Beyond the psychology of self and individual's pro-environmental behaviours: exploring how technology innovations can help organisations achieve and promote sustainability.

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Beyond the psychology of self and individual's pro-environmental behaviours: exploring how technology innovations can help organisations achieve and promote sustainability

Short title: Achieving and promoting sustainability

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Purpose

This study proposes a new agenda for research and practice on pro-environmental behaviours in organisational settings by exploring the intersection between technology innovations and pro-environmental initiatives. The goal is to demonstrate the utility of digital technology in promoting and achieving sustainability by addressing the complexity and inconsistency in pro-environmental behaviours.

Design/methodology/approach

Using relevant literature on pro-environmental behaviours, this study explores the possibility of embedding technology innovations in pro-environmental initiatives to promote and enhance sustainability in organisational settings.

Findings

This study argues that the recent technological advancement and open innovation provide new insights into understanding and implementing pro-environmental initiatives in organisational settings. While pro-environmental behaviours studies have advanced over the past decades, this study shows that many pro-environmental activities do not require employees to change behaviour. According to this study, psychology and technology innovations offer various opportunities for businesses to effectively and pragmatically embed sustainability into their operations without necessarily changing employees' behaviour.

Research limitations/implications

This conceptual study offers opportunities to empirically explore the collaborative nexus between “psychology-based pro-environmental behaviour research and technology innovation”. Despite the plethora of studies on pro- environmental behaviours, results are mixed and inconclusive, raising questions about the dominant practice used for promoting pro-environmental initiatives and behaviours at the corporate level. This study, therefore, provides a new pathway for businesses to address their environmental aspects, demonstrating a pragmatic approach to resolving the complexity of pro-environmental behaviours.

Originality/value

This study allows social investigators, policymakers, and technology developers to re-assess, revive and further investigate how they can collaborate to address practical environmental and social issues.

Keywords: Technology innovations, Psychology, Sustainability, Pro-environmental behaviours, Organisation, Employees' behaviour, Circular economy (CE)

Introduction

The consequences of liberal modernism with its capitalist ideology are precipitating renewed interest in the impact of business and human activities on the environment, economy, and society. This ideology has reshaped the production of goods and services through its push-based operations strategy, increasing resource consumption with detrimental effects on our ecosystem. Our materialism and consumerism behaviour at the expense of social and environmental systems is now at a crisis point and requires a drastic reversal (Oskamp, 2000; Wells, 2018). The mitigation is necessary, particularly through sustainable business strategies and innovations (Bhupendra and Sangle, 2021; Gauthier, 2017), to prevent biodiversity loss, sustain human existence, and enhance economic prosperity. The quest to avoid environmental catastrophe has resulted in many studies and interventions, such as greenhouse gas emissions reduction and waste management, to reduce the consequences of consumption of goods and services. However, there are disparities between interventions and their effectiveness in changing behaviour (Ruepert *et al.*, 2016) and making it stick (Hargreaves, 2011).

Although personal and psychological factors inform many interventions, the contributions of technology innovations that can enhance economic, social, and environmental sustainability are not attracting deserving attention (Wells, 2018; Hankammer and Kleer, 2018). The lack of consideration suggests that businesses are not harnessing technological innovations, such as digital twins, that can address environmental issues resulting from the day-to-day activities of their employees. Consequently, this study explores the utility of technology in facilitating pro-environmental initiatives in organisational settings. The study argues that many pro-environmental initiatives, especially those performed daily, may not necessarily require employees to change their behaviour completely. The study further explains the intersection between technology innovations and pro-environmental initiatives in organisational settings to reduce the tension between pro-environmental behaviours and people's psychological traits. While studies have focused on personal and psychological attributes to explain pro-environmental behaviours (Tolppanen and Kang, 2021; Yuriev *et al.*, 2020a), this study argues that this understanding can underpin technical/technology solutions to address real environmental issues, such as carbon emissions. As such, practitioners and businesses could introduce feasible and acceptable interventions by addressing factors influencing pro-environmental behaviours (Steg and Vlek, 2009) without policing their employees.

It is worth noting that this study aims not to undermine previous research efforts but to instigate constructive discourses on how pro-environmental behaviours are assessed and promoted. The intention is to refocus the pro-environmental research agenda in organisational settings to bring about practical conclusions with real and significant positive impacts. The paradigm shift should change the narrative from behaviour change interventions (Osbaldiston and Schott, 2012) focusing on employees in organisational settings (Oke, 2015) to a more pragmatic approach (Wells, 2018) by understanding the confluence of technology interventions and pro-environmental behaviours. Rather than the individuals as the unit of analysis (McDonald *et al.*, 2016), this study focuses on organisations not as a homogenous market segment but as a separate individual consumer and producer of technology. According to this study, the interactions of pro-environmental initiatives and digital technology artefacts are necessary to increase sustainability and circular economy (CE) in organisational settings.

The dominant logic in pro-environmental research

Over the past decades, the prominent school of thought has mainly advocated for consumers to change behaviour (Yuriev *et al.*, 2020a; Zhang *et al.*, 2021), neglecting the role of open innovation in transitioning into a more

sustainable and CE. Despite the increasing impacts of open innovation on research and practice (Bogers *et al.*, 2018), its diffusion has been slow in addressing environmental issues, especially by promoting pro-environmental initiatives in organisational settings (Bhupendra and Sangle, 2021). This prominent school of thought generally fails to acknowledge the roles of producers, such as organisations, in influencing what and how consumers, especially employees, interact with goods and services in organisational settings.

