



The Product User's Experience of Circular Economy Behaviors: An Interdisciplinary Delphi-Validated Model

Sahra Svensson-Hoglund¹  · M. Joseph Sirgy² · Jennifer D. Russell¹ · Vicki J. Little³ · Alexandra Ganglmair-Wooliscroft⁴ · Dave Webb^{5,6} · Ben Wooliscroft⁷ · Ahmet Ekici⁸ · Grace B. Yu⁹

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Abstract

Adoption of Circular Economy (CE) behaviors, such as repair and sharing, remains slow, often due to high costs, inconvenience, limited rewards, or social undesirability. Accelerating the sustainability transition requires that consumers, or product users, experience these behaviors as predominantly positive. To address the lack of a comprehensive framework for understanding such experiences, this paper introduces the Product User's Experience of CE Behaviors (PUxCEB) Model, developed for durable consumer goods (e.g., clothing and electronics). It is validated through an interdisciplinary Delphi study with two expert groups in CE and Sufficiency, and Consumer Studies and Macromarketing. The Model identifies eight experiential areas: effort, financial, functional, task immersion, aesthetics, social interaction, social status, and moral alignment. Within these areas, the Model captures potential frictions (e.g., costs) and rewards (e.g., gains). It further classifies contextual variables within the experience into four types: mediators (i.e., directly causing effects, such as social status rewards), moderators (i.e., amplifying or reducing effects), determinants (i.e., generating variables), and qualifiers (i.e., determining the salience of variables, based on socio-cultural meanings). The scientific contribution consists of how the Model separates and organizes variables, highlighting the importance of moderators, resource allocation (i.e., time, effort, and money), and the creation of synergies across the experiential areas. In practice, it provides policymakers, businesses, and community organizations with a holistic mapping tool for assessing current, and designing new, initiatives (e.g., policies and business offerings) in which rewards exceeds the frictions, thus ensuring positive experiences of CE behaviors. Directions for future research are proposed to refine the model.

Keywords Sustainable consumption · Mindful consumption · Responsible consumption · Circular economy · Consumer experience · Product user · Consumer durables

Extended author information available on the last page of the article

Introduction

The Circular Economy (CE) is introduced as an alternative to the linear, increasingly untenable, take-make-waste economic model [1]. A CE emphasizes sustainability and resource regeneration, notable in policies such as the European Union's "European Green Deal" [2, 3] and in the operations of corporations [4]. In a CE, consumers of durable products are viewed as "product users," given that such products at the end-of-use stage are retained in the economic system through primarily reuse, refurbishing, or recycling. In addition, some "CE behaviors" involve access without assuming ownership, such as sharing and renting. CE behaviors overlap with sustainable, responsible, and mindful consumption (see Section "Contextual Inputs"). Insights into the role of product users in a CE and their experience of CE behavior are under-researched [5–8], resulting in a limited understanding of how CE behaviors can be made to be positively experienced and perceived by product users. In this paper, we address this research gap by proposing and testing a model capturing the product user experience of CE behaviors. The model supports the creation of strategic interventions aimed at making CE Behaviors positively experienced, hence the prevailing choice and thus the standard practice.

Lacking Insights into the Product User Experience

Currently, research shows that CE behaviors generally entail higher costs, greater inconvenience, and increased effort compared to linear consumption models (e.g., [9–12]). Although this "sacrifice" may be offset by personal values, such as environmentalism and frugality (e.g., [13–15]), the result of such an approach is "a mediocre customer experience" [16], contributing to a slow CE transition [17, 18].

To achieve large-scale shifts in consumption behaviors and practices – thereby increasing both adoption rates and the political legitimacy of the CE transition – product users in the mainstream economy (i.e., not only niche contexts) must be persuaded that these societal changes do not reduce their quality of life [19]. Ideally, they should perceive that engaging in CE behaviors can even improve quality of life and deliver additional benefits [20, 21]. Specifically, individuals need to experience a sense of reward and positive emotion *in the moment* of performing CE behaviors [22]. This requires a shift from "have-to" goals – framed as obligations to act in environmentally friendly ways to prevent distant negative outcomes – to "want-to" goals, in which the behavior is intrinsically enjoyable and experienced as meaningful [22], p. 225). Positive emotions are particularly important for the adoption of CE behaviors [23] as positive experiences can draw product users into a "virtuous circle" that sustains participation in CE practices [24], p. 391). Conversely, negative experiences, such as inconvenience, stigma, or dissatisfaction, reduce the likelihood that individuals will sustain these behaviors over time [25]. Accordingly, there is a clear need to enhance the momentary experience of engaging in CE behaviors [22], see Fig. 1).

Although the creation of positive experiences of CE behaviors might seem straightforward, the decision-maker must reduce frictions (e.g., costs and frustrations) and increase rewards (e.g., financial value and enjoyment) (e.g., [26]). In actuality, it is not that straightforward. For instance, certain frictions are inevitable for CE behaviors to take place, such as sorting through underused belongings and considering passing them on at the end-of-use (e.g., [27]). Moreover, a certain degree of effort is required to experience a reward, such as

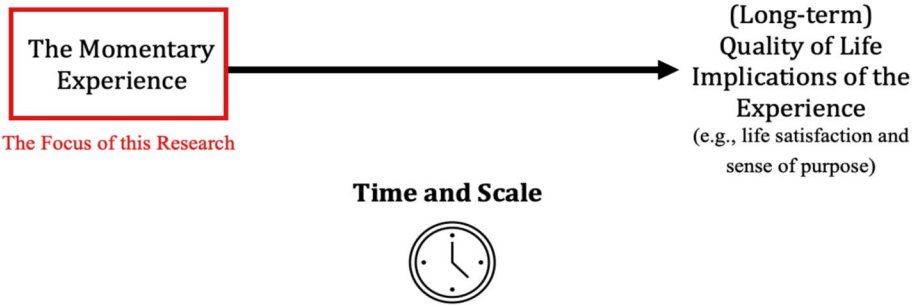


Fig. 1 The momentary outcomes (in Time and Scale) of engagement in CE behaviors

enjoyment from engaging in an activity (e.g., [28, 29]). As such, the goal should be to have reward(s) *exceed* any frictions encountered in the CE behaviors. Such a strategy requires a comprehensive view of the experience of CE behavior engagement [30, 31], which is missing in the literature.

CE behaviors entail a wide range of *activities* (e.g., joining a shared pool, conducting an inventory of already owned products, and performing repairs of broken ones) (e.g., [32]) and *contexts* (e.g., a commercial store versus a non-commercial do-it-yourself repair at the kitchen table or community bartering event). This richness cannot be adequately captured by existing models of consumption-related behavioral and short-term well-being outcomes (see Section "[The Consumption Experience](#)" for more details). In CE research, the social implications of a CE are under-researched [33, 34], including product users' roles [7, 32]. Existing research tend to take a narrow view, focusing on buying and usage, thus failing to capture product users' roles, such as value keepers and sharers [35], and the overall product user experience (e.g., [12]). Instead, research has focused on adoption (e.g., [36, 37]), which is not necessarily indicative of the quality of the experience of CE behaviors. As such, drivers of engagement in CE behaviors may fail to sustain participation if the experience proves negative (e.g., due to inconvenience or stigma) [25] (Section "[The Consumption Experience](#)"). Thus, to advance the sustainability transition, it is critical that the comprehensive experience of CE behaviors is better understood so that it can be enhanced.

Consumption experiences are composed of distinct dimensions or areas, such as functional and social (see Section "[Areas of the Consumption Experience \(Outputs\)](#)" for more details), which are key for understanding experiential outcomes, such as enjoyment and frustration in the moment, and the overall quality of the experience [31, 38]. However, a comprehensive model of such areas in the context of CE behaviors, and their frictions and rewards, is missing [31]. This limitation can hinder decision makers in the CE transition from ensuring that product users have predominantly positive experiences of CE behaviors.

Capturing the Product User's Experience in a Circular Economy

The goal of this paper is to conceptualize the experience of CE behaviors, specifically the impact of contextual factors on the product user's experience, to facilitate the development of strategies to make engagement more rewarding. This is accomplished by developing the Product User Experience of CE Behaviors (PUxCEB) Model for durable consumer products, such as clothing and electronics. This model introduces a novel, integrated, and sys-

tematically structured, experience-focused perspective for examining CE behaviors and the factors shaping product users' experience quality, rather than relying on product-oriented value models or unsystematic lists of "barriers and drivers" common in prior work.

In developing this Model, we borrow from the theoretical rationale related to the Consumption Experience Model [39], thus dividing the PUXCEB Model into "inputs" (i.e., the conditions of CE behaviors) and "outputs" (i.e., areas of the engagement and the frictions and rewards in these respective areas), with inputs giving rise to the outputs (Fig. 2; see also Fig. 1).

In this paper, the areas (i.e., elements, dimensions, or aspects) of the CE behavior experience are distinguished from longer-term well-being outcomes, such as "life changing" effects (cf. [42], see Fig. 1). Svensson-Hoglund et al. [31] propose that before the longer term well-being implications ("outcome", Fig. 2) can be understood, the momentary experience should be mapped. This involves the identification of relevant areas of the CE behavior experience, where both friction and reward occur, and examining which specific conditions (e.g., product features or sharing activities) give rise to these responses. As such, the focus of this paper is on the outputs and inputs in the momentary CE behavior experience (see Figs. 1 and 2).

