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Designing sustainability changes in a tourist accommodation context from a systems perspective

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Pro-sustainability changes are slow and incremental at best in the tourism sector. Research on the topic can take the form of secondary data (e.g., content analysis of strategic documents, social media posts), survey-based intent studies (e.g., willingness to pay), survey-based studies of self-reported behaviors, observation of actual behaviors (e.g., benchmarking studies), lab-based experimental manipulations of measurable behaviors, and, finally, *in situ*, or field-based, experimental manipulations of measurable behaviors. The latter are some of the rarest studies and are held up as the gold standard for changing behaviors by providing evidence-based, measurable, and actionable sustainability interventions for tourism businesses. This study draws inspiration from a 4-year program of action research into pro-sustainability changes in tourist accommodations. It questions whether any of these approaches are sufficient for changing sustainability-oriented behaviors. This questioning extends to whether the theoretical approaches that underpin even "gold standard experiments" capture the operational contexts of accommodation businesses. It proposes instead that a scaffolded approach, built from a systems map of the theories, tools, experimental findings, interviews with stakeholders and operational context is necessary to create sustainability transformations in tourism businesses. This is a radical departure from the dependent/independent variable approach adopted in traditional scientific methods and that requires a different ontological approach to the science of sustainability. The study has implications for contextualizing intervention-based experimental studies within a wider system of influential factors within tourist accommodations.

KEYWORDS

sustainability, green hotels, behavioral interventions, behavioral theory, systems thinking

1 Introduction

Predicting or changing human behavior is a complex endeavor. Sustainable tourism behaviors, or pro-environmental behaviors (PEBs) in tourism are no exception. In this study, we focus on a microcosm of sustainability behaviors (with an understanding that systems are nested within other systems): tourists' pro-environmental behaviors in accommodation sites. This is an important area of research as buildings in general are said to be responsible for up to 40% of global energy consumption (Harputlugil and de Wilde, 2021), with tourists' accommodations being particularly energy-hungry, using up to 200–300% more energy than a similar-sized office building (Chan et al., 2017). Guests themselves are responsible for up to half the energy use in tourist accommodations, making them important contributors to the carbon footprint (Warren et al., 2017). Other environmental impacts include high water usage and waste generation; research by Becken and McLennan (2017) indicates that tourist accommodation can use up to 1,338 L per guest-night, as well as generate 2.1–2.9 L of waste per guest-night.

Studies of pro-environmental behaviors in tourist accommodations, and tourism more broadly, take one of six formats. The first format is secondary data analysis, such as strategic documents or databases within businesses or governments. Examples include Arici et al. (2023), who assessed Trip Advisor reviews for consumers' satisfaction with green hotel service quality. The second format is survey-based intent studies (including willingness to pay), such as that by Lee et al. (2010). The third format is survey-based studies of self-reported behaviors, such as guests' engagement with normative messaging for towel reuse (Schultz et al., 2008). The fourth one is the observations of actual behaviors often used as benchmarking studies, such as Gupta et al.'s (2019) study of what pro-environmental hotel features are noted and valued by guests. The fifth is lab-based experimental manipulations of measurable behaviors, for example, Rahman et al. (2020). Finally, *in situ*, or field-based, experimental manipulations of measurable behaviors are rare but are held up as the gold standard in this area as they provide businesses with evidence-backed, tangible actions to implement (e.g., Dolnicar et al., 2020). An additional advantage is that the (reductionist) nature of these experiments often means that the action is quite small, for example, switching to smaller plates, introducing new signage, or acquiring smart meters with digital displays for showers.

In this article, we question whether these small, incremental, and highly controllable actions that come out of the "gold standard" approach are enough to address the sustainability challenge facing us at present of reducing our resource consumption in line with the Sustainable Development Goals. A different approach is to use social practice theory that contextualizes each (cluster of) targeted sustainability behavior(s) and design through an iterative process similar to action research, a suite of scaffolded interventions. To illustrate what we mean, we use the example of a prominent behavior change example: smoking bans. Imagine that we use smoking in lieu of sustainability-oriented behaviors. We want to ban smoking the same way that we want to discourage unsustainable behaviors; therefore, we place signage at the hotel reception saying this is a smoke-free hotel, we may even emphasize that sign through interpersonal communication from the reception desk staff, or we even ask guests to sign a pledge or wear "I don't smoke" pin during their stay. Now imagine that the hotel has ashtrays on every table and that the staff have cigarette packs poking out of their pockets and can be seen around the back of the house having a cigarette during their breaks. There is a faint smell of cigarette smoke in the air. We can ask ourselves: how well do we expect guests to respond to the signs at reception saying this is a smoke-free hotel?

The example may seem frivolous at first glance, and there might be counter-arguments that not all complex problems require complex solutions and decision-making and, indeed, simple heuristics may work well in some cases (Marewski et al., 2010; Gigerenzer and Gaissmaier, 2011). However, learning how to change everyday patterns of behavior requires greater support, as any smoker will know. Let us replace the word *ashtrays* with "unsorted rubbish bins", the cigarette smell with visible single-use plastics (water bottles or toiletries) and so on, and you start to get a sense of our concern. A typical response might be "we need to start somewhere", but we argue that unless the wider system—and potentially counteracting factors—are taken into account, it will be difficult to change subordinate parts within the system. Moscardo (2021) neatly encapsulated this issue when she called for greater systems thinking in the research field of "persuading guests to engage in and support sustainability programs being implemented in hotels and restaurants" (p. 155). In her study, Moscardo (2021, p. 161) distinguishes between theories and systems by stating that "systems are more connected to real world problems or processes and thus are broader in their scope with theories explaining the specific elements of systems".

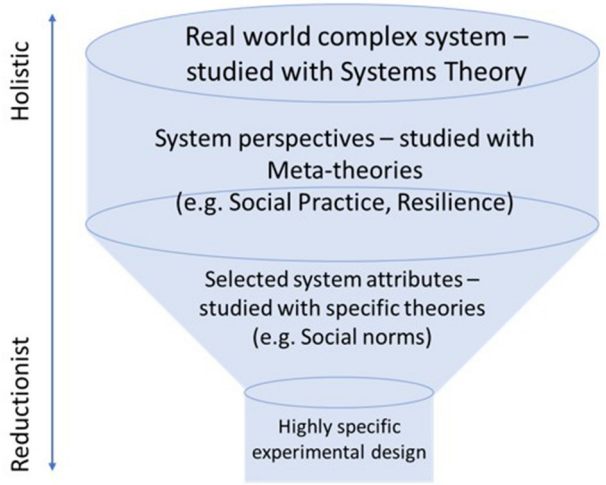

FIGURE 1
The issue of reductionism in sustainability-oriented experiments.