Conservation psychology and environmental psychology, as distinct disciplines, branched out from mainstream psychology to understand how psychology can rescue the world (Clayton and Brook, 2005). The ideology of mainstream psychology resulted in many studies from different authors across many disciplines (Bamberg and Möser, 2007; Osbaldiston and Schott, 2012) using behavioural change principles, theories, and models. These theories, such as Ajzen's (1991) theory of planned behaviour (TPB), Schwartz's (1977) norm activation model (NAM), and Stern *et al.*'s (1999) value-belief-norm theory (VBN), suggest that behaviour is reasoned, planned, deliberate, and informed by personal disposition and values. They also imply that behaviour relies on people's cognition, indicating that behaviour can be automatic based on how often people perform a specific behaviour, leading to the proposition that behaviour can be habitual.

Despite several attempts to associate pro-environmental behaviour with psychological traits (Fransson and Gärling, 1999; Klöckner and Matthies, 2004), there is no clarity or agreement about the formation, reinforcement, and sustenance of many psychological factors, such as attitudes and habits. However, from behavioural perspectives, a deeper understanding of how people's psychological states influence their daily actions is necessary to promote behaviours with minimum or no negative consequences on planetary resources. This understanding can inform policies, including designing behavioural change interventions for sustainability, facilitating CE, and reducing resource consumption and greenhouse gas emissions.

The general perception that the resource-intensive consumption pattern has created the Anthropocene era (Wells, 2018), based on the scientific evidence that environmental issues are rooted in human behaviour (Schultz, 2014), contributes to many studies on pro-environmental behaviour (Francoeur *et al*., 2001; Zhang *et al.*, 2021). The prominent approach applies social psychology, marketing and social marketing worldviews to understand how organisations might promote pro-environmental initiatives, such as recycling and turning off lights when not in use. Although authors have applied models, such as TPB (Ajzen, 1991), VBN (Stern, 2000), NAM (Schwartz, 1977), independently, other scholars have expanded them by incorporating many factors to explain pro-environmental behaviours (Daryanto and Song, 2021; Klöckner, 2013). By modifying and blending these theories and models to understand pro-environmental behaviours, their predictive and explanatory capability is reduced from study to study (Li *et al.*, 2019; McDonald, 2014). Despite the positive contributions of these social psychology theories, the findings are mixed with no single explanation to better understand why people engage in pro-environmental initiatives, such as turning off taps after use (see, for example,(Francoeur *et al*., 2001; Yuriev *et al.*, 2020a). The complexity of human behaviour explains the lack of definitive theory or explanation of human pro-environmental behaviours with the difficulty in mitigating the consequences of human actions through behavioural change models.

Despite the exponential increase in pro-environmental behaviour studies in the last decades (Osbaldiston and Schott, 2012; Yuriev *et al.*, 2020a), there is no clarity on how to promote pro-environmental initiatives, especially day-to-day actions (McDonald *et al.*, 2012), and the contribution of technology is not sufficiently explored. Moreover, CE (Lacy and Rutqvist, 2015) and degrowth (Hankammer and Kleer, 2018; Nesterova, 2020) are the preferred means of promoting sustainable production and consumption. However, there is no specific guidance on achieving these concepts in practice, especially at the corporate level. Although these concepts require consumers and businesses to change their behaviour, innovative business models (Bocken *et al.*, 2014; Gauthier, 2017) underpinned by digital

technology are needed to deliver economic growth aligned with sustainability principles. The lack of understanding of how businesses could embrace and embed sustainability in their operations remains a critical issue (Bocken *et al.*, 2014; Hankammer and Kleer, 2018) for operations managers, practitioners and policymakers.

The mixed and inconclusive findings in the sustainability and pro-environmental behaviour literature signal the complexity of designing effective interventions with positive impacts. It is worth noting that previous research efforts in this realm have contributed significantly to many strategies and interventions (Coelho *et al.*, 2017; Gauthier, 2017; Osbaldiston and Schott, 2012). These interventions, such as creating awareness, incentivise consumers to engage in pro-environmental initiatives, but they often fail to achieve desired outcomes, especially by changing consumer behaviour (Abrahamse *et al.*, 2005). Interventions are underpinned by a false assumption that consumers can change their behaviour by increasing environmental awareness and offering information to influence environmental beliefs and attitudes. However, conflicting findings in the literature indicate methodological issues with the way attitudes and other psychological factors are operationalised in empirical studies (Francoeur *et al*., 2001; Li *et al.*, 2019). On the contrary, policy and market-based interventions, informed by research findings, provide a roadmap for designing and implementing pro-environmental initiatives, such as deposit return schemes (Oke *et al.*, 2020).

Although interventions, particularly financial incentives, information and prompts, could lead to behavioural change in the early stage of their introduction, their effects are often short-lived. The reason is that people generally discontinue the newly acquired pro-environmental behaviours after the intervention period (Abrahamse *et al.*, 2005; Miafodzyeva and Brandt, 2013; Osbaldiston and Schott, 2012). This evidence suggests that human behaviour is dynamic and complex, with disparate influencing factors (Gifford and Nilsson, 2014; Klöckner, 2013), indicating the ambivalence between past and newly acquired behaviours. The ambivalence shows the difficulty in maintaining pro-environmental behaviours over an extended period when the inducements, such as incentives and prompts, are withdrawn. Therefore, further research is required to establish the residual effects of past behaviour on newly acquired behaviour when individuals are exposed to situations similar to past behaviour.

Besides, interventions should consider contextual factors influencing behavioural decisions (Oke *et al.*, 2021; Steg and Vlek, 2009), especially in organisational settings (Blok *et al.*, 2015). Apart from the durability issues facing pro-environmental interventions, there is also a question of how businesses can be innovative in designing and integrating circular and sustainable business models into their operations. Considering how pro-environmental behaviours are conceptualised in research, especially with the individual as a unit of analysis (McDonald *et al.*, 2016), interventions, such as carpooling, may not address practical environmental issues (Gardner and Stern, 2008). For example, people in the same organisation may have different motivations, such as convenience and personal costs, for engaging in pro-environmental behaviour (McDonald *et al.*, 2016; Steg and Vlek, 2009), such as using public transport. Consequently, interventions using behavioural change theories are difficult to implement and mostly less effective in making positive impacts in organisational settings.