The relevant inputs (i.e., system components), such as the product design and the product user's personal values, reside at both the external, or contextual, environment of the product user, as well as internally within the individual – thus pertaining to two separate but interrelated system levels – making the PUXCEB Model multileveled (e.g., [43–45]) (see Section "Multilevel Concepts of the Consumption Experience (Inputs)"). Thus, we use a recently developed modeling method (Section "Method"). The PUXCEB model was first developed, and subsequently tested using two expert groups: (1) CE & Sufficiency, and; (2) Consumer Studies & Macromarketing.

Given the objective of facilitating the CE transition, the PUXCEB Model prioritizes external contextual components (e.g., infrastructure, product design, and marketing strategies) as these are directly controlled by decision-makers. To this end, the model's internal components (e.g., personal values and knowledge) are treated as fully derived from these external conditions (e.g., social norms and accessible information and/or training) (see Section "Internal Inputs"). As such, individual differences are excluded from the model's current scope, as well as reciprocal determinism (i.e., feedback loops) [46], given how bidirectional models complicate interventions. These simplifications are aligned with the premise of the Consumption Experience Model [39] (see Section "The Consumption Experience") which guides the rationale of the PUXCEB model. Foremost, these simplifications are designed to ensure analytical manageability while establishing a foundational model.

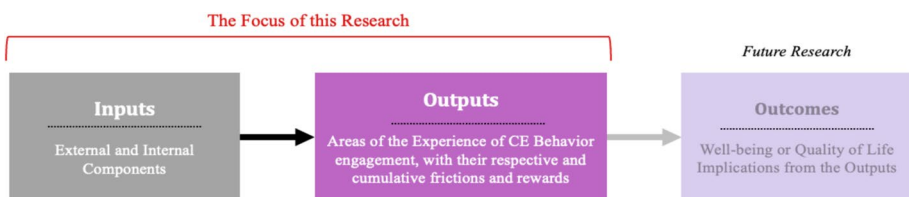


Fig. 2 The *Inputs* (i.e., relevant contextual system components influencing the quality of the experience) and *Outputs* (i.e., areas of the experience and their individual and combined frictions and rewards, determining the quality of the experience) are explored in this paper. The more long-term *Outcomes* (i.e., well-being implications) are delimited (adapted from [40, 41])

In line with the PUxCEB Model's aim to capture the experiential qualities of CE behaviors, linear consumption patterns (i.e., take–make–waste) are deliberately excluded from the model. Including linear options would shift the focus from analyzing how CE behaviors are experienced to modeling choices between CE and linear modes of consumption. The model, therefore, treats CE behaviors as the only consumption mode under consideration, to enable an in-depth analysis of their experiential qualities.

The paper is structured as follows. In Section "[Background](#)", a background is provided on the experience of consumption and CE behaviors, including existing models and literature relating to the same. The modeling method is outlined in Section "[Method](#)", followed by the presentation of the final PUxCEB Model in Section "[The PUxCEB Model](#)". In Section "[Main Delphi Survey Results & Analysis](#)", the results from the Delphi surveys are outlined and discussed, including their feedback on the Model's usefulness and limitations. In Section "[Discussion](#)", we discuss the PUxCEB Model's implications of ensuring a positive CE behavior experience. We conclude in Section "[Concluding Remarks](#)" by outlining the scientific contributions, practical implications, and avenues for future research.

Background

The Consumption Experience

A plethora of models and theories for predicting consumer intentions, decisions, and behaviors exist (e.g., [47–51]). They seek to identify determinants of *engagement or behaviors*, meaning what prompts initial or repeated engagement, such as environmental values or external conditions (e.g., [52–56]). In contrast, determinants of *the consumption experience* concern the real-time quality (i.e., positive or negative) during the act itself, influenced by factors, such as convenience, stigma, sensory appeal, or emotional rewards (e.g., [57, 58]), and do not necessarily align with the determinants of engagement [25]. This distinction arises because consumption intentions may be formed, and behaviors undertaken, out of habit, situational constraints, or unrealized expectations (Jackson 48), with negative experiences leading to dissatisfaction that erodes long-term participation. As such, studying the experience of CE behaviors – beyond engagement – is essential to ensure sustained adoption [22, 25].

In consumer studies, the “consumption experience” constitutes “... a subjective episode that customers live through when they interact with [...] products and services” [59] p. 38 and the external environment. The experience involves thoughts, values, emotions, and activities [57]. Our model uses the concept of inputs-responses-outputs, based on the stimulus-organism-response approach [60], from the Consumption Experience Model [57, 58]. Contextual factors (i.e., *inputs*), such as advertising or setup of a store, give rise to certain short-term *responses* (e.g., thoughts, feelings, and actions). These responses, in turn, lead to slightly more long-term *outputs*, representing the overall cognitive assessments of the experience and the values derived, such as pleasure, social, or functional [39, 57, 61, 62]. While the application of the Consumption Experience Model to studies of well-being outcomes has been encouraged [39, 61, 63], such applications are actually missing. Instead, the Consumption Experience Model and similar concepts have largely been used to predict

commercial consequences of experiences, such as brand endorsement and purchase intention [61, 64, 65].

In the macromarketing literature, the concept of “consumer well-being” links conditions of consumption engagement and life satisfaction, including satisfaction with the experience itself [66, 67]. However, the concept and related models do not capture the areas (i.e., elements or dimensions) of the wider consumption experience in which frictions and rewards may arise (i.e., outputs, Fig. 2) [31].

The distinction between Inputs (i.e., contextual factors, such as product design and information access) and Outputs (i.e., the resultant frictions or rewards experienced during the engagement) enables precise identification of how specific contextual elements shape positive or negative experiences. As such, it is vital for developing targeted strategies to improve the experiential quality of CE behaviors. Camacho-Otero et al.’s [68] systematic review underscores this by outlining seven interconnected factors influencing consumer acceptance of CE behaviors: personal characteristics, product and service attributes; knowledge and understanding; experiential and social aspects; perceptions of risk and uncertainty; perceived benefits; and psychological factors. This blend of drivers (i.e., inputs; Fig. 2) and experiential areas (i.e., outputs; Fig. 2) makes the identification of actionable guidance from the study findings rather challenging (c.f. Sections “[Main Delphi Survey Results & Analysis](#)” and “[Discussion](#)”).

Below, we summarize the literature on outputs (i.e., areas of the PUxCEB Model) and inputs (i.e., as components of the PUxCEB Model).

Areas of the Consumption Experience (Outputs)

The traditional consumer experience consists of both material and experiential elements; buying a watch involves the price and function, considered to be “material,” as well as the “aesthetics,” considered to be “experiential” [29] (see also [69] on the service dominant logic). Specifically, consumption experiences are thought to consist of five dimensions: (1) sensory, (2) affective; (3) cognitive; (4) behavioral, and (5) social [58], c.f. [38]. These dimensions have been applied to some CE behaviors, such as reuse and products made of recycled materials (e.g., [12]). Similarly, in consumer studies, it is common to discuss values derived from products, such as functional (i.e., utilitarian purposes), social (i.e., image and status), emotional (i.e., positive and negative), epistemic (i.e., learning), and conditional (i.e., depending on the specific set of circumstances) [70], c.f. [71]. Other proposed sets of value dimensions may include: emotional, social, functional value linked to price, and functional value linked to product quality and performance [72]. Moreover, in terms of product users’ motivation to engage in second-hand shopping, a study by Machado et al., [24] construed values in terms of three dimensions: critical (i.e., environmentally consciousness); economic (i.e., getting higher quality at a lower price), and; hedonic/recreational (e.g., the “treasure hunt” – finding unique items and forming social relationships with people, such as with store employees). However, these dimensions are convoluted and product-focused and don’t fully account for the experiential, or activity-related, aspects of the CE behaviors, such as swapping clothes [73], being part of a consumer collective [74], engaging in repair [75], and buying reused fashion goods [76].

The activities-centered concept of leisure well-being suggests that activities involved in leisure entails the satisfaction of a set of basic needs (i.e., benefits related to safety, health,

economic, sensory, escape, and/or sensation/stimulation needs) and growth needs (i.e., benefits related to symbolic, aesthetic, moral, mastery, relatedness, and/or distinctiveness needs) [77]. This needs-based framework has not been applied to consumption and is used in this paper to capture areas of the CE behavior experience.

Multilevel Concepts of the Consumption Experience (Inputs)

Any consumption experience consists of both an objective reality that is subjectively experienced [57], meaning that inputs (Fig. 2) can be both contextual, or external, to the product user, as well as internal. Internal factors are often conceptualized as embedded in contextual factors, making the experience multileveled (e.g., [78], p. 706 [45]).

Contextual Inputs

To understand the contextual factors in the experience of CE behaviors, it is helpful to contextualize these behaviors along a multi-stage process (e.g., [79]) (Fig. 3).