As such, we situate ourselves within the school of thought of Meadows (1999, 2008) regarding places to intervene in a system. As shown by Loehr and Becken (2021) in the tourism context, leverage points "require an understanding of system behavior, including feedback loops, to avoid unwanted or unintended knock-on effects" (p. 824). In this study, we leverage the various reviews of PEB experiments in tourist accommodation (e.g., Nisa et al., 2017; Demeter et al., 2023) and consider the theories used to design interventions and their relationship to the complexity of sustainability. Our aim is to move from the more reductionist approaches used in traditional experimental designs toward more holistic approaches embraced by systems thinking (Figure 1). In this way, we illustrate how the various contributions to knowledge in a given field can come together under the umbrella of social practice theory and system thinking to fast-track where possible sustainability initiatives or, at the very least, highlight the extent of work needed to move toward greater sustainability (Figure 1). We use our experiences on a 4-year project on reducing resource use in tourist accommodations but do not directly reference our findings.

This article also seeks to build awareness amongst researchers to take into consideration the contextual factors affecting their experimental designs. Understanding wider systems-level dynamics within which experimental studies take place will likely improve the design, implementation, and interpretation of the outcomes of an experiment, including its possible failings. Ultimately, our desire is to provide some practical guidelines

to anyone designing behavioral interventions (researchers and practitioners) regarding what tools and practices may be successful in generating a behavior change for sustainable tourism. Thus, this article has three objectives:

1. To review existing studies of pro-environmental behaviors in tourist accommodation settings, with particular reference to the theoretical underpinnings of the intervention
2. To present a systems-based approach to interventions, i.e., one that considers how the structure and function of how systems operate and interact with each other affect the effectiveness of interventions
3. To provide recommendations for interventions and future experimental designs to assist in the transition toward greater sustainability in tourism

This article presents a review of experimental design study in the accommodation setting but with the particular angle of understanding the *wider settings* in which these experiments were conducted. The conceptual model underpinning our review is shown in Figure 1, where the highest level of holism reflects the real-world system and the use of the systems theory (Sterman, 2000) to study it. Most research will focus on aspects of a system, leading to simplifications by way of a selected scope and certain aspects that are either approached through a meta-theory or a more specific theory. The theory of planned behavior, for example, is often used to understand environmental choices made in response to people's attitudes (e.g., Ajzen, 1991). Finally, the lowest level in our model—and the highest degree of reductionism—is the actual experimental design where a very specific aspect of the real world is used to test the impact of an intervention, for example, signage to encourage people's recycling behavior (Grazzini et al., 2018). Thus, there are two forms of reduction: first, isolating a specific behavior and the variables under analysis and, second, translating (specific) theory into the intervention for implementation within the constraints of the project (hotel, budget, etc.).

2 Pro-environmental behaviors in tourist accommodation

Pro-environmental behaviors in tourism are defined as all possible actions aimed at avoiding harm to and/or safeguarding the environment (Steg and Vlek, 2009). As noted in the Introduction section, tourist accommodation is one place where a significant impact reduction in resource use can be made (Warren et al., 2018a). As a bounded space (e.g., a hotel, a self-catering cottage, and a campsite) with fairly clear, routinised social practices (sleeping, showering, etc; e.g., Iaquinto, 2015) and availability of some explanatory data (length of stay, nationality, travel party, business vs. leisure, etc.) for guests, accommodation sites are also desirable field study settings for both self-report surveys or quasi-experiments. The former tends to dominate PEB research in general as well as PEBs in tourist accommodation settings (see Dolnicar et al., 2019). Readers interested in this type of work can be directed toward prominent authors such as Heesup Han et al. (e.g., Chua and Han, 2022; Sohaib et al., 2022; Quan et al., 2023).

It is well established in the existing literature that intentions are poorly correlated with actual behaviors, and self-reports of behaviors are often inaccurate (Kormos and Gifford, 2014). This has led many top researchers in this space to argue against using either intentions or self-reported behaviors as insightful measures of behaviors in a behavioral change context (e.g., Viglia and Dolnicar, 2020). Fortunately, accommodation settings do provide ample opportunities to study actual on-site behaviors, specifically those that are observable, either by housekeeping staff, trained observers, or using smart meters (e.g., Coghlan et al., 2022). Observable studied behaviors tend to focus on towel reuse (12 studies, namely, Goldstein et al., 2007, 2008, 2011; Schultz et al., 2008; Mair and Bergin-Seers, 2010; Baca-Motes et al., 2012; Bapuji et al., 2012; Bohner and Schlüter, 2014; Reese et al., 2014; Morgan and Chompreeda, 2015; Terrier and Marfaing, 2015a,b); towel reuse combined with another behavior such as linen reuse (Gössling et al., 2019; León and Araña, 2020) or energy use (Dolnicar et al., 2017), shower length (Pereira-Doel et al., 2019; Tiefenbeck et al., 2019), water use in general (Joo et al., 2018), and room cleans (Dolnicar et al., 2019; Knezevic Cvelbar et al., 2021); and light use (Mascovich et al., 2018), energy reduction (Wang et al., 2017), water, power, and gas use (Warren et al., 2017), using paper serviettes instead of cotton serviettes at a buffet (Dolnicar et al., 2020), food waste (Kallbekken and Sælen, 2013; Antonschmidt and Lund-Durlacher, 2018; Dolnicar et al., 2020), ethical food choices (Cozzio et al., 2020), and finally recycling behaviors (Grazzini et al., 2018). The 30 studies listed in this paragraph form the basis of this research and are identified with an asterisk in the reference list.

