surge of new building developments will create substantial demand for energy and therefore run the risk of higher carbon emissions. With the rising concern over climate change, it is imperative for buildings to have energy-saving strategies in place. Many research has discussed the use of energy efficient technologies as a solution, but overlook the role of energy-saving behaviour during the post-occupancy stage. Occupants' energy-saving behaviour is important in ensuring the optimisation of building technologies. A large part of human behaviour is characterised by habit, which is learned sequences of an act that have become automatic responses to specific ques and are functional in meeting certain needs. The study aims to establish the link between the behaviour of building occupants and their underlying habits. Adopting the Habit Theory as a premise, the study formulates a framework on strategies for behaviour change interventions that captures the underlying motivations to exhibiting energy-saving behaviour. The Effective Theory-Building design process was applied, which engages an axiomatic system to purposefully generate theory, evaluate its utility, and provide an effective representation of the observed phenomena. The theoretical framework addresses how energy-saving behaviour is cultivated through conditions of habits. This shows that the building occupant's behaviour is important for enabling energy efficiency and that it can be construed and explained by repetitive habitual actions of energy-saving practices. To have the greatest effect on a building's energy performance, building managers must examine the nuanced ways that habitual actions may shape the occupants' energy-saving behaviour and consider intervention strategies for changing habits. The paper provides a deeper understanding of building occupants' energy-saving behaviour from a sociotechnical perspective and creates a paradigm for future studies of building energy management.

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Keywords: Energy-saving behaviour; energy efficiency; habit theory; building management; sustainability

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1. Introduction

The global construction industry is expected to experience an average growth of 3.6% annually in construction outputs throughout 2018 to 2022 [1] (1). The surge of new building developments will create substantial demand for energy and therefore run the risk of higher carbon emissions. The non-domestic building sector is responsible for about 18% of carbon emissions in the UK. With 35% of new developments and 60% of existing buildings anticipated to be in use by 2050, the sector presents broad opportunities to economically scale down the UK's carbon footprint [2] (2).

Non-domestic buildings are also workplaces for people, thus, changing energy consumption behaviour in these environments could significantly reduce carbon emissions [3] (3). However, the lack of personal accountability for a shared utility in non-domestic buildings makes it difficult to get occupants to engage with energy-saving strategies [4] (4). To induce engagement within an organization requires someone with leadership and sociable qualities [5] (5). Many organisations have turned to sophisticated technological interventions to improve the building's energy efficiency. While this has been successful in many cases, the approach often requires expensive early investment which cause considerable cost pressures among the wider business population. 'Softer' forms of intervention strategies that target change in the occupants' energy consumption behaviour offer a more economical and modest approach [6] (6). In addition, buildings that adopt energy-saving technology consistently underachieve the expected energy targets by 30 to 100 percent of difference due to occupant's actual energy consumption [7-9] (7) (8) (9). It is argued that savings of up to 21% can be achieved through occupants' energy-saving behaviour alone at no additional costs [10, 11] (10) (11). The studies confirm that occupants' energy consumption behaviour can significantly affect a building's energy performance despite the use of energy-saving technology [12, 13 14] (12) (13) (14). Thus, even though the use of technology aims to achieve energy efficiency, changes in the occupants' energy-saving behaviour is important to avoid technical efficiency gains being overtaken by consumption growth [15] (15). In light of this, energy-saving behavior has become a targeted field of study world-wide as it is important to understand what influences an occupants' energy-saving behaviour.

Researchers have found that a large part of human behaviour is characterised by habit, which is learned sequences of an act that have become automatic responses to specific ques in meeting certain needs (16) (17) (18) (19)[16-19]. Psychologists, sociologists and neurobiologists estimate that forty percent of human behaviour is driven by habits [20, 21] (20) (21). Pioneer French sociologist, Emile Durkheim (22) viewed habits as the real forces that govern human behaviour to the extent of reinforcing the moral fabric of modern societies [22, 23] (23) (24). Corresponding this, Azar & Ansari [17] iterated that a change in habits is key to alter current behaviours and emphasised the need to further studies into understanding why occupants engage in energy-saving behaviour. The paper considers the connection between occupants' habits and energy-saving behaviour, and provides an explanation from a sociotechnical perspective.