Towards changing pro-environmental behaviour

Research focusing on behavioural aspects of environmental protection using psychology and sociology has been ongoing for more than 40 years (Schultz, 2014). In recent years, marketing, including social marketing principles, is gaining traction to inform how and why people engage in pro-environmental activities, such as using energy-efficient equipment (Issock *et al.*, 2020; McKenzie-Mohr *et al.*, 2011). The adoption of these techniques is primarily instigated by researchers' worldviews, research background, and the funding organisations they represent.

The accumulation of knowledge in the literature raises fundamental questions about the implications of research enterprise focusing on consumers' everyday pro-environmental behaviours (McDonald *et al.*, 2012; Schultz *et al.*, 1995), especially in organisational settings. Daily pro-environmental behaviours, such as switching lights off or turning water taps off when not in use, should be evaluated using Stern's (2000) impact and intent categorisations to address sustainability issues. According to Stern (2000), intent-oriented pro-environmental behaviours are considered from people's intention and beliefs to change environmental problems, which may fail to result in environmental impact. However, intent- and impact-oriented pro-environmental behaviours, and those with both dimensions, differ in their motivations and consequences. While the intent-oriented and impact-oriented pro-environmental behaviours differ in their motivations and effects, there is a need to evaluate the contributions of pro-environmental research to the sustainability credentials of businesses, particularly from the impact-oriented definition.

Many factors specific to disciplines (Table 1), such as psychology, sociology, and marketing, have been shown to influence consumers' pro-environmental behaviours in different settings (Oke, 2015; Osbaldiston and Schott, 2012; Yuriev *et al.*, 2020b). Yet, there is no clarity on how to promote pro-environmental behaviours in organisational settings (Unsworth *et al.*, 2013; Yuriev *et al.*, 2020b). While psychologists were not initially convinced about their involvement in protecting the environment (Clayton and Brook, 2005), recent efforts emphasise the contributions of psychology, human resources, corporate social responsibility (CSR), organisational citizenship behaviour (OCB), and organisational culture (Ojo *et al.*, 2020; Unsworth *et al.*, 2020).

Table 1. Factors influencing pro-environmental behaviours

Themes	Factors
Demographics	Age
	Education
	Gender
	Income
Psychological	Attitudes
	Beliefs
	Concern
	Habit
	Intentions
	Perceived behavioural control (PBC)
	Social norms (subjective and descriptive)
Situational	Consequences of behaviour
	Environmental benefits and values
	Facilities
	Feedback
	Goal setting
	Infrastructure (availability, adequacy, appearance)
	Organisation size
	Organisational commitment
	Organisational culture
	Penalty
	Policy/regulation
	Pro-environmental initiative
	Prompts/information/signage
	Proximity/convenience
	Reward/incentives
Personal	Awareness
	Convenience
	Cultural (individualism and collectivism)

	Environmental knowledge
	Experience/past behaviour
	Personal identity
	Knowledge
	Moral obligation/norms/values
	Past behaviour
	Personal benefits (intrinsic and extrinsic)
	Personal commitment

Source(s): Adapted from Oke (2015)

However, environmental psychologists focus on psychological factors such as attitudes and beliefs. Sociologists observe that pro-environmental behaviour is better explained using identity and norms. Legal practitioners argued for policy-based instruments such as regulation to influence pro-environmental behaviours. Different market-based instruments, such as rewards/incentives, have been adopted by social marketers. These disciplines have provided opportunities for behaviourists to identify motivations and barriers to pro-environmental behaviours (Gifford and Nilsson, 2014; Maki *et al.*, 2019).

Consistent with the thesis on context-specific factors (McDonald and Oke, 2018; Schultz, 2014), the fundamental question is whether all pro-environmental behaviours, within and across contexts, can be facilitated using the same (or a single) approach. This is a grey area in behavioural research, and the current knowledge about the motivations of pro- environmental behaviours is contradictory. Also, there is no evidence that effective interventions at home will exert comparable effects in other behavioural settings, particularly in organisational settings (Maki *et al.*, 2019; McDonald and Oke, 2018). One of the main issues is how models, such as TPB, and their constructs, such as attitudes, are operationalised in pro-environmental studies, making it challenging to compare studies. For example, Steg and Vlek (2009) reported that authors operationalise different pro-environmental behaviours in their factor analyses scales, making it difficult to compare results from one study to another. There is also a potential methodological issue, especially with self-reported cross-sectional data, affecting the external validity of pro-environmental studies (Larson and Kinsey, 2019; Lo *et al.*, 2012). Besides, research has predominantly focused on recycling and household settings compared to other behaviours and/or behavioural settings (Yuriev *et al.*, 2020b). With these approaches, there is no clarity on whether survey respondents report their personal or household behaviours, indicating that research findings, especially on pro-environmental behaviours at home, should be interpreted cautiously.

The research approach and framing of questionnaire questions with no clarity on whether personal or household behaviours are analysed could be the root of conflicting research findings. The inconsistency in research findings suggests that different motivational needs may underpin pro-environmental behaviours within and across contexts (Nilsson *et al.*, 2017; Oke *et al.*, 2021; Steg and Vlek, 2009). For instance, a householder may purchase energy-saving light bulbs to reduce energy bills at home; the same individual may not switch off the lights when not in use at work due to the lack of direct cost of energy use. The existing approaches, including the lack of convincing evidence in the literature, indicate that the complexity of human behaviour and the heterogeneity of pro-environmental behaviours (Dolnicar and Grün, 2009), cannot be explicitly explained using the established wisdom in the literature. While understanding the motivations and barriers is a starting point in designing interventions (Steg and Vlek, 2009; Tolppanen and Kang, 2021), translating theoretical knowledge into effective interventions is complex, undermining the effectiveness of pro-environmental policies designed based on research findings.