Because the behaviors in the studies listed above are observable and can be manipulated by accommodation providers, they are highly amenable to interventions using experimental designs. Viglia and Dolnicar (2020) describe experimental designs as delivering third-order knowledge, allowing conclusions to be drawn about cause-and-effect relationships, and "lead[ing] to a quantum leap in both knowledge creation, and in the practical usefulness of such knowledge to industry" (p. 2). Experiments provide the dual benefits of advancing knowledge beyond associations (the latter makes up 87% of the tourism research, according to Dolnicar and Ring, 2014) as well as providing very clear, well-defined actions (based on successful interventions) for practitioners to implement. Experimental, intervention-based studies are, therefore, arguably a highly useful tool in moving toward pro-environmental, sustainability-oriented behaviors in accommodation guests.

The preceding statement comes with two caveats. First, for experiments to deliver third-order knowledge, they must be well designed. "Well designed" often implies having a solid theoretical foundation, backed by a manipulation check that ensures that the sample is, in fact, interpreting the intervention through the lens of the desired theory and sample sizes are large enough to generate robust results, clear interventions and control groups with identifiable independent and dependent variables. In addition, for the accommodation sector, it is useful to have studies that extend over several seasons to account for temperature variations (which may affect energy or water use for heating/cooling) and holiday periods or weekdays as these determine the share of business vs. leisure travelers. The relevance of these attributes to this study,

or indeed any study focussing on experimental designs in the accommodation sector, is further discussed in the Section 3.

Second, there must be an in-depth understanding of the context in which the experiment is undertaken, as this affects the experiment's internal and external validity. Researchers must be familiar with the operational constraints and general workings of the accommodation sector. Overlooking an operational feature can derail even the best-designed experiments. This second caveat is at the core of the conceptual model shown in Figure 1. It relates to a broader epistemological issue of reductionist science- vs. holistic systems-based research. The parable of the blind men and the elephant is a useful way to think of this issue. An experiment will isolate variables and focus on those dependent and independent variables. As such, experiments will present a "piece of the puzzle" and should be considered as such and placed within the broader system (Gallagher and Appenzeller, 1999). Sometimes, the use of meta-theories may help place specific theories into a wider context. For example, social practice theory (e.g., Reckwitz, 2002) has become more prominent in sustainability research because of its focus on connecting individual behaviors with the structure of the broader system in which people make choices (Lamers et al., 2017; Becken and Hughey, 2022). Capturing the wider context has been operationalised, for example, by undertaking supplementary data collection tools such as accompanying guest surveys and/or interviews with managers and housekeeping staff to assist in both understanding whether the design of the experiment had high external (or field) validity and helping interpret the results (e.g., Mair and Bergin-Seers, 2010; Dolnicar et al., 2020). The review presented in this article will shed further light on how studies address the issue of capturing systemic dynamics whilst designing relatively narrowly defined (and manageable) experiments.

3 Method

To bring together the various theories that have been used to effectuate change in pro-environmental behaviors in tourist accommodation, we have leveraged studies by Nisa et al. (2017), Souza-Neto et al. (2022), and Demeter et al. (2023). A total of 30 (quasi-)experimental studies in tourist accommodation were identified in this way, and the comprehensiveness of the review was validated with both forward-citation and backward-referencing checks on all references listed in the three review papers earlier.

We then used a scoping review approach to analyse the full content of each of the 30 papers. One explicit purpose of scoping reviews is to examine how research is conducted on a certain topic as well as to present a map of the area under review to identify and analyse knowledge gaps (Munn et al., 2018). Scoping reviews benefit from a clearly defined focus. Here, the criteria for inclusion in this scoping review are three-fold and based on the arguments that were previously presented:

- They take place in a tourist accommodation setting (i.e., studies of booking intention/choice architecture studies were not included).
- They use an experimental design [i.e., association studies are not included, and neither are studies such as Scheibehenne et al.'s (2016) Bayesian analysis of towel reuse studies or Knezevik Cvelbar et al.'s (2017) study which segmented tourists based on their towel use but did not test any behavior change interventions included].
- They used actual behaviors as an outcome variable.

The full citations of each study are provided in the reference list with asterisks indicating the 30 studies that matched the three criteria mentioned previously. In each study, we consider (1) the theoretical framework underpinning the studies, (2) whether a manipulation check was performed (to ensure the salience of the theory within the intervention), (3) how that theoretical framework relates to the broader operational context of the hotel, and (4) whether any follow-up data collection allowed other factors, e.g., confounding variables, to emerge from the study.

Next, the review findings feed into a preliminary causal loop diagram (CLD; see Figure 2) of pro-environmental behaviors in tourist accommodation settings. We specifically focused on an endogenous system rather than the broader system in which the resource consumption takes place (e.g., water capture and distribution infrastructure, government policies, pricing, etc.) as we want to be able to provide actionable recommendations for businesses to implement change within their own buildings. We then map onto the CLD the various theories that have been identified from experimental studies reviewed in this article. This is a key point of difference to other review papers such as that by Demeter et al. (2023), who adopt a different position from the one that we describe in our introduction (i.e., holistic, contextualized, practice-based approach that draws on other forms of knowledge, e.g., practitioner experience). Indeed, Demeter et al. (2023) specifically argue for studies that remove "context biases" (p. 5), eliminate imperfect randomization, and do not comply with the *ceteris paribus* condition in experimental designs and call for the greater use of technologically based interventions.

4 Findings

4.1 Overview of the reviewed experimental studies

A total of 30 studies were included based on the selection criteria presented in the Methods section. Overall, the studies delivered mixed results or even contradictory findings in some cases in response to the interventions. For example, interventions using social norm theories sometimes resulted in lower resource use and other times not. The provision of relevant information to guests increased bed linen reuse but not towel reuse (León and Araña, 2020). Whilst there are some patterns (e.g., nudges seem more effective than environmental appeals), discerning what types of interventions are most reliable in producing positive environmental outcomes is difficult. As discussed later, one reason is the complexity of the specific context in which an experiment takes place.