2. Methodology

The purpose of a theoretical framework is to introduce and explain theories supporting predictions about the relationship between variables of a research study [24] (25). It sets the context for the study to develop hypotheses, interpret a phenomena, and identify connections between interrelated ideas [25] (26). The theoretical framework is important for understanding the theoretical assumptions of the research under study and allows the researcher to make generalisations of a phenomena [26] (27). The study adopts a theory-then-research strategy to theory building [27] (28). The strategy engages a continuous, reiterative interaction process between theory development and empirical inquiry until the theory is made explicit (28). The Effective Theory-Building design process was applied, which begins with developing an explicit theory based upon an axiomatic system, testing the theory with empirical research, and then making appropriate changes in the theory to correspond with research results (29). The paper attempts to explain the rationale of the theoretical assumption derived from literature review. Fig. 1 illustrates the literature review process undertaken in the development of the theoretical framework.

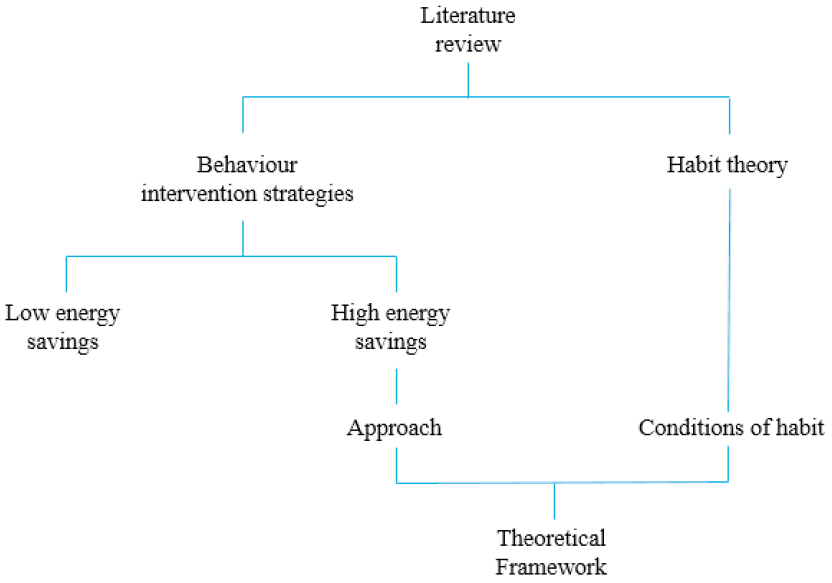


Fig. 1 Review process for development of theoretical framework

The review process involved a systematic search for relevant areas of study as identified in Fig. 1. The relevant studies were analysed to identify key information pertinent to aim of this study. Findings from the analysis were summarised and synthesised methodically, and presented in a theoretical framework. This was used to interpret the problem under study and extrapolate theoretical assumptions that form the research context.

3. Literature Review and Hypothesis

3.1. The role of habits in energy-saving behaviour

Energy-saving behavior can be viewed in two ways i.e. habitual energy-saving behavior (reducing energy consumption by adjusting daily activities) and purchasing energy-saving behavior (investing in energy efficient technologies) (30) (31) (32). This paper shall only focus on habitual energy-saving behavior.

Practitioners have reported that the particular challenge in encouraging energy-saving behaviour was the difficulty to overcome habitual behavior. Some of the common strategies adopted by organisations to overcome this challenge include introducing dedicated energy leaders, applying incentives and penalties, and supporting information and dialogue on energy use (6). Several studies supported the role of dedicated leaders provided significant opportunities to influence change in the organizational culture (and by effect, change social norm behaviour) and was effective in achieving energy reduction (12) (5) (6). Incentives that capitalized on financial rewards were also effective in motivating engagement and helped to develop habits that subsequently became normal behaviour even after the reward system ended (6). Despite these findings, no attempt has been made to understand the process of the development of habits in relation to energy use. While scholars have recognized the importance of habit in shaping behaviour, they did not explicate the entwining role of habit in deploying intervention strategies. There is much thought to be had on the possibility of using habits as a way of understanding and transforming energy-saving behaviour. A thorough understanding of habit is important to inform policies so that intervention strategies can be tailored to the habit strength of the targeted behavior (33).