It should be noted that pro-environmental behaviour is systematically different within and across contexts (Barr *et al.*,

2010; Lo *et al.*, 2012; Oke *et al.*, 2021), with individuals reporting different motivations and behaviours depending on the context (Dolnicar and Grün, 2009; Steg and Vlek, 2009). In theory, the knowledge of why people engage in pro-environmental initiatives using many perspectives, such as social marketing and psychology, is appropriate in designing interventions; however, the focus should be on the "impact" and not the "intent" of the interventions following Stern's (2000) categorisations. In addition, studies have not convincingly addressed the extent to which behavioural theories translate to practice, given that the understanding of motivations and barriers alone is insufficient. For example, the desire and intention to reduce carbon emissions, including the knowledge of its financial and environmental benefits, are insufficient to make an impact without knowing specific impact-oriented actions (Gardner and Stern, 2008) underlying the carbon emissions reduction.

Nonetheless, many models such as Dunlap and Van Liere's New Environmental Paradigm (NEP) and different behavioural theories such as Ajzen's TPB have enhanced our understanding of why people undertake ecological behaviours. Vining and Ebreo (2002) identified and extensively discussed various theories and models relevant to pro-environmental behaviours to assist researchers and practitioners. These include learning theories, theories of emotion and affect, and theories of attitude formation. While these theories are distant from the mainstream environmental discipline, NEP assesses people's worldviews about the consequences of economic growth on the environment.

Building on the existing theories, including NEP, Stern *et al.* (1999) proposed VBN to assess pro-environmental behaviour. The theory integrated the concept of (personal) values, Schwartz's (1977) and Dunlap and Van Liere's (2008) NEP to predict pro-environmental behaviour. According to VBN, pro-environmental behaviour is determined by values, NEP, awareness of consequences (AC), ascription of responsibility (AR), and personal norms (PN). Values guide people's environmental behaviour and are sub-classified into egoistic, altruistic, and biospheric values (Stern *et al., 1995;* Tolppanen and Kang, 2021). While egoistic values address concerns for self, altruistic values explain concerns for others, and biospheric values suggest people's concern for the ecological system, including living beings. Values are fundamental to an individual's decision-making and central to people's belief-system, attitudes, concerns, and behaviour toward the environment, especially when confronted with difficult or competing environmental situations. However, values are unstable and influenced by different pro-environmental actions and goals (Sloot *et al.*, 2018; Tolppanen and Kang, 2021). Depending on value-orientation and behavioural context, awareness of behavioural consequences and acceptance of responsibility may not necessarily activate personal norms towards pro- environmental behaviour. Nonetheless, studies (such as Nordfjærn and Rundmo, 2019; Sloot *et al.*, 2018; Tolppanen and Kang, 2021) have attributed these values to different pro-environmental behaviours, such as pro-environmental activism (like protest and policy support) and non-activism (i.e. recycling, transportation, and buying behaviour).

These theories and other suggest that the roles of social-psychology and marketing, including social marketing, in understanding pro-environmental behaviours (Klöckner, 2013; Onwezen *et al.*, 2013; Steg and Vlek, 2009), such as energy use, waste consumption, and travel behaviour, cannot be underestimated. In our view, future research efforts should expand the scope of these theories by estimating how they facilitate behaviour change while integrating them into technology innovations to develop human-centred technology solutions improving sustainability. For example, with increasing energy prices, businesses could save energy and money by automatically pre-setting their electronic equipment to enter a sleep or standby mode when not in use after some minutes, say five minutes. Similarly, companies can install motion sensor lighting systems in offices, especially in boardrooms, restrooms and spaces with less traffic, so the lights can automatically go off when not in use.

Challenges in addressing environmental problems

Research efforts on behavioural interventions that could offer practical solutions to environmental problems are

declining while more emphasis is on research gaps and psychological aspects of human behaviour. Many models exist to investigate pro-environmental behaviours in different behavioural contexts (Miafodzyeva and Brandt, 2013; Yuriev *et al.*, 2020a; Zhang *et al.*, 2021), culminating in disparate factors, such as attitudes and values (see Table 1), that may promote pro-environmental behaviours. However, there is no evidence about the practical implications of behavioural interventions based on psychological attributes suggesting that the external validity of many pro- environmental interventions in the literature is weak or non-existent (Lehman and Geller, 2004; Schultz, 2014). Also, studies have failed to present effective frameworks to elicit more understanding of contextual determinants interacting with pro-environmental behaviours (Lo *et al.*, 2012; Steg and Vlek, 2009), particularly at work.

According to Schultz (2014), there is no practical guidance on what, where, when and to whom many pro-environmental models are most effective. Despite the utility of behaviour theories, many authors operationalise them differently by adding/removing constructs while adapting their underlying questions to their research areas. The inability of many investigators to anticipate the practical implications and impacts of their research outcomes during the design stage is a contributing factor. Rather than addressing real problems (Steg and Vlek, 2009), research enterprises on pro-environmental studies are more about gaps in research efforts. While there is an exponential increase in studies on pro-environmental behaviours (Yuriev *et al.*, 2020a), investigators tend to focus on actions and contexts that are easy or convenient to investigate, especially for data collection. For instance, the amount of studies on recycling increases every year compared to other pro-environmental behaviours. While the scale of environmental problems is getting larger and more complex than ever before, the trend within some research traditions is to focus on smaller and smaller parts of the whole to reduce and isolate factors for research purposes. The approach is more and more precise from a research standpoint; it is at the same time less and less valuable from a practical point of view.