Towel reuse was the most common target behavior, used as a measure in 14 of the 30 studies (sometimes in isolation and sometimes in combination with other behaviors). Seven other behaviors were measured as target behaviors, namely, energy use, food-related behaviors, reducing wildlife disturbance, recycling,

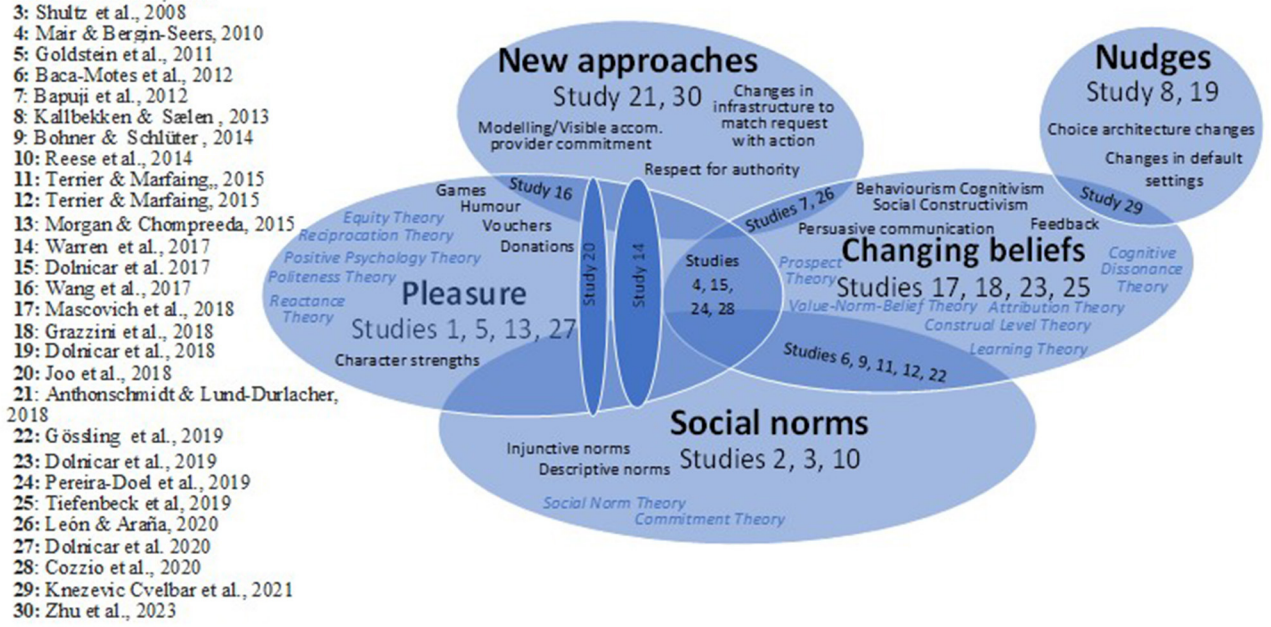

FIGURE 2
A scoping map of the reviewed studies according to their different approaches, theories (italicized), and tools. Some studies use more than one approach.

water use, bed linen change, and rooms cleans. Towel reuse is commonly used as a target behavior because it is relatively easy to observe, it is an acceptable behavior in terms of minimizing risk to experience satisfaction, it is a so-called low-investment behavior, meaning that it is fairly malleable, and it has a cumulative environmental impact in terms of water use, energy use (in washing and hot-water production for washing), and chemical pollution. Indeed, overall, water usage receives the most attention in tourist accommodation pro-environmental behavior experiments, with 19 of the 30 studies targeting water usage in some capacity. For this reason, we present the sub-sample of water-related studies (Table 1) to illustrate two key observations that emerged from this analysis.

The first observation is a chronological progression in the studies in terms of their complexity. The first nine studies up to 2015 focus solely on towel reuse as a variable. Dolnicar et al. (2017) focus on both electricity usage and water, but it is not clear whether the authors (at that point) are deliberately drawing a connection between water and electricity use, while the most recent studies have been considering room cleans more broadly, with all their associated water usage (and anecdotal evidence from discussing smart-meter data with hotel managers suggest that water usage peaks while staff are cleaning rooms). This is relevant from a systems perspective because viewing target behaviors, for example, towel reuse, as part of a bundle of social practices, e.g., towel and linen reuse, recognizes higher-level linkages between meanings, materials, and competencies (Shove et al., 2012; Warren et al., 2018b). Thus, relating this finding to Figure 1, researchers have extended experimental designs in ways that work "upwards" to overcome the limitations of highly reductionist approaches.

Second, true replication studies are relatively rare (unlike in the sciences), and only a few researchers have published more than one study in this space. These include Terrier and Marfaing (2015a,b), Araña (Gössling et al., 2019; León and Araña, 2020), and Font and his team at the University of Surrey for the Showering Smartly (2024) programme. Goldstein and colleagues were early pioneers but from a psychology, rather than a tourism or hospitality, perspective. More recently, Dolnicar and her team have built a cohesive body of research on the topic of PEB in accommodation. Conducting replication research, as well as building systematically on a previous study, allows researchers to experience embeddedness in the context, that is, tourist accommodations in our case. The resulting increase in environmental literacy (Hollweg et al., 2011; Becken and Coghlan, 2023) includes not only technical knowledge but also practitioner knowledge, skills, and intuition, all of which will assist in the design of (future) effective experiments with high external validity (Viglia and Dolnicar, 2020). As one of the earliest and most influential proponents of systems thinking put it (and with reference to sustainability), a "systems-thinking lens allows us to reclaim our intuition about whole systems and hone our ability to understand parts, see interconnections, ask 'what-if' questions about possible future behaviors and be creative and courageous about system design" (Meadows, 1999, p. 6–7).

4.2 Theoretical underpinnings of interventions

When we interpret Moscardo's point about systems thinking approaches being broader (and therefore more able to capture real-world problems) than individual theories and combine it with

TABLE 1 Subset of experimental studies on changing behavior related to hotel water use.