In order to introduce incentives aimed at inducing behavioral change, a clear understanding of the occupants' present motivation levels and action needed to be established first (12). Kollmuss & Agyeman (2002) (34) stated that behavior represented a complex array of intervening factors including demographics, external factors (e.g. institutional, economic, social and cultural) and internal factors (e.g. motivation, knowledge, values, attitudes, awareness, participation, control, responsibility and priorities). However, most intervention models neglect the role of habits in everyday practices that use energy (34). Social Practice Theory views behavior as the interrelation between human action and a fusion of elements of a practice, and posits that a change in any of these elements would contribute to behavior change. The theory introduces a realistic perspective on behavior by revealing the fact that behavior change requires more than simply removing contextual barriers (35). Similarly, habits are described as repetitive behavior that are performed automatically (in the absence of thought) on a day-to-day basis. In other words, habits are behavior derived from the subconscious mind. Habits are taught and developed over time. As it is possible to form habits, it is also possible to remove or replace them by changing elements of the habitual behavior.

An individual's engagement in energy-saving behaviour is motivated by its position of egoism and altruism (15). Wang, et al. (2018) (36) found that habitual behaviour was mostly motivated by altruism, specifically through the activation of personal norms where the individual supports pro-social behaviours and can be held responsible. Changes in energy-saving behaviour were theoretically possible through approaches that stimulate inner moral sensitivity to environmental protection. Wang, et al. (2018) suggested strengthening energy efficiency policies that enforced stricter laws and regulations as well as continuously improving policies by incorporating occupants' feedback. In addition, disseminating information via Internet channels was recommended to ensure that occupants were well-informed. However, other studies have found that information awareness and attitude towards saving energy does not necessarily lead to a change in behaviour especially at the workplace (12) (37), suggesting that there is no relationship between these with behaviour. Nevertheless, the arrival of big data offers a sublime opportunity for analyzing behavior more comprehensively to interpret how energy-saving behavior develops (36)(Wang, et al., 2018). A recent study (2017) (38) using big data to model occupants' behavioural patterns demonstrated high impact on the building's energy performance and concluded the need for accurate behavioural data to achieve energy savings. In spite of this, while the study established the contingent relationship between habitual behavior and energy performance, it did not explain how and why occupants developed pro energy-saving behavior. It was still unclear what sort of changes led to energy-saving actions that formed habitual behavior (5). Staddon, et al. (2016) (39) confirmed the need for research to consider and measure the theoretical reasons behind energy-saving behaviour. This need corresponds to the gap in literature identified by scholars, which lacks attention on the human dimension of building energy performance to further understand occupants' behaviour (12) (40).

3.2. Habit Theory

Habit is formed when an action is performed regularly and becomes automated behavior after some time (41). Despite habit being intentional to achieving a specific goal, habits are not planned behavior and occur in the absence of awareness (42). Habits develop by associative learning between actions and stable contexts in which they are performed, and are then triggered by environmental cues such as time of the day, particular moods and the presence of partners. Research has found that informational strategies to change behavior are often ineffective when dealing with strong habitual behavior because an individual becomes less attentive to information, which affects processes of judgement and choice (17). Habits may also be observed in tangent with a person's mind-set. Habitual behavior may be linked to a prevailing mental orientation that stimulates behavior. When strong habits are present, the intention-behaviour relationship becomes weak. Intention had little effect on behavior to the extent that a behavior could still transpire even when the intention was not clear (17).

Another category of habits presented by Verplanken is the counter-intentional habits in which habits motivated by short-term hedonistic goals transcend long-term goals intended. Counter-intentional habits generate behavior that focus on immediate relief and are intensified by the measure of urgency and desirability of that relief. The reoccurrence of situations prompting counter-intentional habits result in a rise in habit strength. As habit development relies on past actions, it can therefore be used to predict future behavior (43). However, an important aspect of habit stimulus is its dependence on environmental cues. Research found that a change in the environmental cues disrupted the occurrence

of habits and as a result, behavior became more susceptible to intention (33). This means that habit strength is thinned when the context is destabilized. At this point, information-based intervention strategies may be more effective in guiding behavior with clear intentions.

There are four features underlining habit i.e. lack of awareness, limited controllability, increased mental efficiency and goal-directed (42). Habit was prevalent when consciousness and attention were particularly weak because the mind relied on memory to respond to familiar environmental cues, which freed the mind from complex cognitive processes and essentially increased mental efficiency. The effect of habitual behavior was often difficult to restrain and was driven by the need to meet a specific function. On this premise, it is possible to manipulate habits for behavioral change by altering one or more of the elements supporting habitual behavior.