Also, pro-environmental behaviours at home are prioritised compared to non-home contexts, especially the workplace (McDonald and Oke, 2018). As remote working is becoming a norm, a new business model with digital technology as its foundation is required to address environmental issues in organisational settings. In the past, businesses mainly depended on their employees to undertake pro-environmental behaviours (Unsworth *et al.*, 2020), such as recycling. However, the COVID-19 pandemic and the lockdowns suggest that employees are no more at the centre of pro-environmental initiatives at work, as previously reported. The current situation should accelerate the adoption of digital technology, so that office buildings and factories are smart, consolidating information, particularly on energy and water consumption, powered by the internet of Things (IoT). Making office buildings more intelligent using sensors and machine learning (ML)/artificial intelligence (AI) could facilitate proactive asset management for predictive maintenance, increase building efficiency, reduce operational costs, and decrease building carbon emissions.

However, there are many issues with pro-environmental research and findings, limiting the practicality of research findings. Many interventions are intent-oriented with little or no practical impact (Gardner and Stern, 2008; Steg and Vlek, 2009), indicating the need for investigators to address efficiency rather than curtailment behaviour for a real positive contribution to the sustainability agenda. Unlike curtailment behaviour, efficiency behaviour is non-repetitive, convenient for social actors, and may involve a one-off investment (Gardner and Stern, 2002). Compared to efficiency behaviour, studies (Osbaldiston and Schott, 2012; Porter *et al.*, 1995) have shown that curtailment behaviour, such as switching off lights, is problematic to maintain, especially after the interventions are withdrawn. Similarly, researchers are fixating on achieving methodological requirements such as the internal validity of their instruments rather than assessing the practical implications of their research.

Furthermore, studies are generally designed to change behaviours through psychological and personal factors without considering how behavioural contexts influence people's engagement in pro-environmental initiatives (Osbaldiston and Schott, 2012; Miafodzyeva and Brandt, 2013). While promotions, information, attitudes, values, beliefs, and norms

have been linked to everyday (curtailment) behaviour, contextual attributes may disrupt the intentions of social actors to curtail everyday behaviour, such as energy and water consumption, in organisational settings. According to Barr *et al.* (2005), curtailment behaviour, such as switching off lights in unused rooms, involves some structural adjustment, and the behaviour may be inconvenient due to its repetitive nature. Innovative technology, such as motion sensor lights, can eliminate the perceived inconvenience of curtailment behaviour, such as switching lights off when not in use at work.

It is evident from the available published studies (see, for example, Li *et al.*, 2019; Lo *et al.*, 2012; Yuriev *et al.*, 2020a) that motivations and barriers to pro-environmental behaviours, especially psychology factors, have been over-researched and well-documented by different authors. Scholars need to pause and consider the practical implications of research findings for business operations and contributions in addressing environmental issues. Consequently, this study challenges investigators to refocus their research agenda on how the established factors could facilitate pro-environmental behaviours through technology, especially at the corporate level. In response to Clayton and Brook (2005) and Oskamp (2000), this study argues that the interaction of psychology, sociology, marketing, and digital technology can address the challenges of curtailment (every day) behaviours, enhancing impact-oriented behaviours in organisational settings.

Resolving the challenges and complexities of pro-environmental behaviours

This study acknowledges that sociology, psychology, and marketing have offered unprecedented explanations of pro-environmental behaviours. However, technology innovations, especially the 4th industrial revolution (4IR), provide organisations with opportunities to enhance sustainability across their value chain. A deep integration of technology intelligence and networking systems which are the basis of 4IR (Longo *et al.*, 2017; Weyer *et al.*, 2015), may allow pro-environmental initiatives to make far-reaching impacts beyond Scopes 1 and 2 emissions to Scope 3 emissions. According to World Resources Institute and World Business Council for Sustainable Development (2004), Scope 1 indicates direct greenhouse gas emissions from sources owned or controlled by an entity. Scope 2 is indirect GHG emissions associated with the production of electricity, heat, or steam purchased by the entity. Scope 3 is all other indirect emissions, especially from the extraction and production of purchased materials, fuels, and services, including transport in vehicles not owned or controlled by the entity, outsourced activities, and waste disposal. Embedding technology could facilitate carbon emission measuring, reporting and mitigation by delineating direct and indirect emission sources across the value chain.

According to Lehman and Geller (2004), behavioural analysis can complement technological solutions if human behaviour is the sole cause of environmental problems. There is a need for pro-environmental behaviour investigators to explore the utility of technical solutions despite their disruptive capability, as observed in other sectors (Oke and Fernandes, 2020). Technology innovations, such as ML and AI, can disrupt the established practice in environmental research and applications, allowing for a more pragmatic approach to addressing environmental problems while achieving a net-zero carbon economy. By building on the power of digital innovation beyond the age of mass production of the 2nd industrial revolution, businesses can effectively address environmental issues, such as resource consumption, to achieve sustainability, contributing to the prospect of the circular economy.

The present age has stepped into a technological transformation that significantly influences day-to-day human activities, including industrial manufacturing operations and consumption. Digitalisation transforms the production and

consumption of goods and services; social psychology can help businesses develop capabilities to offset their carbon footprint through smart devices. This transformation would require a higher degree of flexibility in customising products to the context and the needs of organisations. For instance, the components of digital power, IoT, AI and ML, Big Data and Cloud Computing (CC) can be utilised to design innovative devices incorporated into many human activities and involve human-device interactions. These components, especially IoT and AI/ML, involve communication protocols and distributed intelligence enhancing communication with humans and other devices using sensors and actuator networks (Atzori *et al.*, 2010; Oke and Fernandes, 2020).