References and Setting	Sample size	Theoretical underpinning	Measure	Outcome
Goldstein et al. (2007), City hotel in the USA	*No details*	Persuasive appeals, reciprocation norm, and social norm	Towel reuse	Exp. 1: Environmental appeals and social responsibility appeals had the same effect. Exp. 2: Reciprocation-norm was more effective than env. cooperation. Exp. 3: Descriptive norm was as effective as reciprocation-norm and more effective than env. protection. Exp. 4: Provincial norm was more effective than both env. protection or general descriptive norm.
Goldstein et al. (2008), Mid-sized, mid-priced hotel in the USA	Study 1: 1,058 observations from 190 rooms across 80 days. Study 2: 1,595 observations. over 53 days	Norms and reference groups	Towel reuse	Normative messages led to significantly higher towel reuse than environmental protection. The provincial norm, i.e., guest reference group, led to significantly higher towel reuse than other conditions.
Goldstein et al. (2011), Mid-sized, mid-priced hotel in the USA	634 instances of potential guest towel reuse over 80 days	Reciprocation	Towel reuse	The reciprocity-by-proxy condition significantly increased towel reuse; no significant difference between other conditions were observed.
Schultz et al. (2008), Upscale beach resort	2,359 guest stays in 62 hotel rooms	Norms (injunctive and descriptive)	Towel reuse	Both experimental conditions significantly decreased towel use compared to the control but no significant difference between specific and general normative messages was observed.
Mair and Bergin-Seers (2010), 4 motels in Victoria, Australia	109 guests	Norms and incentives	Towel reuse	No statistical differences betweenfour conditions were observed.
Baca-Motes et al. (2012), Hotel in California	2,416 guest parties over 31 days	Commitment and signaling	Towel reuse	Specific env. message significantly increased towel reuse. Specific + pin more likely to reuse towels than in the message-only, pin-only, and control conditions. Members of the pin-only group were least likely to reuse towels.
Bapuji et al. (2012), Pleasant Stay Hotel (country NA)	177 guest days	Routines and actor–network theory	Towel reuse	Significantly higher towel reuse occurred in the experimental condition.
Terrier and Marfaing (2015a), 4-star city hotel in Switzerland	803 guest stays from 110 rooms in 3 months	Norms and commitment	Towel reuse	Condition 1 (simple messages/no commitment) led to significantly lower towel reuse but no significant differences between the other three conditions.
Terrier and Marfaing (2015a), 4-star city hotel in Switzerland	187 stays across 50 rooms across 3 months	Commitment and persuasive communication	Towel reuse	The persuasive communication + binding commitment led to significantly more towels being reused.

(Continued)

TABLE 1 (Continued)

References and Setting	Sample size	Theoretical underpinning	Measure	Outcome
Reese et al. (2014), 2 alpine hotels in Central EU	132 guests over 6 weeks	Norms	Towel reuse	Provincial norms resulted in significantly higher towel reuse than global norm but no significant differences between other conditions.
Morgan and Chompreeda (2015), Ko Tao resort, Thailand	287 observations from 15 rooms across 8 weeks	Norms and incentives	Towel reuse	Significant differences between treatment groups on towel reuse, with the highest reuse in the injunctive norm, followed by descriptive + injunctive, economic incentives, and descriptive norm. No pairwise comparisons.
Dolnicar et al. (2017), Eco hotel in Slovenia	1,836 room nights, from 784 guest parties, over 81 days.	Pro-environmental appeals, cognitive dissonance, and humor	Towel reuse and electricity use	No significant differences detected between the groups.
Warren et al. (2017), 4 rural cottages in Australia	759 guests over 10 months.	Feedback, personal communication, norms, and reciprocation	Cottage water usage	Significant reduction in resource use between the three groups.
Joo et al. (2018), City hotel in Korea	306 guests from 66 rooms over 2 months	Injunctive norm, commitments, and social goal communications	Room water usage	All three conditions led to significantly reduced water use but no statistical differences between the three conditions.
Pereira-Doel et al. (2019), City hotel in Spain	1,962 observations from 20 rooms over 12 months	Feedback	Shower time	Feedback using displays significantly reduced shower time.
Gössling et al. (2019), 7 hotels in Gran Canaria, Spain	2,100 observations from 30 rooms across 100 days	Normative appeals	Towel reuse, bed linen change	The comprehensive message led to significantly more towel reuse and bed linen reuse than the standard message.
Tiefenbeck et al. (2019), 6 hotels in Switzerland	265 rooms, 19,596 observations over 3 months	Feedback	Shower time	Feedback using displays significantly reduced shower time.
León and Araña (2020), 4 apartment establishments, 165 rooms	1,968 accommodation stays over 3 months	Personal communication	Towel reuse and linen change	The "additional information" condition increased bed linen reuse but not towel reuse. The "personal communication" condition significantly affected both towel and linen reuse.
Knezevic Cvelbar et al. (2021), City hotel in Ljubjana, Slovenia	989 observations from 616 guest parties over 27 days	Default settings and value-belief norm theory	Room cleaning rates	Both conditions reduced room cleans, but no overall difference was noted between the two experimental conditions.

Exp., experiment; obs., observations; env., environmental.

Meadows's view about taking a systems lens to create change, we build a platform from which to examine the theories used in previous experimental design studies. This wider perspective might help identify how to build bridges from understanding parts of the system to reflecting on (and redesigning) the system as a whole.

A broad range of theories have been used to design experimental interventions in the reviewed studies. Table 2 illustrates the breadth of the 13 theoretical frameworks in the context of PEBs and provides examples of studies that have used them. As a way of categorizing them, we draw on the four approaches put forward by Dolnicar (2020) and reprised by Demeter et al. (2023). The four high-level approaches are (1) changing beliefs, (2) social norms, (3) nudges, and (4) pleasure, which each builds on a number of theoretical frameworks to design interventions. In addition, Zhu et al. (2023) develop interventions around what they refer to as non-cognitive theoretical constructs (e.g., respect for authority and empathy), although they abandoned the empathy intervention as the manipulation check was unsuccessful. Finally, nudges arguably represent their own theoretical approach (Thaler and Sunstein, 2008).

TABLE 2 Theories used in the 30 reviewed studies.