On the other hand, a recent study found that the success of intervention strategies depended on the degree to which they aligned with existing practices (44). While habits referred to the recurring performance of a specific action, it was often part of a routine practice. Routine practices can be perceived as an assemblage of people, objects and places. Cohn & Lynch (2017) inferred that as long as interventions did not threaten to overly disrupt existing practices and could merge with routine practice assemblages, then the potential for success was presumably high. The study recommended maintaining the stability of routine practice assemblages with a degree of flexibility for elements to respond to changes. Thus, behavioral change was possible through intervention strategies that could be integrated within existing routine practices. In this context, the idea of habit was not focused on internal mental processes, but its interaction with elements of a routine practice assemblage. Habits can consequently alter behavior when patterns of actions are normalized into one's everyday activity and subsequently become entrenched and automatic.

4. Strategies for behavior change interventions

The work of Staddon et al. (2016) (39) heavily influences this paper. It is referred to understand the different types of intervention strategies that can be used to affect behaviour change in energy-saving practice. Nine types of intervention strategies were drawn including Education, Persuasion, Incentivisation, Environmental Restructuring, Modelling, Enablement, Coercion, Training, and Restriction. These intervention strategies were evaluated against the Behaviour Change Wheel (BCW) to identify the source of behaviour in which the strategies appealed to. The most successful strategies, namely Enablement, Environmental Restructuring, and Modelling, were found to benefit from social and physical opportunities for behaviour change to occur. Social opportunities created interpersonal influences that changed individual perception of a situation or behaviour by means of social pressures, norms, conformity and comparisons. Whereas, physical opportunities referred to making changes in the infrastructure and technologies by use of automation or retrofitting. The study concluded the importance of applying intervention strategies within workplace processes and the organisational management to affect change in employee actions as well as the management policy on energy efficiency. While the study recognised the importance of these intervention strategies, it did not consider or measure the theoretical reasons behind energy saving behaviour, and emphasised the need for other researchers to do so. It was not yet understood how and why social influences affected individual and collective actions of energy-saving behaviour.

Using the Habit Theory as a premise, this paper aims to explore the connection between successful intervention strategies and habits. We understand from scholars that up to forty percent of human behaviour is comprised of habits. Thus, for behaviour change to be effective and long-lasting, change needs to occur in the habitual comportment as habitual action is recurrently automated in the absence of awareness. We posit that certain intervention strategies are more successful over others because they target change in habitual action. To establish this, we examine the elements of successful intervention strategies and consider them in connection with the development of habit. The assessment aims to reveal whether habit is a strong conductor of behavioural change. Recognising this would advance our theoretical understanding of the reasons guiding energy-saving behaviour and thus future intervention strategies can be tailored to target these reasons.

4.1. Environmental Restructuring

Environmental Restructuring is defined as applying changes to the context of where behaviour occurs either through physical alterations or social reformations within the organisation (39). Examples of environmental restructuring include retrofitting buildings with energy efficient technology and automation, providing energy use feedback, and putting up signs and posters. Studies utilising environmental restructuring as their intervention strategy reported energy savings between 20 to 50 percent (45) (46) (47), (48) – the highest savings coming from a behaviour change program that included the use of automation and energy efficient devices (49). While it is recognised that technological solutions do not specifically target behaviour change in building occupants, they change the context for behaviour performance. Occupants' behaviour can be observed in response to these contextual changes, either by passively accepting or actively engaging with the technology in place to align with their personal comfort. Context is an important element of habit development. The development of habit relies on the existence of a stable context to trigger actions based on memory (17). Thus, changing the context of where behaviour occurs to a pro-environmental climate would inadvertently inspire pro-environmental actions. Environmental restructuring can also signal an organisation's commitment to energy efficiency goals and consequently have long-term impacts on the behavioural norm of occupants (39). This can be seen as influencing change in the societal mind-set (17). When the organisation establishes a clear standpoint about their energy efficiency goals, it sends a clear message to the building occupants on the expectations of energy-saving behaviour.

4.2. Modelling

Modelling is described as setting a paradigm of energy-saving behaviour through the influence of role models or social comparison (39). Studies utilising Modelling as an intervention strategy showed significant energy savings (35) (50) (51). However, it could not be concluded that this was a direct result of Modelling alone as other intervention strategies were used concurrently. It was noted that comparison between groups was more effective than peer-to-peer comparison as this potentially breached issues of privacy (52). Group comparisons also established a sense of group identity – the effect of which made feedback more successful in affecting behaviour change (53). The success of Modelling intervention strategies can be associated to its approach of providing environmental cues for specific behaviour through the presence of a model colleague. This is consistent with the development of habit as the existence of cues trigger learning by association (17). Modelling generates social influence either by directly introducing colleagues of exemplary energy-saving behaviour or by initiating a sense of competition between colleagues. The strategy establishes points of reference and creates a compelling atmosphere that encourages energy-saving behaviour. It prepares individual behaviour by instigating the imitation and aspiration of specific acts. The use of Modelling over the long term would facilitate continuous associative learning and ingrain memory of expected behaviour until the behaviour becomes an accepted norm in the context.