Adopting these innovations can change behaviours, reduce environmental burdens and facilitate many operations (such as facilities management) with specific pro-environmental (such as energy) related job responsibilities. For instance, evidence from our university buildings shows that about 4 million gallons of water are saved annually by installing 19 waterless urinals. Besides, evidence from cities worldwide showed the potential of digital technology in reducing negative environmental impacts (Cardullo and Kitchin, 2019; Sancino and Hudson, 2020). By monitoring their operations using innovative technology, such as digital twins, businesses can save costs while reducing resource use, preventing waste and lowering their overall carbon footprint. For example, the installation of 95 innovative urinals across the UK's Euro Tunnel campus resulted in about 22,248.37 m^3 of annual water saving and 4,338.43 kg of carbon footprint reduction. A digital twin represents a virtual platform or model that accurately reflects a physical asset or object, allowing for informed decisions about the asset/object's operations through machine learning (ML), artificial intelligence (AI), simulations, and real-time data analytics.

The speed of technological change coupled with changing consumer behaviours and preferences suggests a need for the paradigm shift in pro-environmental and conservation research. With the pace of technological innovations, whether a total (or minimal) behaviour change is necessary for reducing environmental problems remains a fundamental question. This thinking resonates with Gardner and Stern's (2002) concern regarding the role of psychology in environmental research. While psychology is critical in understanding pro-environmental behaviours (see Table 1), this study calls for more interdisciplinary efforts and collaborations among the disparate disciplines to keep up with technological innovations (see Figure 1) in reducing environmental aspects.

Consistent with Figure 1, the field of environmental psychology can utilise the capability of technology in designing research that can nudge consumers and organisations towards the use of smart technology in achieving sustainability. Besides, technology developers can learn from social and behavioural sciences to design and manufacture consumer products tailored to human personal/psychological traits. This shift of focus could also redefine the roles of social psychology, including marketing, in explaining pro-environmental behaviours, particularly in organisational settings. The approach may offer opportunities for policymakers to introduce policies and strategies to support initiatives, such as paperless billing, car-sharing, and e-procurement, that can positively affect the environment, contributing to circular economy initiatives.

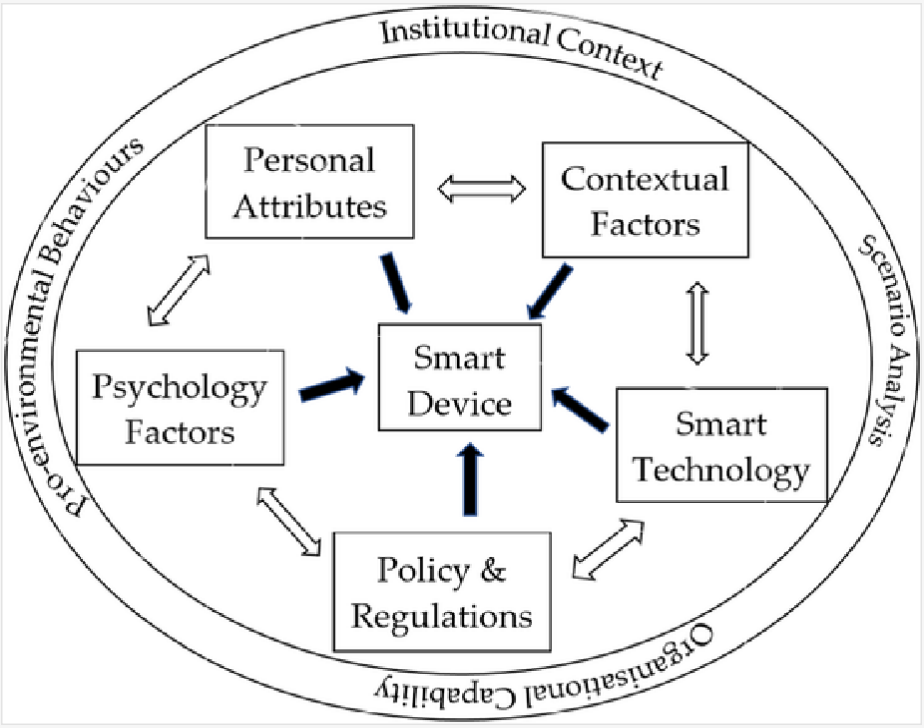

Figure 1. Design and application of smart device in addressing pro-environmental challenges

Such policies should address the supply side of resources/products where producers and retailers adopt marketing approaches, editing-out unsustainable behaviour by preventing customers' access from, environmentally damaging goods/services. By editing products upstream of the supply chain, consumers, including businesses/organisations, are exposed to only products with little/no adverse environmental effects. According to Maniates (2010), choice editing for sustainability is the approach taken by producers/retailers to eliminate the option of consuming damaging products with negative environmental impacts. Choice editing for sustainability would assist businesses/organisations to make informed decisions to install pro-environmental products, such as A-rated appliances and energy-saving bulbs. Although costs differential could be a barrier, choice editing facilitates pro-environmental behaviours at work without requiring employees to change their behaviour. Rather than relying on employees to change behaviour, choice editing allows their organisations to promote and install products with positive sustainability credentials.

Embedding technology innovations in pro-environmental behaviours

Given the recent advancement and investment in technology, the pertinent question is whether consumers (individuals and businesses) should change their behaviours for all pro-environmental initiatives. This question is plausible because research has failed to identify, characterise, and differentiate pro-environmental behaviours that require a behavioural change from those that only need a single (or one-off) investment in technology. With the current advancement and diffusion of technology, businesses can harness innovative technology such as IoT, Internet of Service (IoS), and ML/AI to address everyday pro-environmental behaviour (see Figure 2), such as energy use. For instance, many energy-efficient products with green labels provide prompts such as Energy label, Ecolabel, and Energy ratings. Many of these ratings demonstrate the energy efficiency of consumer products to inform and provide guidance on products with minimum adverse environmental effects.