Type of approach	Theory	Principles of theory (in brief) in a PEB context	References
Social norms	Social norm theory	Our behavior is shaped by what we perceive to be the norm around us, therefore explicitly setting a PEB-related norm can change that behavior.	Goldstein et al., 2007, 2008; Schultz et al., 2008; Bohner and Schlüter, 2014; Reese et al., 2014
	Commitment theory	Individuals want to minimize discrepancies between beliefs/attitudes and behaviors, particularly where these are signaled publicly.	Baca-Motes et al., 2012
Pleasure-based approaches	Politeness theory	Draws on individual's need for both appreciation and freedom in exchanges and the ability to modify the PEB request accordingly.	Warren et al., 2017
	Positive psychology theory	Focuses on what humans need to flourish, and how strengths-based activities can be given a PEB "flavor" so that they become enjoyable.	Warren et al., 2017
	Reactance theory	Explores how people respond when they feel their freedom of behavior is limited. In a PEB context, we want to eliminate messages that can cause reactance.	Wang et al., 2017
	Equity theory	Predicts how people will maintain a balance of give and take in a social exchange; i.e., if the guest engages in PEB, what will the hotel do as its part?	Dolnicar et al., 2019
	Reciprocation theory	Similar to equity theory, but with a greater focus on informal contracts of positive behavior reciprocation.	Goldstein et al., 2007; Wang et al., 2017
Changing beliefs	Prospect theory	Models how people decide between alternatives based on perceived risk versus reward.	Grazzini et al., 2018
	Value-norm belief theory	PEB is influenced by values that are shaped by personal beliefs as well as personal norms.	Dolnicar et al., 2019; Knezevic Cvelbar et al., 2021
	Cognitive dissonance theory	Posits that individuals do not like to hold conflicting beliefs and behaviors and will try to reduce the 'dissonance' by changing one or the other.	Dolnicar et al., 2017
	Attribution theory	Focuses on how we explain the causes of behaviors and events, including who is responsible for PEBs	Dolnicar et al., 2019
	Learning theory	A broad class of theories on how people learn, for example through feedback, associations, etc.	Warren et al., 2017; Pereira-Doel et al., 2019
	Construal-level theory	Explores the impact of psychological distance (arguably described as personal relevance) and concrete/abstract thinking, e.g., plastic pollution on MY beach, vs. climate change and coral bleaching elsewhere.	Grazzini et al., 2018
Nudges	Nudges	Free choice behaviors can be influenced by the layout/design of the "architecture" in which that choice takes place, e.g., default settings of "please change my room" vs. "do not disturb".	Kallbekken and Sælen, 2013; Dolnicar et al., 2018; Knezevic Cvelbar et al., 2021

PEB, pro-environmental behavior.

Importantly, several studies have combined the different types of approaches and specific theories to broaden the way in which they can capture PEB complexity in the accommodation setting. These are presented in Figure 2, where Study 14 (Warren et al., 2017), for example, combined pleasure (e.g., picking your own fruit or feeding chickens with compost) with social norms (e.g., information on how much water other guests use) and changing beliefs (e.g., information on water storage and drought conditions) in an overall setting of authentic leadership by the business. The latter is what Wang et al. (2017) called "visible firm commitment", where the firm's commitment to sustainability was made visually obvious to the guest through solar panels, rain storage tanks, and other clues such as restored biodiversity on the premises. Study 29 (Knezevic Cvelbar et al., 2021) was unique in that it combined nudging (i.e., default changes to opt in for room cleaning) with environmental information on how much chemicals, water, and electricity are used (changing beliefs in Figure 2). The findings showed that, whilst the change in default did deliver significant reductions in room cleans rate, the addition of the pro-environmental appeal did increase uptake but only for certain segments (whilst reducing for others). This highlights the importance of nuanced approaches that can elicit wider perspectives (moving upwards in Figure 1), in this case the different types of hotel guests.

Only 9 of the 30 studies performed manipulation checks prior to implementing the experimental condition (Goldstein et al., 2008; Baca-Motes et al., 2012; Bohner and Schlüter, 2014; Wang et al., 2017; Antonschmidt and Lund-Durlacher, 2018; Grazzini et al., 2018; Gössling et al., 2019; Dolnicar et al., 2020; Zhu et al., 2023). Manipulation checks are important when designing theory-based interventions to ensure that the intervention, such as signage, actually captures the important features of the theory and is recognized as such by participants (Viglia and Dolnicar, 2020). While not all studies needed manipulation checks (e.g., changing default settings), those relying on psychology theories or pleasure-based interventions could have perhaps benefitted from manipulation checks in their design. For example, it is possible that the monetary incentive offered in Morgan and Chompreeda (2015) study was not high enough to motivate behavior changes. Elsewhere, Zhu et al. (2023) did note that their intervention designed around empathy did not appear to elicit that emotion and therefore discarded it and focused only on their other theoretical underpinning, respect for authority.

4.3 From theories to practices

It is noteworthy that a few interventions were also designed without explicit use of a theory. Changing the infrastructure to match the requested behavior with the act of performing the behavior is one example (Bapuji et al., 2012). This is not the same as nudging, as it is not about encouraging one desired choice over another by changing the salience or desirability of a particular option, but it is more basic than that by just ensuring the infrastructure is there to allow the guest to perform a behavior. An example of the difference might be the following: large recycling bins are placed every few meters in the public spaces of a hotel, while general rubbish bins are much harder to find (an example of nudging). Contrast this with recycling bins, which were formally not clearly labeled and therefore caused uncertainty as to whether they were indeed recycling but are clearly labeled in the current times so that guests are able to perform the requested recycling action (matching infrastructure with desired behavior).

Another approach is modeling, or a "walk the talk" approach (e.g., Wang et al., 2017). More specifically, Wang et al. (2017) tested a variable they called "visible firm commitment", or changes within the hotel's practices to signal that the accommodation provider is committed to positive pro-environmental outcomes. They placed bamboo toothbrushes in each room for the "visible firm commitment" experimental condition. The idea was that recyclable bamboo toothbrushes are more expensive than plastic ones, implying that the hotel was contributing its part. This type of investment presumably meant that the hotel was also engaging in less visible, behind-the-scenes, and sustainability behaviors. A similar approach was used by Warren et al. (2017), whereby the manager explicitly took the guest on a tour of the accommodation to highlight sustainability features and how to use them, requesting that the guest assist the host in minimizing negative environmental impacts. While this explicit staff-leadership approach was not tested elsewhere, at least four other studies (Antonschmidt and Lund-Durlacher, 2018; Joo et al., 2018; León and Araña, 2020) used statements by the company about the authenticity of their commitment, for example, "We handle food carefully so that less is wasted: We plan our buffets conscientiously, our dishes are freshly prepared, many are cooked in front of the guests, we offer a wide variety of different portion sizes" (Antonschmidt and Lund-Durlacher, 2018).

Finally, a similar, but slightly different, idea was tested by Bapuji et al. (2012), who argued that a large part of the problem is that "action-responses" are rarely clearly aligned between guests and hotel staff. We understand action-response to mean the "action" that the accommodation provider is requesting from the guest, and the "response" is the action offered by the guest based on their understanding of the request. This is reminiscent of Gössling et al.'s (2019) focus on procedural knowledge—exactly what is the guest being asked to do and how should they perform the task.