The process starts with “problem identification,” at which stage the product user identifies a need or want for a product, and ends with “end-of-use” when the product is disposed. As captured in Fig. 3, CE behaviors apply differently to these process stages and can be organized under three pathways: Reduce (e.g., practicing voluntary simplicity); Own (e.g., buying reused or refurbished goods); and Access (i.e., rent or share) (Fig. 3). As outlined in Fig. 3, there are many interconnections between CE behaviors and sustainable, mind-

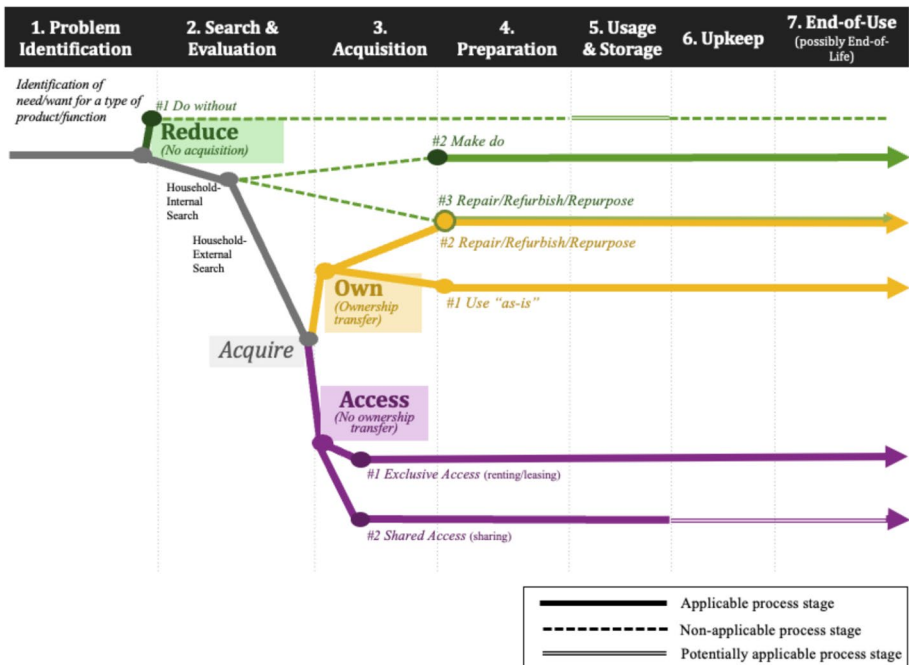


Fig. 3 The CE behavior process framework depicts how the different CE behaviors are applicable across seven process stages in three distinct pathways (Reduce-Own-Access) (Adapted from [80]). See Supplementary File A, for the framework development method

ful, and responsible consumption as these concepts collectively underpin efforts to combat overconsumption and foster harmonious coexistence between humanity and the planet (e.g., [32, 81–83]).

Although research on the consumption experience traditionally focuses on commercial acquisition (i.e., involving a commercial provider), it is widely acknowledged that the experience also includes non-commercial value exchanges, such as bartering products and services among friends, in addition to non-commercial non-value exchanges, such as usage and disposal [29, 84], which is highly relevant to CE behaviors (Fig. 3).

Other insights about the contexts of CE behaviors can be gained from research on what is needed for CE behaviors to be possible to execute, such as the product, settings, and capabilities [31]. Factors determining engagement include environmental concerns, trust, and perceived utility [85]. Also, contextual conditions in the CE Behavior Process (Fig. 3 identified as important for well-being outcomes, including affective outcomes in the moment, consist of: monetary and non-monetary costs; physical layout and atmospherics; platforms and communities [31].

Internal Inputs

Internal factors within individual product users play a crucial role in shaping how they perceive and find meaning in their engagement with CE behaviors. A literature review on well-being outcomes from CE behaviors identified several key internal conditions that significantly influence said experience: knowledge, skills, and empowerment; psychological ownership; habits; consumption desires; values and motivation; and motives [86]. The individual's *value set* impacts what the individual considers desirable compared to alternatives [57, 87, 88]. *Motivation* is linked to both beliefs and values as it defines the desired end state the individual seeks to bring about, and thereby the expectations driving the behavior [57], p. 220f). Motivation can consist of, for example, seeking uniqueness and variety [89].

In the PUXCEB Model, internal conditions are treated as derived from external conditions due to the focus on discerning the impact of contextual factors on the product user's experience of CE Behaviors (Section "[Capturing the Product User's Experience in a Circular Economy](#)"). To this end, social norms and values shape what the individual considers to be acceptable, desirable, and prestigious [90, 91] through a process of internalization, learning, and conditioning [92–94]. Similarly, preferences are "learned" (i.e., socio-culturally specific to a certain environment, such as the desired size of a diamond), in addition to being "inherent" (i.e., a product of evolution, such as a preference for room temperature above a certain degree) [95].

On the note of how individual factors are derived from external ones, the product user's *knowledge, skills and awareness* come from external resources, such as available educational materials, training, and information [57].

The findings described in this Section "[Background](#)" were used to develop the PUXCEB Model, as outlined below in Section "[Method](#)".

Method

In this section, we first provide an overview of the research process (Section "[An Overview of the Research Process](#)"), followed by more detail on the model development (Section "[Developing the PUXCEB Model](#)") and testing (Section "[Validation & Refinement Through Interdisciplinary Delphi Surveys](#)").

An Overview of the Research Process

The PUXCEB Model was developed and tested in six stages (Fig. 4).

Comprehensive details regarding our complete method (Fig. 4), based on a recently developed multilevel system modeling method, are provided in the Supplementary File A.

Developing the PUXCEB Model

The structural logic of the PUXCEB Model was defined (see Section "[The Foundational Logic of the PUXCEB Model](#)" for results), followed by the identification of areas of the CE behavior experience (Stage 3.a; Fig. 4), based on the literature (Section "[Areas of the Consumption Experience \(Outputs\)](#)"). To ensure that the areas were relevant and complete, they were tested against the CE Behavior Process Framework (Fig. 3). In the next stage (3.b; Fig. 4), the CE Behavior Process Framework was also used to explore each Area in terms of its elements (i.e., tangible/objective vs. intangible/subjective) and frictions and rewards.

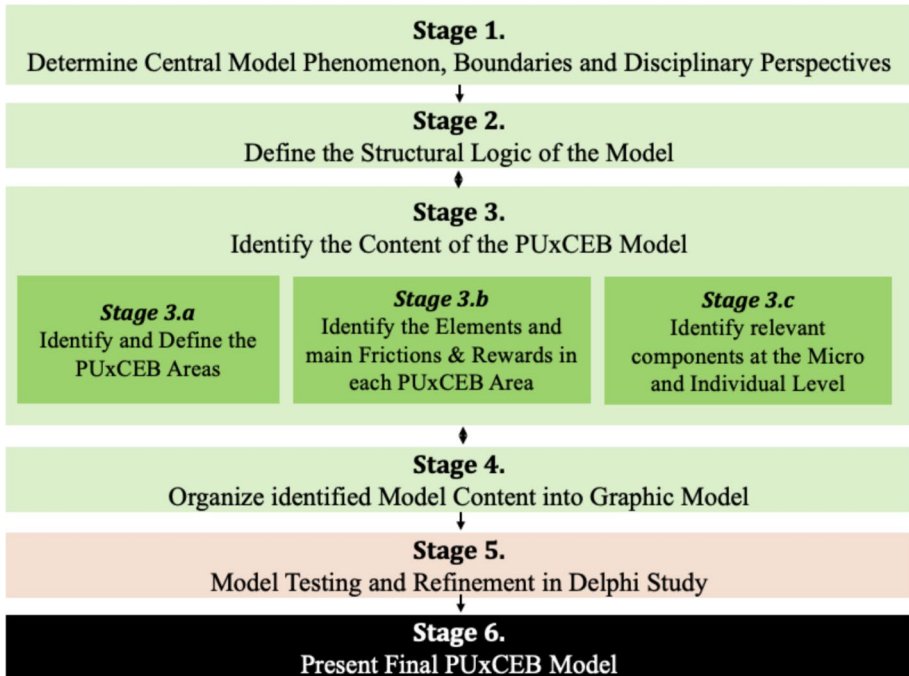


Fig. 4 The PUXCEB Model development process with conceptual development stages in green and testing and refinement stage in orange

Additionally, the outcomes of stages 3.a and 3.b (Fig. 4) were used to identify the model components (Stage 3.c; Fig. 4), complementary to the literature on inputs (Section "Multi-level Concepts of the Consumption Experience (Inputs)"). As indicated, stages 3.a-c were conducted in parallel in an iterative process (Fig. 4), resulting in eight PUXCEB tables, one for each area (see Supplementary File B for the results). Once finalized, the eight PUXCEB tables were combined into one graphic model (Stage 4; Fig. 4). This meant that input components (identified as mediators, moderators, determinants, and qualifiers; see Section "The Foundational Logic of the PUXCEB Model" for more details) across the eight tables were synthesized into one set of model components.

Validation & Refinement Through Interdisciplinary Delphi Surveys

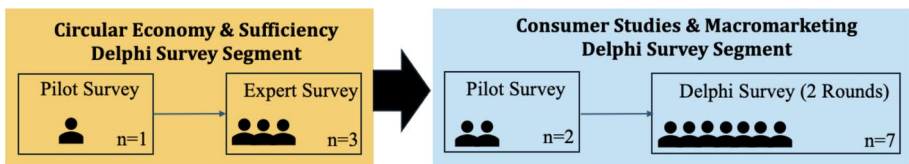
Two expert groups participated in a total of five survey rounds to test and refine the PUXCEB Model and the accompanying eight tables (Stage 5; Fig. 4), divided into two segments (Fig. 5).

To facilitate the experts' participation, the Model was explained in a video format. Also, the participants were invited to co-author the manuscript, resulting in a manuscript-draft feedback mechanism that resembles a process of "peer check" [96].

In the first segment (Fig. 5), four CE experts in total assessed the Model and eight tables (one pilot and one regular survey round). Due to high levels of agreement and no significant revisions, a second round was deemed unnecessary. Next, after minor revisions, the PUXCEB Model and tables were presented in a two-round survey to a group of nine scholars in consumer studies and macromarketing, preceded by a pilot (Fig. 5).