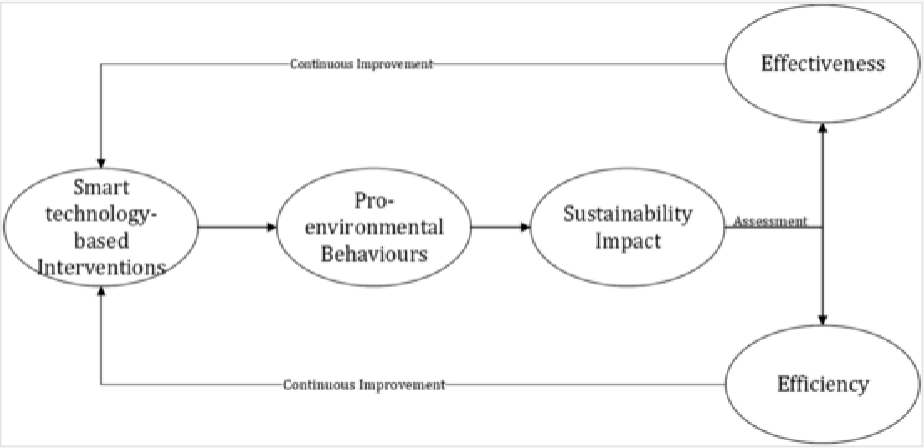

Figure 2. Interaction of technology interventions and pro-environmental behaviours

The approach directly responds to Abrahamse *et al.*'s (2005) attribution of rising domestic energy use to TEDIC factors. In their study, Abrahamse *et al.* (2005) argued that technological developments, economic growth, demographic factors, institutional factors, and cultural developments are macro-level factors that may affect micro-level factors and consequently influence pro-environmental behaviour.

There is a need to appreciate the tension and complementarity between macro- and micro-level environmental systems in achieving a state of social, economic, and environmental sustainability. According to Steg *et al.* (2006), businesses are more likely to adopt technology solutions (such as buying energy-saving light bulbs) than initiatives that require behaviour change (such as switching lights off when leaving a room). This knowledge is consistent with Black *et al.* (1985), who argued that technical solutions are more attractive to consumers than behaviour change pro-environmental initiatives, especially curtailment-based actions. The starting point is identifying environmental issues, including activities and behaviours contributing to the identified issues. The motivations for these activities and behaviours can then be analysed to identify whether they are everyday behaviours, including their impacts. Considering that institutional context contributes to organisations' environmental impacts (Unsworth *et al.*, 2020), there is a need to contextualise technology innovations to businesses' requirements/needs and attributes (Figure 1) to achieve more social and environmental benefits (Figure 2). This may require an in/expensive one-off investment that is accruable during the adopted technology's functional lifetime. With this approach, employees do not need to change their lifestyle and behaviour, while businesses are less reliant on their employees to perform everyday pro-environmental behaviours, meaning that employeers, can focus more on their core and contractual roles/responsibilities.

Besides, technology, such as IoT and cloud-based platforms, may reduce energy use and prevent waste. For example, businesses can transform their equipment into smart devices through sensors and microchips to facilitate tracking, maintenance, and efficiency. These platforms can underpin a new business operating model involving organisations sharing the same resource pool instead of owning. Rather than individual ownerships, a sharing economy emphasises collaborative consumption of goods and services facilitated through libraries of things (Baden *et al.*, 2020). The concept of libraries of things supported by digital technology could be deployed within a company or on industrial sites where seldomly-used equipment or items are held and maintained centrally and loaned out whenever needed. Indeed, IoT and AI will allow for resource traceability, accounting, and maintenance when implementing a sharing economy by connecting

people, processes, and services. Despite the application of recent innovations, from refrigeration to heating systems, digital technology's full potential has not been sufficiently explored in homes and businesses. Unlike many pro-environmental behaviours mostly studied to date, such as recycling and purchasing, organisational contexts provide the best testing grounds for many of these sharing or technology-based approaches because each building is multi- occupant but centrally controlled. The sustainability impact of IoT and cloud-based technology should be sufficiently explored using a lifecycle assessment approach.

With smart technology, organisations, whether manufacturers or service providers, can tailor the operating conditions of assets to their energy consumption pattern to drive efficiency. The critical challenge is how organisations can facilitate the potential of 4IR in enhancing their competitive advantage and sustained growth by embedding sustainability into their operations. Digital technologies can enhance consumers' participation in environmental initiatives through interactions between humans and machines using a human-centred approach to designing and deploying technology innovations (see Figure 1). The combinatorial power of technology through digital twins, fast cloud computing power, data storing and processing capability, and the internet of Things (IoT) (Oke and Fernandes, 2020) offers businesses the opportunities to install efficiency-based pro- environmental initiatives.

While technology can effectively reduce water consumption and energy use (Lo *et al.*, 2012), it is problematic to apply technology to increase material (waste) collection for recycling. For example, Lehman and Geller (2004) estimated that energy-efficient equipment, such as compact fluorescent lighting, could save 800 billion kWh of energy while preventing about a trillion pounds of greenhouse gas. Also, LED lighting systems are estimated to have a lifetime of about 50,000 h compared to incandescent bulbs. As digital technology influences everyday behaviour, there should be more attention to rebound effects in resource consumption. There is a need to understand the psycho-social determinants of pro-environmental behaviours, given that a possible rebound effect of consumer behaviour may undermine the effectiveness of technical approaches (Buhl *et al.*, 2017; Stapleton *et al.*, 2016). Behavioural measures alone are insufficient to address environmental problems considering the complexity of human behaviour regarding its predictability and the effects of contexts on consumption behaviour. Schultz's (2014) observations on the lack of guidance in utilising behavioural intervention tools suggest that pro-environmental behaviours are not likely to be predicted and explained with high accuracy, reducing the utility of behavioural change initiatives. Considering that people tend to prioritise work efficiency and productivity over pro-environmental behaviour at work (Lo *et al.*, 2012), research efforts should examine how technology could facilitate the implementation of pro-environmental initiatives in organisational settings. If the primary goal of research is to protect the environment, researchers and practitioners should divert their attention to the intersection/interaction between smart technology and human behavior (Figure 1) to effectively address environmental issues currently challenging human existence.