Each of these approaches relied on the business demonstrating that it is committed to sustainability through modifying its practices. In this way, these three studies (Bapuji et al., 2012; Wang et al., 2017; Warren et al., 2017) adopt more of a social practice theory approach rather than relying on one specific theory to explain one aspect of an intervention. To further validate their results and check for confounding variables within the wider system, some studies used guest observations (Warren et al., 2017; Dolnicar et al., 2020) or ran accompanying surveys (Mair and Bergin-Seers, 2010; Baca-Motes et al., 2012; Wang et al., 2017; Warren et al., 2017; Antonschmidt and Lund-Durlacher, 2018; Dolnicar et al., 2020). Two studies used follow-up lab studies to test for variables with a mediating role (in these cases, trustworthiness and self-efficacy, respectively) in the relationship

between intervention and behavioral outcomes (Goldstein et al., 2011; Grazzini et al., 2018). Additionally, Bapuji et al. (2012) conducted interviews with hotel staff.

These *post-hoc* reviews of the experiments noted some issues with relying on hotel staff to collect the data. While a number of studies specifically state that housekeeping were trained in data collection and "blinded" to the nature of the experiment or at least the expected findings, at least one (using independent data collectors) specifically noted that 43% of towels hung by guests for reuse were replaced by housekeeping (Baca-Motes et al., 2012). Goldstein et al. (2011) also report that "data from several room attendants who did not understand our directions during training due to the language barrier or who did not follow our instructions throughout the study were excluded from the analyses" (p. 449). Moreover, Bapuji et al.'s (2012) study of towel reuse routines specifically looked at how staff interpreted guests' towel reuse behavior, noting that housekeeping often guessed what guests wanted done with their towels as guests "throw their towels all over the place: tub, floor, counter tops, bed, chair, everywhere" (p. 1593).

4.4 A systems-based approach

Based on our review of the 30 studies provided earlier, we return to our smoking example in the introduction and the need for a more holistic approach. We posit that a systems approach, which by its nature transcends individual theories, is useful when tackling complex issues such as sustainability and pro-environmental behaviors. The word *transcend* is chosen with care; we have already noted Moscardo's views that theories might explain specific elements of a system and Meadows's view that systems thinking actually allows us to harness intuition when seeking to understand systems. Moreover, a theory is commonly understood as "a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena" (Kerlinger and Lee, 2000, p. 11). By definition, a "set" and "specific relations" represent a partial view of a system. In most cases, it is practically not possible to model or understand the system in its entirety, but researchers need to be aware that reduction increases the risk of missing some of the emergent, adaptive, and non-linear qualities that characterize complex systems.

To explore how we might retain the benefits of theory-led experiments with some of the benefits of systems thinking, we have trialed a CLD approach to the issue of water savings in tourist accommodation (Figure 3). A CLD is a popular tool in system thinking that visualizes the dynamic processes within the system in which the chain of effects between a cause and an effect can be traced across a set of related variables (Maani and Cavana, 2007). These dynamic processes usually take the form of feedback loops that can trace the chain of effects through a set of related variables from beginning to end. Each one tells a story of phenomena occurring in the system (Maani and Cavana, 2007). There are two types of feedback loops, balancing (–) and reinforcing (+) ones (Dhirasasna and Sahin, 2019). According to Meadows (2008), reinforcing feedback loops can be either a "vicious circle" or a "virtuous circle". The former rapidly builds momentum in a negative direction away from the intended intervention outcome, while the latter moves in the direction of the policy goal.

Figure 3 shows some of the key variables identified in our scoping review (see Table 1) and their relationships. Investments into water savings measures could be targeted at staff or guests. Most studies reviewed here focused on guests. For example, the link between increasing awareness and using learning theory may lead to changes in water consumption. Staff play a key role in demonstrating PEB (as in our no-smoking scenario in the introduction) by defining the social norms at the property. Creating a sense of authenticity, amongst others through "visible firm commitment", represents a positive feedback loop to encourage guest behavior change. Conversely, staff disengagement from PEB directives may reduce the perceived authenticity of the activity and therefore pro-environmental attitudes of guests through observed behavior. The benefit of mapping the whole system is to gain a better understanding of the extent of reduction that had to be made to conduct a targeted experiment. Capturing the wider dynamics of the system is particularly important in the case of a failed experiment, where a CLD or similar techniques might give useful clues regarding other potential influences.

5 Concluding discussion

This study argues that we need to accelerate our research into pro-environmental behaviors by moving beyond the "gold standard" of experimental designs in tourism field settings. Overall, from reviewing experimental designs, we have found that what works in one setting does not necessarily work in another, and few approaches have been replicated beyond their original study to allow for any degree of reliability in the findings. While a meta-analysis of the results of these studies was beyond this review article (see Dimara et al., 2017), the following recommendations aim to marry up the most successful interventions with what accommodations providers are comfortable implementing in their businesses. For example, whilst interesting from a research perspective and enjoyable for the guest, Borden et al. (2017, p. 916) warn that "pleasure-based" approaches require the "highest financial and logistical investment" by accommodation providers and are less likely to be adopted. When designing an intervention, we suggest that good practice involves (1) selecting suitable theoretical frameworks, (2) conducting a manipulation check, (3) using accompanying guest surveys (or observations), and (4) assessing field validity by drawing on practitioner feedback.