4.3. Enablement

Enablement looks at creating opportunities for energy-saving behaviour by increasing means and removing barriers within the workplace (39). Examples of enablement include providing an electronic dashboard for employees to control electronic devices remotely (47) (54), acquiring individualised support on work practices that use energy (45), adjusting work practices after office hours (55), and allocating responsibility for energy-related practices and projects (56). Studies using Enablement intervention strategies reported the highest energy savings compared to other studies that did not, thus, clearly indicating its contribution to improved energy performance (39). Staddon notes the tactical shift in responsibility and control over energy performance in Enablement strategies that clearly set it apart from other forms of intervention. The finding suggests that enabling occupants to take charge of their own energy-use performance stimulated better energy-saving behaviour that led to high energy-saving accomplishments. However, this method is at risk of energy abuse from both ignorance and unawareness of occupants. Thus, it should be used

with caution and in tangent or ensuing other forms of intervention that has addressed and strengthened the level of awareness on energy-saving practices.

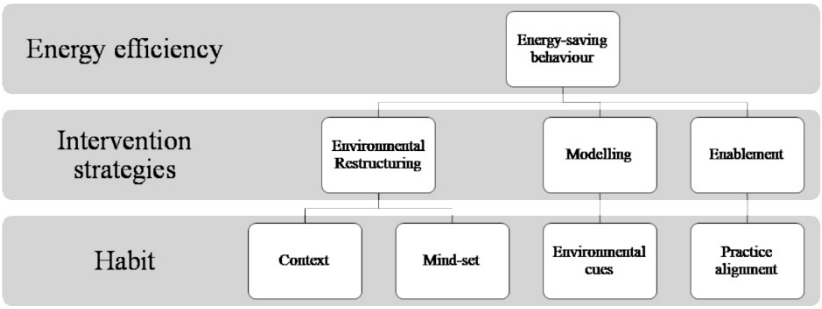
The paper demonstrates only the first step of theory building (knowledge) and will publish the results of empirical research separately. A theoretical framework is proposed based on existing knowledge of behavior intervention strategy and habit theories to explain how energy-saving behaviour is cultivated through conditions of habits. On this premise, the study establishes the theoretical assumption that habit underlies the assimilation of energy-saving behaviour. It infers that the success of behavior intervention strategies depend on its correspondence with conditions of habit.

5. Discussion

5.1. Interrelationship between habit and intervention strategies

Literature review of intervention strategies used for addressing behavioural change elicited three prominent strategies that were most effective in achieving energy savings namely, Environmental Restructuring, Modelling, and Enablement. The strategies were examined alongside theories of habit and were found to match the conditions for habit development. Based on this discovery, the study postulates that energy-saving behaviour is cultivated through conditions of habit. This shows that the building occupant's behaviour is important for enabling energy efficiency and that it can be construed and explained by repetitive habitual actions of energy-saving practices. Figure 2 shows the theoretical framework delineating the conceptual construct of the study.

Fig. 2. Theoretical framework of energy-saving behaviour change supported by conditions of habit in the use of intervention strategies



Environmental Restructuring involved the modification of context, which breaks the stability of old habits and allows new habits to form (Staddon, et al., 2016). Azar & Ansari (12) iterated the importance of changing habits in order for behaviour change to occur. As habits relied on a stable context to persist, restructuring the context allowed behaviour to correspond to changes. It also incidentally promotes a shift in the general mind-set of an organisation, which affects the social and group norms intrinsic to an organisational culture (39). Studies have found that individuals who identified with a pro-environmental image were found to commit to energy-saving practices (40). This corresponds to the need for motivations beyond energy reduction in order to harness energy-saving behaviour (57). Stephenson, et al. (58) explained that the energy culture of an organisation was affected by the interrelationships between their norms, practices and material culture, which were shaped by external influences. Thus, it was important to apply change in the external environment of an organisation whether through explicit law and policy reformations, or indirect measures such as developments in IT, market trends, and energy price (58). This explains why the use of technology adaptations, although does not specifically target behaviour change, is crucial to the success of behavioural change and cannot be ignored alongside the use of other intervention strategies.