The current “take-make-consume-dispose” economic model (Reichel *et al.*, 2016) encourages mass-production of goods, and throw-away consumer culture (Reichel *et al.*, 2016) is contributing to the rate of resource consumption. For example, “buy one get one free” (BOGOF) increases resource consumption and is responsible for the burgeoning food waste in the UK from a rational point of view, it makes more economic sense for consumers to adopt the “BOGOF” approach; the main challenge is how to address the consequences of such practices from producers to consumers. According to Oskamp (2000), psychologists should play a leading role in changing consumer behaviour patterns to reduce environmental threats. This study argues that using social psychology principles alone is insufficient in addressing the current unprecedented rate of resource consumption–mainly influenced by the present linear economic model. This linear economic model poses a new challenge and should be addressed proactively to promote the circular economy through an interdisciplinary approach and underpinned by digital technology.

Conclusion and future direction for research and practice

While digitisation can reduce environmental problems (see Figure 2), the gap between research, especially behavioural-related research, and practice is widening, indicating the lack of external validity of many published studies in addressing real-world environmental problems. Investigators should adopt Gardner and Stern's (2002) curtailment and efficiency classification of behaviours when proposing interventions that may significantly reduce environmental issues. While curtailment involves repetitive behaviours over a long period, efficiency behaviours are one-off actions that may require a significant amount of investment. Some environmental problems (such as waste production) can be addressed using curtailment behavioural change (such as recycling) compared to other behaviours such as energy use that may require efficient-based actions. For instance, using a digital twin can have more significant impacts by installing smart equipment to monitor electric, gas, and water use, with real-time data to service providers remotely and consumers to understand the consumption pattern.

However, many studies, including interventions, especially on energy use, focus more on curtailment than efficiency behaviours (Lehman and Geller, 2004; van der Werff *et al.*, 2018). Although these definitions have been specific to energy use behaviour, efficiency behaviours result in environmental benefits compared to curtailment behaviours. The advantage is more likely to be long-term and not immediate than the curtailment pro-environmental actions (Gardner and Stern, 2008; Lehman and Geller, 2004). While some pro-environmental initiatives, such as recycling, may require people to change their existing behaviours, it is argued in this study that many other pro-environmental initiatives, such as energy and water use, may not necessarily need to involve behavioural change. For instance, installing an innovative lighting system will likely increase energy and cost savings, making it easier for people and businesses to prevent waste while improving efficient resource use. Nonetheless, making the initial investment may be challenging and requires high-level managerial decisions and sustainability business case to achieve executive buy-in. Social-psychology and marketing efforts should reduce psychological, economic, and institutional barriers to the diffusion and usage of technological innovations such as digitisation.

If environmental concerns and behaviours are declining (Vining and Ebreo, 2002), more interdisciplinary research efforts are required to address the motivations/barriers underlying the adoption of curtailment and efficiency behaviours. The multi-disciplinary efforts provide more insights into the possible interactions between different categories of pro- environmental behaviour. The approach may offer the opportunity to address structural factors that could undermine the contributions of personal/psychological factors (see Figure 1). For example, the provision of appropriate recycling bins can increase recycling without necessarily changing consumers' psychological and personality traits towards the environment or waste. While technology is increasingly changing the dynamics of business and consumer behaviour, it is evident that other disciplines, including social psychology and marketing, have significant roles to play in environmental research. Therefore, a synergy between curtailment and efficient actions through smart technology will accelerate environmental change rather than understanding individual behaviour alone.

Suppose Stern's (2000) argument on pro-environmental behaviour is valid and relevant. In that case, behavioural change interventions should enhance motivations and eliminate barriers reported in the literature. For any intervention be attractive and effective. However, this is a difficult task from policy and planning perspectives, especially to design and implement a holistic behavioural change intervention strategy. The complexity of pro-environmental behaviours indicates the need for proactive decisions with little or no human interactions by adopting smart technology to design-out behavioural barriers. Rather than influencing or changing individuals' behaviour, especially at work, marketing and psychology could be repositioned by focusing on how marketing and psychology principles could inform the building and design of pro-environmental technology (see Figure 1). The approach will curtail environmental issues through a one-off investment, such as a smart thermostat, with no requirement for continuous renewal of interventions.

Despite the difficulties in changing behaviour, many studies are being published every year, discussing motivations and barriers without offering practical solutions to sustainability problems facing businesses. Rather than re-inventing what has already been known in the literature about people's behavior (see Table 1), scholars should adopt an inter-disciplinary approach, where human-centred technology is developed to make pro-environmental initiatives effective without policing employees to change their behaviour. As a result, there is a need for practitioners (researchers and policymakers), businesses, and consumers (people at work) to collaborate on interventions that will eliminate barriers to behavioural change, and ensuring the effective implementation of pro-environmental initiatives. While pro-environmental and consumer research can contribute to policies by understanding behaviour (Stern, 2000), efforts should explore the contribution and adoption of technology innovations, particularly concerning curtailment behaviour in organisational settings. The concept of sustainability and technology innovations, including their interactions, requires more attention and policymakers and investigators should revisit it. However, this study suggests that the application of technology in promoting sustainability is a function of technology, sustainability initiatives in focus, organisational attributes, and the amount of investment an organisation is willing to make by performing scenario analysis (see Figure 1). When designing and implementing pro-environmental initiatives, organisations should examine how technology might contribute and influence interventions in achieving sustainability (see Figure 2).

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