Across segments, the experts were asked to rate their level of agreement, provide general comments, and make tracked edits to the eight tables. They were also asked to share any insights prompted by the Model and tables, as well as thoughts on anticipated usefulness. The core task of the two expert groups was to provide critical feedback on the overall intuitiveness of the Model (Fig. 7) and its accompanying tables (see Supplementary File B), as well as on the level of detail.

Acceptance rates were conservatively calculated as average acceptance, measured between 1 and 7, with "7" being fully agreeing and "1" fully disagreeing. General and specific feedback from experts was coded and characterized into three categories: clarifications, remedies, or changes. Feedback was categorized as *clarification* if it consisted of suggested alterations that would increase understanding of the Model. Clarifications were incorporated into the Model unless they added significant details, in which case Delphi participants were asked to vote in the subsequent review round. Feedback was categorized as a *remedy* if it consisted of suggested alterations that would serve to address an omission or misrepre-



N = 13

Fig. 5 The two segments of the delphi survey study

sentation. Remedies were always incorporated. Lastly, feedback was treated as a *change* if it included suggestions to alter the Framework's main idea (e.g., add a component or area). These changes, if suggested by >50% of participants, were automatically incorporated into the revised Framework; changes suggested by >25% of participants went to a Delphi participant vote in the subsequent round, and were decided by majority vote.

For more details on the Delphi study, including the expert selection process, refer to Supplementary File A, Section "[The PUxCEB Model](#)".

The final PUxCEB Model is presented in Section "[The PUxCEB Model](#)", while the findings from the Delphi surveys are outlined and analyzed in Section "[Main Delphi Survey Results & Analysis](#)". The resulting eight PUxCEB tables on which the Model (Fig. 7) is based can be found in the Supplementary File B.

The PUxCEB Model

The theoretical rationale of the Model is described in Section "[The Foundational Logic of the PUxCEB Model](#)", as presented to the Delphi participants. The final PUxCEB Model is presented in Section "[The PUxCEB Model](#)".

The Foundational Logic of the PUxCEB Model

The PUxCEB Model is built on the critical realism or “subjective-interactionist” perspective, which acknowledges a physical reality that is subjectively interpreted, thereby shaping the consumer experience [57, 97]. Drawing from the Consumption Experience Model (see Fig. 2), the PUxCEB Model consists of two sets of variables: Outputs (Section "[The Outputs of the PUxCEB Model](#)") and Inputs (Section "[The Inputs of the PUxCEB Model](#)") as presented below, based on the background literature review in Section "[Background](#)". Next, we outline the variable types related to Inputs (Section "[The Inputs as Different Variable Types](#)").

The Outputs of the PUxCEB Model

The PUxCEB Model outputs consist of the eight areas of the experience (e.g., financial and status), their respective elements (i.e., tangible/objective and intangible/subjective), frictions (i.e., costs, losses, and risks), and rewards (i.e., benefits and gains), such as effort or attaining social status (Table 1).

The rewards and frictions the product user may encounter in the CE Behavior Process (Fig. 3) pertains to eight PUxCEB Areas: (1) *Effort* – cognitive and behavioral exertion and time that the CE Behavior require; (2) *Financial* – monetary out- and inputs; (3) *Functional* – functionality and safety of the product; (4) *Task* – immersion into task performance, or experience of a “flow” state; (5) *Aesthetics* – sensory inputs and hygiene; (6) *Social* – opportunities to socialize; (7) (Social) *Status* among peers; and (8) *Moral* alignment – perception of right or wrong (Table 1). The cumulatively experienced rewards and friction across these areas determine whether the experience is predominantly positive or negative [39, 57, 62], which can be likened to scale tipping in favor of one side.

Table 1 The product user experience of CE behavior (PUxCEB) model areas, and their respective elements, frictions, and rewards

Product user experience of CE behavior (PUxCEB) area	Outputs Elements (Tangible/Intangible and objective/ subjective)	Frictions & Rewards
Effort (i.e., cognitive/mental, emotional, and physical exertion and time)	The actual extent of effort in the CE behavior process (Fig. 3) (<i>intangible; objective</i>)	Friction: Effort ^a <i>For the benefits from Effort, see the Rewards in the Financial, Functional Task, Aesthetics, Social, Status, and Moral Areas</i>
Financial (i.e., monetary resources)	The actual amount of monetary resources required and/or earned in the CE behavior process (Fig. 3) (<i>tangible; objective</i>)	Friction: Monetary outflow and risk(s) thereof <i>For the benefits from monetary out-flow, see the Rewards in Functional, Task, Aesthetics, Social, Status, and Moral</i> Reward: Monetary inflow
Functional (i.e., product functionality)	The actual functionality (i.e., function, durability, reliability, and safety) is derived from the product (<i>tangible; objective</i>) The level of trust in the product's performance (i.e., the product user's confidence in the product's performance) (<i>intangible; subjective</i>) The meaning of "sufficient" functionality (e.g., degree of tolerance for short battery time) (<i>intangible; subjective</i>)	Friction: Low or no functionality derived Reward: Functionality derived Friction: Uncertainty regarding product functionality (i.e., risk) Reward: Certainty regarding product functionality Friction: Tangible functionality is inferior to the standard Reward: Tangible functionality is at, or above, the standard for functionality
Task (i.e., immersion in task, or experienced flow state)	The actual degree of task difficulty (<i>intangible; objective</i>) The degree of task interest (<i>intangible; subjective</i>)	Friction: Absence of task immersion (i.e., task is either too difficult or too easy, and interest is low) Reward: Presence of task immersion (i.e., task is challenging, but manageable, and interest is high)
Aesthetics (i.e., sensory impact and hygiene/cleanliness)	The meaning of pleasing vs. displeasing aesthetics (<i>intangible; subjective</i>) The actual presence of salient features of aesthetics in the CE behavior process (Fig. 3) (e.g., smell and lights in a store or product color and form/shape) (<i>tangible; objective</i>)	Friction: Disapproval of the aesthetics Reward: Approval of the aesthetics
Social (i.e., socialization to form new and sustain old connections and relationships)	The actual opportunities for socialization in the CE behavior process (Fig. 3) (<i>tangible; objective</i>) <i>*The intangible level of enjoyment of said opportunities is considered too complex to be included</i>	Neutral: No socialization opportunities awarded Reward: Socialization opportunities awarded

Table 1 (continued)

Product user experience of CE behavior (PUxCEB) area	Outputs	
	Elements (Tangible/Intangible and objective/subjective)	Frictions & Rewards
Status (i.e., rank or position in social hierarchy in peer groups, family, and communities, impacting social capital and determining the social response the individual receives (i.e., acceptance/appreciation vs. rejection)	The meaning or attributes and importance of “status” (i.e., <i>what</i> is relevant for status and what is considered low vs. high status, and <i>how much</i> that matters) (<i>intangible; subjective</i>)	Friction: Lack of, or low, status (i.e., lower social capital and higher social rejection) Reward: (at least some degree of) status (i.e., higher social capital and social acceptance/appreciation)
	The actual presence of salient features of status in the CE behavior process (Fig. 3) (<i>tangible; objective</i>)	
Morality (i.e., “right or wrong”)	The meaning/attributes, and importance, of “morality” (i.e., <i>what</i> is considered moral vs. immoral vs. amoral, and how much that matters) (<i>intangible; subjective</i>)	Friction: Moral misalignment (i.e., acting against moral values) Reward: Moral alignment (i.e., acting in accordance with moral values)
	The actual presence of salient features of morality in the CE behavior process (Fig. 3) (<i>tangible; objective</i>)	

^aEffort can be positive, but that is primarily in relation to the reward, such as waiting for a delivery of product for a specific purpose (i.e., function, aesthetics, or status). We discuss this more in Section “The Interrelationships among the PUxCEB areas”

The Inputs of the PUxCEB Model

The occurrence and size of the rewards and frictions in each PUxCEB Area (Table 1) are influenced by various system components – the PUxCEB Model inputs. These are the conditions of the CE behavior experience, divided into external (i.e., the contextual conditions of the environment faced by the product user) and internal (e.g., the individual’s values, internalized from the contextual sociocultural conditions). In the PUxCEB Model, inputs are referred to as “components” of the CE behavior experience model and are either *tangible* (i.e., objective, or “significant”), such as features of the physical environment, or *intangible* (i.e., subjective, or “sign”), such as the nature of social norms and values and knowledge (see [57], p. 223).

The PUxCEB Model is multileveled. The external components are located at the micro system level (i.e., the external context of the individual) and consist of: (1) *The Product* – its functionality, design, conditions, and brand, etc.; (2) *Outer Capabilities* – enabling technology (e.g., app for searching for used items for sale and refurbishment provider directories), transportation options (e.g., access to a car or public transportation, necessities (e.g., maintenance tools and repair manuals), and information and training (e.g., pamphlets or courses); (3) (physical) *Settings* – stores and other physical places; (4) *Activities* – such as searching and cleaning, (5) *Finances* – monetary outflow and inflow; and (6) *Social Norms & Values* – in social contexts.

Components internal to the individual are located at the individual system and consist of: (1) *Inner Capabilities* – the knowledge and skills of the individual; (2) *Values, Motivation,*

and Preferences; and (3) Trust. These are all derived from (external) micro-level components (Fig. 7).

The Inputs as Different Variable Types

The outputs of a CE behavior experience (i.e., results in each individual PU \times CEB area and their cumulative configuration) arise through configurations of interrelated components, commonly referred to as a “variable chain” [98], p. 4). In this context, the CE behavior constitutes the independent variable, whereas the output represents the dependent variable (Fig. 6).