Alternatively, modelling makes use of environmental cues in the form of peer influence to encourage the emulation of desirable energy-saving behaviour (39). While peer influence has shown to be effective in achieving energy reduction, it relies on the provision of someone with leadership and sociable qualities (5). The success of Modelling intervention is contingent on the success of model figures signalling environmental cues – a marked characteristic of

habit (17). Behaviour was found to be susceptible and reactive to environmental cues (59). Continuous encounter with environmental cues would lead to the development of habit and shape behaviour. Modelling interventions went beyond providing social incentive, but motivated psychologically, reinforced energy-efficient goals and guided actions (60). Cox, et al. (6) stated that the potential to influence behaviour was most potent where organisations engaged employees in value-based change. Engaging Modelling interventions in the long term is likely to provide a lasting impression on the social norm and sustain behavioural change over time.

Finally, Enablement was found to be distinctive in its approach to creating opportunities for behavioural change to occur organically (39). Energy-saving behaviour is affected by situational contexts such as access to power sources, personal preferences and energy costs, (37). Day & Gunderson (59) emphasised that people want to be able to control their environment to suit their comfort level. This could be interpreted in line with the findings of Cohn & Lynch (44) which linked the success of intervention strategies to its alignment with exisiting practices. When occupants are able to take control and responsibility over their own energy-related practices, they are able to adapt and integrate these practices into their own individual routine and comfort. Enablement avoids the problem of occupants making make-shift adjustments to fit around an external practice that may not align with their personal notions of comfort. For example, occupants could override an automated heating system or use a personal heater if the regulated practice did not align with their comfort level. Introducing Enablement interventions does not overly disrupt contextual stability; thus, the adapted practices can be easily assimiliated into long-lasting behaviour.

5.2. Recommendations for future study

The study brings together the understanding of habit and behaviour intervention strategies to identify how they are interrelated in affecting energy-saving behaviour. Three of the most successful intervention strategies were examined i.e. Environmental Restructuring, Modelling, and Enablement. It was found that the approach used in all three forms of intervention were connected to some condition of habit. However, much remains to be understood about the weight of habits on intervention strategies to achieve energy-saving behaviour. Other under-researched intervention strategies such as Coercion, Restriction, and Training were also not explored due to limited resources. The study recommends piloting a subsequent study to assess the extent of habit influence on the effectiveness of intervention strategies and to include other forms of intervention strategy not yet investigated.

6. Conclusion

The study takes a social approach to understanding the relevance of habit in behavior intervention strategies. It reviewed three forms of successful intervention strategies from literature and compared the approach used with theories of habit. The study found that the success of intervention strategies for energy-saving behaviour (Environmental Restructuring, Modelling, and Enablement) was supported by meeting the characteristics of habit. Given the significance of habit in behaviour, the study attempts to construe and explain the efficacy of behaviour intervention strategies by identifying how they conform to conditions of habit. The study proposes a theoretical framework to describe the connection between intervention strategies and conditions of habits namely, context, mind-set, environmental cues, and practice alignment. Context was important in the delivery of intervention strategies as it situated the circumstance in which behaviour is performed. Environmental Restructuring interventions addressed context by building a conducive energy efficient environment. In doing so, they were more likely to be successful in engaging energy-saving behaviour even when the intervention strategy was not aimed at behavioural change. A feature of habit is that it is sensitive to context, thereby allowing behaviour change to occur as a result. The other effect of contextual interventions is its influence on the general mind-set, which determines the course of actions of energy-related practices and sets the social order. Modelling interventions were also consistent with the characteristics of habit by means of providing environmental cues through the social influence of model figures. The strategy enables associative learning to happen between context and environmental cues, thus, supporting the development of habit. Enablement interventions presented social and physical opportunities for occupants to embrace energy-saving practices on their own resolve and were found to be most effective in engaging energy-saving behaviour. The success of this method is attributed to its degree of alignment with existing practices conforming to notions of habit development.

Based on these conceptions, the study calls to attention the significance of habit as the underlying driver of energy-saving behaviour within behaviour intervention strategies. To have the greatest effect on a building's energy performance, building managers must examine the nuanced ways that habitual actions may shape the occupants' energy-saving behaviour and consider intervention strategies for changing habits. The paper provides a deeper understanding of building occupants' energy-saving behaviour from a sociotechnical perspective and creates a paradigm for future studies of building energy management.

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