Moreover, and as indicated in all three figures in this article, we recommend considering a blended or scaffolded approach of multiple theories into a more complex design. While highly reductionist approaches could be considered purer from an experimental point of view (i.e., eliminating as much "noise" as possible, akin to a laboratory situation), more holistic designs are better suited to capture the complexities of real-world settings relevant to achieving PEB outcomes. In carefully reflecting on these trade-offs, recognizing that the precariousness of the environmental crisis demands that we use all the tools in our toolbox is important. This would involve carefully designing the choice architecture, building pleasure into the design of

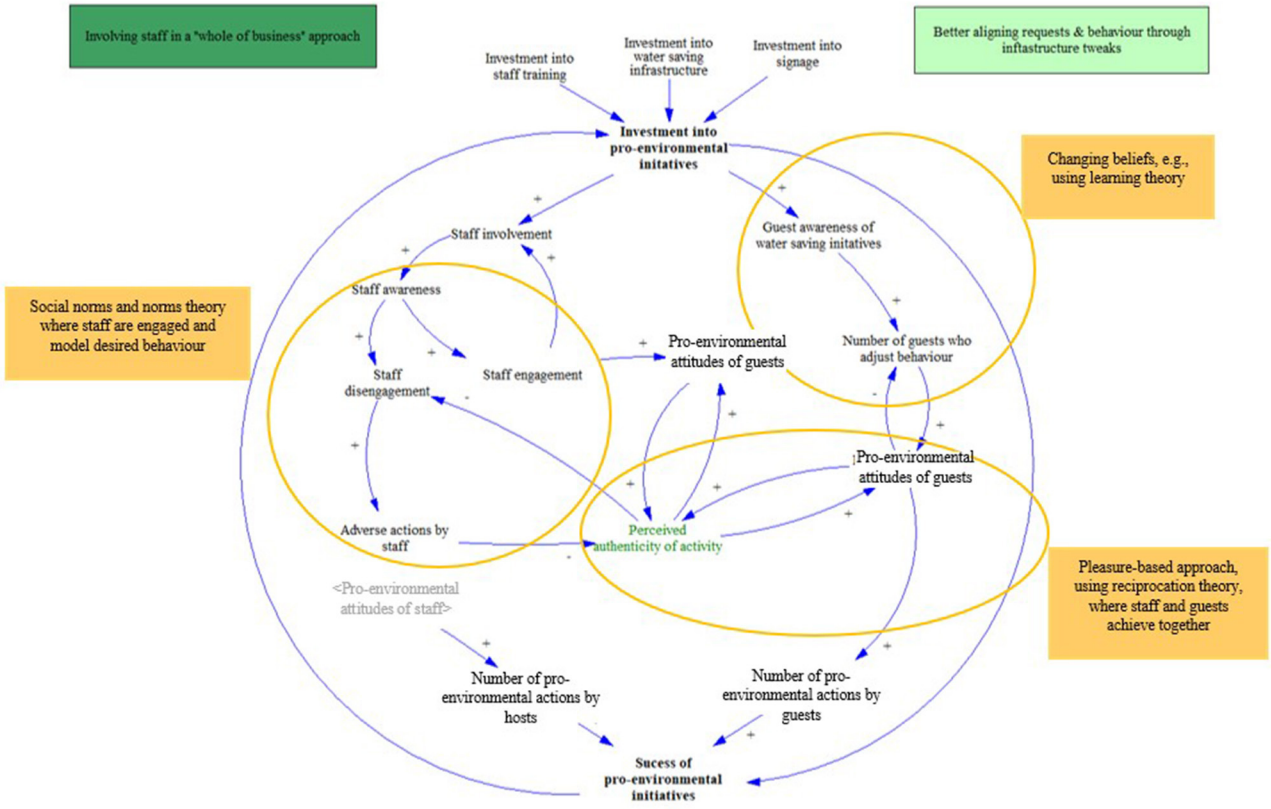

FIGURE 3
A causal loop diagram illustrating the complexity of changing water consumption in accommodation, as well as the role of specific theories to explain particular phenomena within the system. For clarity in the causal loop diagram, the "Pro-environmental attitude of staff" variable has been included as a shadow variable.

pro-environmental behaviors (i.e., making pro-environmental behaviors part of value creation), using appropriate incentives, using social reference points and commitment signaling, providing information to change beliefs, and, finally, using feedback mechanisms wherever possible. Most importantly, however, we argue that research needs to bring the staff and infrastructure of the business to the forefront. Identifying areas where the staff themselves can contribute to increasing the sustainability of tourist accommodation, an area that, to date, largely remains understudied, will lead to greater authenticity and further encourage changes in guest behavior. Thus, it will be important to focus on what Sovacool and Hess (2017, p. 733) refer to as "relational theories", which they describe as ones that "apply their focus across agency, structure, and meaning", i.e., that interconnect the different approaches in Figure 1, building a sense of meaning and agency for staff, management and guests.

Indeed, we found that the studies that adopt this type of design thinking (Bapuji et al., 2012; Wang et al., 2017; Warren et al., 2017) achieved some of the better experimental outcomes. The potential of bridging the practitioner/researcher divide (Thomas and Ormerod, 2017) would foster what Tribe (1997) describes as "procedural knowledge" (professional practice knowledge as opposed to propositional knowledge or "knowing that" which is validated against a discipline's knowledge criteria). We suggest that building researcher literacy (Becken and Coghlan, 2023) and fostering intuition (Meadows, 2008) are key ingredients for designing effective sustainability research.

In conclusion, and reminding the reader of our smoking example, we argue that a systems-based approach that takes into account the wider context, including operational constraints that may work against theory-based designs or cues (positive and negative) that encourage certain types of behaviors, should be developed alongside the more reductionist, controlled (quasi-)experimental studies. Regarding our first objective review of existing studies of pro-environmental behaviors in tourist accommodation settings, with particular reference to the theoretical underpinnings of the intervention, Tables 1, 2 highlight that there is no shortage of interventions designed based on strong theoretical underpinnings, and yet, these do not regularly produce the desired sustainability outcomes.

This led us to our second objective to present a systems-based approach to interventions in Figure 3, which hopefully will prompt the reader to see how interventions can and should layer on each other so that the (nested) system can be targeted as a whole. Finally, our third objective was to provide recommendations for interventions and future experimental designs to assist in the transition toward greater sustainability in tourism. In this review, we make four recommendations:

first, to be aware of the theories that can be applied but, second, not to be wedded to a single approach for solving the problem. Using meta-theories may help in bridging the specific aspects of a behavior with the dynamics of the system as a whole (our second recommendation). Instead, our third recommendation is to give greater consideration to the bigger picture, allowing more nuanced designs, including, for example, related to the origin of visitors that demands "the development of culture-specific interventions" (Liu et al., 2022, p. 1200). In conclusion, we recommend working as closely as possible with those who will implement the intervention, perhaps eschewing the desire for "novel" research to focus instead on action-oriented research.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Griffith University–Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

AC: Conceptualization, Funding acquisition, Methodology, Visualization, Writing—original draft. SB: Conceptualization, Funding acquisition, Writing—review & editing. SM: Visualization, Writing—review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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