To explain how the independent variable produces its effects on the dependent variable, a set of intervening variables must be considered, namely mediators, moderators, determinants [31, 99, 100], and qualifiers (Fig. 6).

These intervening variables constitute the components at the micro- and individual-system levels (i.e., inputs) in the PU \times CEB Model (Fig. 7).

Using the PU \times CEB area of effort (i.e., the physical, behavioral, and cognitive exertion and time a CE behavior entails) as an example, the effort output from a CE behavior is *mediated* (i.e., brought about) by the specific activities involved in that behavior (e.g., searching for a product rental or cleaning a piece of furniture before a resale). In mediation terms, these activities lie on the causal pathway from CE behavior to effort; the CE behavior(s) influence which, and how many, activities are required, and these activities, in turn, generate the effort output. Thus, the mediator is the intervening mechanism that transmits the effect of the independent variable to the dependent variable (Fig. 6).

The presence of *moderators*, in turn, shapes the magnitude and/or direction of the effect of CE behaviors on the output(s). In the case of effort, moderators influence how strongly the CE behavior translates into effort (e.g., how much time the product user must invest in performing a required activity). The time required to perform an activity, such as locating a rental product, depends on the availability and quality of external capabilities, such as enabling technologies (e.g., websites listing rental products, their features, and availability dates) (see [57]). In addition, the required time is influenced by the product user’s internal capabilities—their knowledge and skills regarding where, and how, to search. The pres-

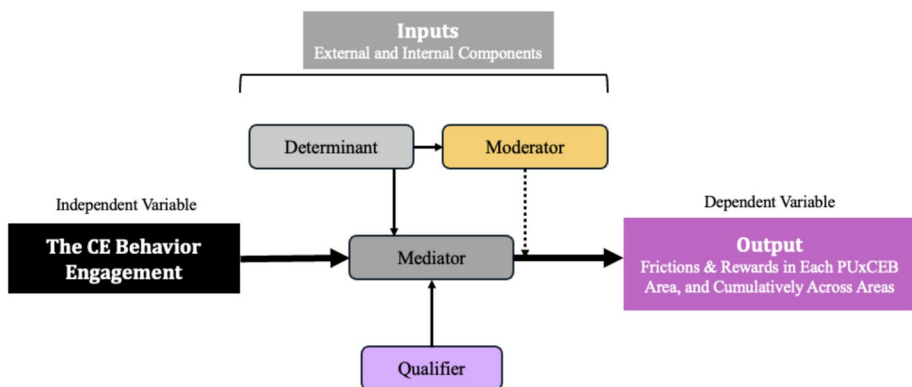


Fig. 6 The four categories of (Input) components influencing how the CE behaviors impact the Output of the experience (i.e., whether it is predominantly positive or negative) (Adapted from [57, 99, 100])

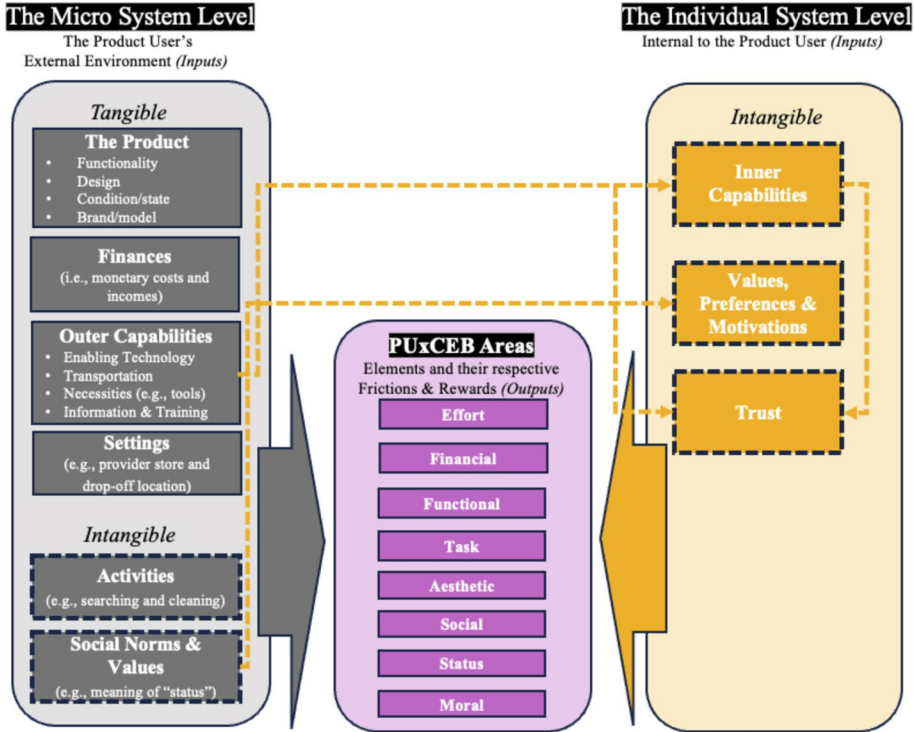


Fig. 7 The product user experience of CE behaviors (PUxCEB) model

ence (or absence) and quality of these moderating components (i.e., enabling technology and internal capabilities) can increase or decrease the extent and type of effort needed to engage in CE behavior. These moderating variables do not lie on the causal path from CE behavior to effort, rather, they specify under which conditions a given CE behavior, namely the activities herein (i.e., the mediator), is more or less effortful. Accordingly, moderators are modeled as variables that interact with the independent variable, thereby changing the strength of the effect on the dependent variable (Fig. 6).

Some model components (i.e., inputs) are intangible, or subjective (i.e., non-material), such as moral values. Although such variables do not change the objective amount of behavioral effort, they can moderate the subjective, or perceived, experience of effort. For instance, value alignment can make the effort feel less burdensome (i.e., resulting in a perceived reduction in friction) and, when values are strongly aligned, may even lead the effort to be experienced as positive [13, 101, 102]. Intangible conditions may thus have a subjective moderating effect, either positive or negative, depending on the individual's values. This suggests potentially compensatory relationships among PUXCEB areas, which are discussed further in Section "The Interrelationships among the PUXCEB Areas".

Components at the individual system level (i.e., internal inputs) are all intangible (i.e., values, preferences, motivations, and trust), yet they are shaped by both tangible and intangible components located at the external micro level. These external influences are referred to as *determinants*, in the sense of antecedent variables that give rise to mediators and mod-

erators, rather than directly intervening in the focal causal relationship. As for determinants of moderators, continuing the example of effort in the context of searching for a rental product, the product user's internal capabilities regarding where and how to search (i.e., a moderator of effort) are determined by the available external capabilities in the form of information that feeds into the individual's knowledge (see [57]). Similarly, in the PUXCEB model, the individual's internal, or personal, "values, motivations, and preferences" are considered derived from, or determined by, contextual social norms and values. As such, determinants shape the level, or degree, and content of mediators and moderators (e.g., the degree of knowledge or the type of personal values), but are not themselves modeled as moderators unless they directly impact the effect of the CE behavior on the output in question (Fig. 6).

Mediators (i.e., direct causes of the output) can also have determinants (Fig. 6). For example, in the PUXCEB area of social status, the status output (i.e., the degree of status in the eyes of peers) may be mediated by the individual's internal capabilities, such as being a skilled repairer or having extensive knowledge of reputable product providers. Such capabilities can lead others to seek out this product user for help and advice. The nature and extent of these internal capabilities are, in turn, determined by the external capabilities available to the individual (e.g., access to training and information platforms) that allow them to acquire and refine their knowledge and skills, thereby further enhancing their social status in their community or peer group. As such, outer capabilities give rise to internal capabilities, while the resulting internal capabilities produce the status output from CE behaviors. In the context of determinants, it should be noted that variables, such as infrastructural policies, business operations, economic principles, and ideologies, constitute higher system-level determinants (e.g., [31]). However, this model is limited to the micro level (i.e., what is directly experienced by the product user) (Section "Capturing the Product User's Experience in a Circular Economy").

Lastly, what we refer to as *qualifiers* (Fig. 6) influence which mediator(s) are relevant for a given outcome in a particular context. Returning to social status, a product user's skill set may serve as the mediator linking CE behavior to status, as prevailing social norms and values defining skills as status-relevant. In another context where monetary wealth is the dominant status signal, the brand or model of the product (e.g., owning the "right" versus "wrong" product) may instead function as the mediator between CE behavior and status. Qualifiers determine what is considered status-enhancing, moral, or aesthetically pleasing (i.e., the meaning of these concepts) and how this meaning becomes relevant in CE behaviors (i.e., which parts of the process in Fig. 3 are pertinent to these concepts). Qualifiers thus determine which construct occupies the mediating role in the causal pathway from CE behavior to the status outcome. In addition, Qualifiers may also moderate the extent to which the mediator it qualifies affects the output, such as whether certain skills are strongly or only weakly translated into social status.

Conceptually, qualifiers are distinct from determinants. While determinants shape the extent and/or content of mediators and moderators (e.g., how much information is available, which in turn affects knowledge), qualifiers specify which variable assumes the mediating role in the relationship between the independent and dependent variables. Qualifiers may also act as moderators when they influence how consequential that mediator is for the relationship (i.e., governing effect size).

The PUxCEB Model

The focus of the PUxCEB Model is on conditions applicable to Europe and the US, related to durable consumer products (e.g., clothing, electronics, furniture, and appliances). Moreover, the Model depicts product users' experience of the CE Behavior Process (Fig. 3), not in competition with linear consumption patterns. The Model captures the content of the CE behavior experience, *not* product user decisions or behaviors. It constitutes a conceptual framework for understanding said experience, and, to a certain degree, an assessment or diagnostic tool (see Section "[Practical and Academic Applications of the PUxCEB Model](#)" for more on Model applications). For simplicity, individual differences, such as personality traits, preferences, and motivations, are disregarded, as well as differences in abilities and access (i.e., wealth and time availability), as described in Section "[Capturing the Product User's Experience in a Circular Economy](#)". Instead, all the individual level components in the PUxCEB Model are considered to be fully derived from external level components; an example is how trust is determined by outer capabilities (e.g., product warranty and information to base assessments on) and inner capabilities (e.g., knowledge on how to assess product quality, which in turn is determined by external resources, such as training) (Fig. 7). The strong influence of external variables, such as availability and norms, has been established in consumer studies (e.g., [103]).

The PUxCEB Model is built from Tables 1–8, one for each of the eight PUxCEB Model areas, in Supplementary File B. While the PUxCEB Model does not distinguish between the components' variable type (i.e., mediator, moderator, determinant, and qualifier; Fig. 6), the PUxCEB Area Tables capture how the (input) components take on varying variable types in each PUxCEB Area. For example, while tangible components are more relevant in the Effort and Financial Area (Tables 1 and 2 in Supplementary File B), intangible components and qualifiers play a prominent role in the Status and Moral Areas (Tables 7 and 8 in Supplementary File B).

Below, we outline the main feedback from the Delphi participants regarding the PUxCEB Model (Fig. 7) and the eight Area Tables 1–8.

Main Delphi Survey Results & Analysis

The 13 experts largely agreed with the accuracy and credibility of the PUxCEB Model (Fig. 7) and Tables (Supplementary File B). The average agreement was 85.7% across the two expert groups.

Below, we present the main remedies (i.e., corrections) and clarifications implemented according to the experts' feedback across the two expert groups (Section "[Alterations to the Model](#)"). No feedback amounted to a change (i.e., to the main idea of the Model; see Section "[Validation & Refinement Through Interdisciplinary Delphi Surveys](#)"). The experts' thoughts on insights generated from the Model, its usefulness, and limitations are summarized in Section "[Insights, Usefulness, and Limitations of the PUxCEB Model](#)". Herein, experts in Circular Economy and Sufficiency are denoted as "CE&S" experts, while experts in consumer studies and macromarketing are referred to as "CS&M" experts.

Alterations to the Model

Remedies

Six main remedies were implemented to correct mistakes and omissions pointed out by the experts:

- Effort Area (Table 1 in Supplementary File B): “Emotional and/or mental” was added to the definition of effort.
- Effort, Financial, Functional, and Task Areas (Tables 1, 2, 3, and 4; Supplementary File B): Outer capabilities, such as access to training and information, were explicitly added as a determinant of “Inner Capabilities” across all relevant PUxCEB areas.
- Functional Area (Table 3 in Supplementary File B): The micro and individual level moderators of “Trust” were considered determinants, as these components (according to the simplification of the model) completely make up the individual's internal trust (as with values, motivations, preferences, and inner capabilities). This was also reflected in the Figure of the PUxCEB Model (Fig. 7) by adding arrows from both outer and inner capabilities to trust, denoting how these components are determinants of trust.
- Functional Area (Table 3 in Supplementary File B): Inner capabilities were added as an individual level moderator to the Functional Area's element 1 to capture how proper product usage and preventative product maintenance play an important role in the functionality derived from a product.
- Aesthetics area (Table 6 in Supplementary File B): The individual level “Value, Preferences, and Motivation” was moved from the tangible elements to the intangible (i.e., moved to a different row).
- Morality Area (Table 8 in Supplementary File B): The individual level “Value, Preferences and Motivation” was moved from the micro levels to the individual level (i.e., moved to a different column).

Clarifications

Following voting in round 2 of segment 2 (Fig. 5), “Motivations and Preferences” were added to “Value” due to five participants' comments on how values do not cover these concepts (four voted in favor of this clarification and three declined). However, the comments were rather conflicted, with hesitation largely stemming from how “... [values, preferences and motivation] could then be extended to other psychological constructs...” (CS&M expert).

The main clarifications implemented consisted of:

- Effort Area (Table 1 in Supplementary File B): A footnote was included, stating that while effort can have a positive impact, reward is related to the other areas, such as receiving a delivery of a product for a specific purpose (i.e., Functional, Aesthetics and/or Status).
- Financial Area (Table 2 in Supplementary File B): Added the risk of monetary loss as a possible friction.
- Social Area (Table 6 in Supplementary File B): The definition of this area was expanded

from “socialization opportunities” to include the formation of new and to sustain old connections and relationships.

- Status Area (Table 7 in Supplementary File B): The definition of this area was expanded in that social status entails the rank or position in social hierarchy in peer groups, family, and communities, impacting social capital and determining the social response the individual receives (i.e., acceptance vs. rejection).
- Moral Area (Table 8 in Supplementary File B): The intangible/subjective elements of the meaning of morality were expanded to also include what is considered “amoral.”

Insights, Usefulness, and Limitations of the PUXCEB Model

The expert feedback is outlined below and summarized in Table 2.

Insights

In terms of insights prompted by the Model, one CE&S expert expressed that it made them realize the complexity of CE behaviors, such as repair and reuse; this “greater depth” of thinking was echoed by a CS&M expert. Another CS&M participant expressed that the model “... forced me to think about how user experiences could be created in a realized CE economy,” and this was echoed by a CE&S expert (“... this exercise forced a thoughtful consideration of the individual’s experience...”). To this end, the model made a CE&S expert realize “... how tied we are to capitalism and consumerism and [how] breaking away from the current system is not easy and will require so many little tweaks to shift behaviors and reasoning and opportunities.” (CE&S Expert).

While the Model did not prompt any new insights for four of the experts (Table 2), two of them (one CS&M and one CE&S) expressed that it was because they fully agreed with the Model (i.e., it corresponded with their understanding).

A CS&M expert pointed out that the outputs of the PUXCEB Model are not unique to CE behaviors, but to all consumption behaviors. On this note, another CS&M expert pointed out that the areas constitute types of values that may be derived from the experience.

Usefulness

On the note of complexity and usefulness, one CS&M participant found that the model will be: “... great for policy makers, especially if you can figure out how to show them the tip of the iceberg before you push them into the water!” Similarly, another CS&M participant pointed out that while the model is useful for understanding CE behaviors, the model’s complexity and interrelated concepts may reduce its usefulness.

One CS&M expert found that the focus on the CE Behavior Process (Fig. 3) (i.e., a hypothetical context in which CE behaviors are normalized and do not compete with linear consumption practices), deprives the model of use in the current state (CS&M expert). This feedback counters a CE&S expert’s thoughts on how the model will: “... provoke new ideas about implementations and transitions, etc.”. On usefulness, the same CE&S expert found that the model is “Very useful for academics who are figuring out which aspects of transition and operationalization will be most impactful; also, for non-academic decision-makers

Table 2 Summary of Delphi study participant feedback regarding insights derived from the PUxCEB model, its usefulness, and limitations

	Details on insights, usefulness & limitations of the PUxCEB model	Number of participants (not summative ^a)
Insights (i.e., takeaways and learnings)	General (positive)	0
	The complexity of CE Behaviors	4
	Understand the role of trust	1
	Importance of education in CE Behaviors	1
	Morals in the use of products	1
Usefulness (for context or actor, or lack thereof)	General (No insights or Takeaways)	4
	Useful for Specific Purposes	
	How to create user experiences of CE Behavior and encourage engagement	4
	Modelling costs and comparing frictions for different alternative circular solutions vs. linear “business and usual” products	1
	Valuable to consider friction and rewards	1
	Study ill-being and well-being using frictions and rewards as proxies	1
	Specific Lack of Usefulness	
	Unrealistic assumption on lack of individual differences (see Limitations)	1
	The focus on a realized CE (i.e., the C Behavior Process) deprives the model of usefulness in the current transition	1
	General Usefulness (all stakeholders)	2
	Businesses	2
	Consumers/Product Users	0
	Policymakers	3
	Academia & Education	1
	General Lack of Usefulness	1
Limitations^b	Applicability is to be determined	1
	Model is too complex	4
	Individual level is incomplete; it is missing e.g., self-efficacy and agency, which is connected to “ability to access” external resources and financial capacity	4
	The delimitation to only external impacts on the experience, and disregard of individual differences	2
	Hygiene should be moved from aesthetics to functional	2
	A person’s perception of their status may not align with that of their peers	1
	The subjectivity of e.g., morals, makes some Areas difficult to assess from an objective research perspective	1
	The Model is too simplified	1
	Considering effort as an output is counterintuitive (it is usually an input)	1
	The Model does not include social skills and networking as inner capabilities, which is important since outer capabilities may come from peers, such as transport or tools	1

^aParticipants are counted once for each detail they mentioned. For example, if someone mentioned both businesses and policymakers, they appear on each of these table rows

^bHerein, some of the experts' underrepresented changes to the Model are also outlined (see "Validation & Refinement Through Interdisciplinary Delphi Surveys")

(policymakers, industry) who are working on supportive policy and regulatory efforts and investments.” We discuss the model’s usefulness more in Section ["Discussion"](#).

Limitations

While four participants requested simplifications of the Model (see [Table 2](#)), one of them (CS&M expert) also noted that the model was: “... both super detailed and not detailed enough,” adding that: “There’s probably more to it and less to [the product user experience] – however as always there are tradeoffs between completeness and parsimony.” Here, it is interesting to note that the clarifications requested (as described in Section ["Clarifications"](#)) all contain additions of explanations and thereby details. No suggestions for removal of details were provided, apart from one suggestion from a CE&S expert who found the division of components into variable types (e.g., mediators and moderators) “overcomplicating and not necessarily useful or valuable.” In addition to removing this differentiation, the expert also suggested merging areas that overlap (i.e., Task with Effort and Aesthetics with Functional).

Across the experts’ feedback, we noted a tendency to assess the model as a behavioral or decision model—and not for capturing the complete experience. This could be seen, for example, in experts taking issue with Effort being an Output rather than an Input (CS&M expert) and questions on how the model considers incentives (CE&S experts). This speaks to the lack not only of models of consumer/product user experience, but also the difficulties in “zooming out” and regarding the experience without a market-based objective, such as to achieve brand endorsement or loyalty (Section ["The Consumption Experience"](#)). Similarly, the idea of separating outputs (i.e., experience) from more long-term outcomes in the form of well-being implications (Figs. [1](#) and [2](#)) was also not intuitive; some experts pointed out how Effort can be its own reward, such as future time saved, learning and self-development (two CS&M experts) and how Frictions could represent ill-being and the rewards well-being (one CS&M expert).

Another problematic assumption behind the PUXCEB Model consisted of that of “values, preferences, and motivations” being fully derived from social norms and values (i.e., absence of individual differences), as this direct link is not true in the real world (two CS&M experts); one of these experts found themselves “... stuck on these individuals that are all exactly the same and driven by the societal settings. That’s anti-marketing thinking.” (CS&M expert). Similarly, another CS&M expert inquired about how “individual codes”, which are not part of social norms and values, are accounted for in the model. These codes are important from an adoption perspective as so-called “innovators” may follow personal code(s) as drivers of their adoption (CS&M expert). We discussed the difference between adoption and sustained habits in Section ["The Consumption Experience"](#) and the delimitation of the modeling in Section ["Capturing the Product User’s Experience in a Circular Economy"](#).

The expert feedback is summarized in [Table 2](#).

Below, the PUXCEB Model is discussed by the paper’s main authors, focusing on implications.

Discussion

In this section, we discuss issues related to the interrelationships among the PUxCEB areas (Section "[The Interrelationships among the PUxCEB Areas](#)") and practical and academic applications of the PUxCEB model (Section "[Practical and Academic Applications of the PUxCEB Model](#)").

The Interrelationships among the PUxCEB Areas

To conceptualize the product user's experience of CE behaviors, it is important to consider the effect across PUxCEBs (Table 3).

The interrelations between the PUxCEB areas in Table 3 are tri-fold in nature. First, *synergies* occur when rewards in one area coincide with gains in another, such as borrowing an aesthetically pleasing item (Aesthetics reward) at no financial cost (Financial gain or avoided friction). Second, a *compensatory* effect arises when rewards in one area comes with frictions in another, for example, experiencing deep task immersion during a repair (Task reward), while simultaneously incurring a status loss in conversations about leisure time (Status friction; [105]). Third, *trade-offs* involve explicit resource decisions, such as whether to expend effort or financial resources to address a functional problem (Table 3).

Regarding *compensatory* effects (Table 3), the Effort and Financial Areas within the PUxCEB Model represent finite resources (i.e., time, exertion, and money) that product users allocate throughout the CE Behavior Process (Fig. 3). These frictions constitute necessary expenditures that enable rewards in other PUxCEB Areas, such as obtaining a functioning bicycle (Functional Area) or securing a desirable watch (Status Area). At the same time, frictions arising in other areas (i.e., Functional, Task, Aesthetics, Status, and Moral) often trigger additional Effort and Financial costs to resolve, for example, cleaning or repairing reused clothing deemed aesthetically displeasing, or purchasing spare parts to restore the functionality of a broken bike. Effort and Financial frictions are thus closely interconnected with the other areas, shaping and overlapping with broader resource allocation decisions within the PUxCEB Model. Whether these costs contribute to an overall positive or negative experience depends on the perceived compensatory rewards derived from other areas. In practice, contradictions between areas often manifest as trade-offs, whereby product users must choose which outcome they prefer, such as doing without a broken product versus investing resources to repair it. These contradictions comes with the opportunity to have the reward in one area outweigh the friction in another (e.g., a successful repair outcome justifying the associated expense) ("potentially compensatory"; Table 3).

As to *trade-offs* (Table 3), product users continually decide how to allocate their limited resources, for instance, by investing time and effort in immersive tasks or by engaging in morally motivated activities. Resource allocations in the Effort and Financial areas are therefore characterized by inherent trade-offs and opportunity costs. A further dimension of this trade-off is the substitutability between effort and financial expenditure; product users may choose to perform tasks themselves, investing personal effort, or outsource them to professionals at additional financial cost, such as paying for home delivery instead of collecting a product in person ("potential trade off"; Table 3).

As to *synergies*, many PUxCEB Areas are potentially related, such as when the aesthetics of a product take on moral significance, or when functionality enables socialization

Table 3 A two-dimensional matrix of the relations across and between the eight PUxCEB Areas, divided into “potentially compensatory” (i.e., there is a friction, but the potential for a reward to exceed any costs), “potentially synergistic” (i.e., the areas are tangential and offer opportunities for synergistic rewards), and “potential trade-off” (i.e., there may be a choice regarding which types of frictions to assume)

PUx-CEB Areas	Effort	Financial	Functional	Task	Aesthetics	Social	Status	Moral
Effort								
Financial	<i>Potential Trade-off</i>							
Functional	Frictions & Rewards (<i>Potentially Compensatory</i>)	Frictions & Rewards (<i>Potentially Compensatory</i>)						
Task	Frictions & Rewards (<i>Potentially Compensatory</i>)	Frictions & Rewards (<i>Potentially Compensatory</i>)	Tasks, such as repair and maintenance, can be conducted to gained/improved functionality (<i>Potentially Synergistic</i>)					
Aesthetics	Frictions & Rewards (<i>Potentially Compensatory</i>)	Frictions & Rewards (<i>Potentially Compensatory</i>)	Ideals and preferences regarding product function and aesthetics may align (<i>Potentially Synergistic</i>)	Tasks can be conducted to improve the aesthetics of a product (e.g., making an artful patch over a garment tear) (<i>Potentially Synergistic</i>)				

Table 3 (continued)

PUx-CEB Areas	Effort	Financial	Functional	Task	Aes-thet-ics	Social	Status	Moral
Social	Frictions & Rewards (<i>Potentially Compensatory</i>)	Frictions & Rewards (<i>Potentially Compensatory</i>)	Product func-tions can allow for socializa-tion (e.g., using a football to play with friends or a cell phone to keep in touch with social network) (<i>Potentially Synergistic</i>)	Flow-induc-ing tasks, in-clud-ing prod-uct use, can be social (e.g., repair-ing or play-ing a game to-gether with oth-ers) (<i>Po-ten-tially Syner-gistic</i>)	<i>n/a</i>			

Table 3 (continued)

PUx-CEB Areas	Effort	Financial	Functional	Task	Aesthetics	Social	Status	Moral
Status	Frictions & Rewards (<i>Potentially Compensatory</i>) Effort can have status-connotations (e.g., convenience aspirations) (<i>Potentially Synergistic</i>)	Frictions & Rewards (<i>Potentially Compensatory</i>) Financial aspects can have status-connotations (e.g., price of product, reflected in the brand and/or model) (<i>Potentially Synergistic</i>)	Having certain functions/capabilities can have status-connotations (e.g., owning a skateboard or a smart watch) (<i>Potentially Synergistic</i>)	Similar to Effort, task immersion can have status-significance (e.g., spending time on maintenance vs. using a product, such as playing chess) (<i>Potentially Synergistic</i>)	The aesthetics of one's products can have social status-significance (e.g., brand, appearance) (<i>Potentially Synergistic</i>)	In social settings, certain status-aspects may matter in how the product user is perceived (e.g., skills and knowledge) (<i>Potentially Synergistic</i>)		

Table 3 (continued)

PUx-CEB Areas	Effort	Financial	Functional	Task	Aesthetics	Social	Status	Moral
Moral	Frictions & Rewards (<i>Potentially Compensatory</i>) Effort can have moral connotations (e.g., working hard or not at all) (<i>Potentially Synergistic</i>)	Frictions & Rewards (<i>Potentially Compensatory</i>) Financial aspects can have moral connotations (e.g., paying extra for socially responsible brand or label) (<i>Potentially Synergistic</i>)	Having certain functions/capabilities can have moral connotations (e.g., a durable or repairable product for lessened environmental impact) (<i>Potentially Synergistic</i>)	Task im-mer-sion can be facilitated by moral con-tin- u- tions (e.g., main-tain- ing a prod- uct out of a sense of steward-ship) (<i>Po-ten- tially Syner- gistic</i>)	The aes- thetics of one’s prod- ucts can have moral signif- icance (e.g., using a worn prod- uct to signal envi- ron- mental values and iden- tity) (<i>Po-ten- tially Syner- gistic</i>)	In social set- tings, certain moral- as- pects may matter in how the prod- uct user is per- ceived (e.g., prod- uct brand or condi- tion) (<i>Po-ten- tially Syner- gistic</i>)	Status and social ideals may align [104] (e.g., mate- rial- ism can con- stitute a form of moral- ity) (<i>Po-ten- tially Syner- gistic</i>)	Moral and social ideals may align [104] (e.g., mate- rial- ism can con- stitute a form of moral- ity) (<i>Po-ten- tially Syner- gistic</i>)

opportunities during the usage stage (Fig. 3) (e.g., playing football or performing a craft in a group) (Table 3). These possible overlaps provide opportunities for creating “potential synergies” (Table 3), especially where interrelations might otherwise be contradictory, for example, when pleasing aesthetics risk generating moral friction, which must be mitigated if the overall experience is to remain positive.

Practical and Academic Applications of the PUxCEB Model

Taken together, the PUxCEB Model and Table 3 indicate that positive experiences of CE behaviors require a holistic strategy that addresses multiple system components in their roles as mediators, moderators, qualifiers, and determinants within the relevant experiential areas. To this end, potentially compensatory and synergistic effects can be achieved by deliberately targeting the relevant system components associated with each area (see Supplementary File B). It should be noted that while Table 3 is only two-dimensional, interrelations may involve more than two PUxCEB areas, such as when an activity requires effort, and has status, as well as moral connotations.

Moderating components are particularly crucial: outer and inner capabilities can substantially reduce the effort required, but their impact depends not only on their mere availability (e.g., tutorials or directories) but on their actual capacity to meaningfully lower product user burden in practice (i.e., quality). This insight is especially important for decision-makers responsible for infrastructure development and product or service design, as it highlights where interventions can most effectively tip the experiential balance toward positive CE behavior engagement (see “Diagnostic Insights” in Table 4).

The PUXCEB Model can serve as a diagnostic lens for dissecting product user experiences at multiple levels of granularity: (1) *discrete activities* (e.g., posting an item for resale); (2) *cumulative processes* (e.g., complete resale process, from decision to transaction); and (3) *full product/service process experiences* (i.e., from search to end-of-use/end-of-life; see Fig. 3). This multi-scale applicability enables researchers and practitioners to pinpoint friction-reward imbalances and compensatory dynamics that determine the nature (i.e., positive or negative) of the particular experience under study. The study of discrete activities yields granular insights into experiential drivers (e.g., spikes in effort during resale listing creation). Process-level aggregation reveals how episode sequences compound (e.g., financial costs offset later functional gains). Service or product experience evaluation provides a holistic assessment (e.g., moral alignment sustaining positivity throughout the process). For cumulative assessment and service or product experience evaluation, researchers should decompose broad processes into discrete activities, measuring each before aggregation to preserve diagnostic specificity (e.g., separate “listing creation,” “buyer communications,” and “handoff”). These data can be collected through product user surveys or interviews, and triangulated with contextual indicators (Table 4) to disentangle objective conditions from subjective interpretations.

In addition to exploring each of the eight PUXCEB areas individually, it is also important to consider their cumulative configuration in terms of inter-area dynamics (Table 3) to create: (1) Synergistic effects (e.g., “Product aesthetics caused positive feedback from peers”); and (2) Compensatory relations (e.g., “The regained product functionality made the repair costs worth it”) (Table 4). Together, this data enables a global diagnostic of the net balance (e.g., “Rewards outweighed frictions”) and scale-tipping (“Overall experience was positive”).

This diagnostic assessment equips decision-makers across industries (such as fashion and electronics), service sectors, and public policy with actionable insights for making CE behaviors more rewarding. Such insights can inform product and service design interventions, infrastructure improvements, and educational campaigns that strategically enhance rewards and mitigate frictions in and across targeted areas (see “Diagnostic Insights” in Table 4).

The PUXCEB Model further lends itself to design-based and experimental research approaches that enable causal inference about experiential drivers. Researchers can systematically manipulate design features hypothesized to target specific PUXCEB areas, such as varying interface complexity to influence Effort, sustainability messaging to enhance Moral output, or visibility options (e.g., award badges) to amplify Status rewards, and then measure subsequent changes across all eight areas.

Complementing these quantitative methods, participatory and qualitative design processes can employ the PUXCEB areas as analytical lenses during co-design workshops and in-depth interviews. Participants may be prompted to map their journeys by reflecting on

Table 4 Examples of measurement of individual PUXCEB areas and their interconnections (column 2 and 3), with examples of context from fashion, electronics, and the service industry (column 4), and diagnostic insights (column 5)

PUXCEB areas (examples)	Objective indicators	Subjective rating (1–7 Likert Scale)	Example of es and Service context (Fashion, Electroni	Possible diagnostic insights (considering Area-Specific system components; Supplementary File B)
Part I. Individual PUXCEB areas				
<i>Effort</i> Cognitive/behavioral exertion and time demands (and opportunity cost of the same)	Steps/actions to complete Total duration (logs) Abandonment rate	"This requires too much mental/physical effort" "Takes excessive time."	<i>Fashion</i> : Steps to list garment for resale. <i>Electronics</i> : Maintenance steps <i>Services</i> : Rental booking steps	Process improvements are needed to reduce effort (e.g., by adding or improving salient moderators)
<i>Task</i> immersion/flow in task performance	Task dwell time Voluntary extensions	"I get fully absorbed/lost in the task." "Feels like flow."	<i>Fashion</i> : Garment Repurposing. <i>Electronics</i> : Troubleshooting. <i>Services</i> : Coordinating rental logistics	Sustain current activity support (i.e., maintain existing salient moderators)
<i>Status</i> peer-recognized prestige/distinction	Visibility metrics (e.g., likes/shares on social media) Role centrality (e.g., "go-to" expert)	"The engagement did not impact my status/image." "I did not experience any admiration by peers."	<i>Fashion</i> : Wearing a vintage piece <i>Electronics</i> : Showcasing custom repair skills <i>Services</i> : Obtaining high-rater status on the service platform	Modify the product/offer to align with social status elements (i.e., align the features of the mediator with social norms and values) Increase visibility of engagement/activity (i.e., make features of the mediator more socially visible) Attempt to change what is considered status-filled (i.e., introduce a new or modified qualifier of status)
Part II. Interconnected PUXCEB Areas (exemplifying)				
<i>Effort and functional</i> (synergistic or compensatory)	N/a	"The degree of regained product functionality compensated for the repair cost." "The (pleasing) aesthetics of the product caused negative feedback from peers"	<i>Fashion</i> : Garment repair <i>Electronics</i> : Device repair <i>Services</i> : Repair service <i>Fashion</i> : Garment design, repair or repurpose <i>Electronics</i> : Device design, repair or remanufacturing <i>Services</i> : Assortment of products offered	Sustain current activity support (i.e., maintain existing moderators) Modify the product or service to align with social status elements (i.e., align the features of the mediator with social norms and values) Align status connotations with the aesthetic elements (e.g., introduce a new or modified status qualifier)
<i>Aesthetics and status</i> (contradictory or trade-off)	N/a			

targeted questions, such as "Where in this process did you experience high effort?" or "At which points did you gain or lose status among peers?" Such exercises may surface more nuanced experiential patterns, including possible synergies and compensations, which can subsequently be translated into candidate survey items and behavioral indicators for quantitative validation.

In essence, the value proposition of the PUXCEB Model lies in its ability to decompose experiential complexity into prioritized intervention targets with measurable scale-tipping effects, thereby supporting the design and governance of CE systems that systematically shift the experiential balance toward positive engagement.

Concluding Remarks

To mainstream circular economy (CE) behaviors and sustainable consumption, product users must experience predominantly positive engagements. This paper conceptualizes that experience in the Product User's Experience of CE behavior (PUXCEB) Model—emphasizing alterable contextual factors—to guide decision-makers in crafting more rewarding CE strategies as levers for the transition. The PUXCEB Model posits that positive user experiences emerge when rewards are commensurate with, or exceed, encountered frictions.

In terms of *scientific contributions*, the PUXCEB Model fills a crucial gap for the CE transition in terms of what the CE behavior experience consists of; while current research examines behavioral determinants and intentions, it rarely assesses whether the engagement is positively perceived. Combining insights from CE research on activities and (for the behavior) relevant system components with areas (i.e., dimensions) and components (i.e., conditions) from consumer studies and macromarketing, the PUXCEB Model offers a novel, holistic, explicitly structured, experience-centric way to analyze CE behaviors and what determines the quality of product users' experience—going beyond product-centric value frameworks or generic "barriers and enablers" lists that characterize much existing work.

The Model captures how ensuring a positive experience requires a nuanced analysis of friction-reward interactions across eight areas of the experience (e.g., Effort, Functional, and Status), alongside contextual/external and internal system components (e.g., product appearance and physical setting) that mediate, moderate, determine, and qualify the engagement's impact on the quality of the experience as predominantly (i.e., cumulatively across the eight areas) positive or negative. This is discussed more under practical implications below.

The PUXCEB Model provides an important organization of experiential variables as foundational for understanding the product user's experience (Fig. 2). First, following the well-established Consumer Experience Model [39], the Model establishes the separation between inputs (i.e., external and, to the individual, internal conditions) vs. outputs (i.e., frictions and rewards pertaining to eight areas). The conflation of these two variable categories in current research (e.g., [68]) impedes the ability to disentangle causal relationships within the product user experience. As such, clearly distinguishing between them is essential for identifying causal mechanisms and, consequently, for designing interventions that reliably foster more positive engagement outcomes.

Second, the PUXCEB Model encompasses a dual-level input structure, distinguishing between input conditions related to the external environment and those internal to the indi-

vidual – each representing interconnected yet distinct system levels. This also yield valuable insights for the design of CE behavior initiatives, especially given how effective interventions often require alignment between these levels. While many models mention both, the PUxCEB model makes their alignment (or misalignment) a central diagnostic lens for CE initiatives by showing how CE interventions must coordinate internal capacities with external affordances. For example, product user knowledge and skills (i.e., an internal condition, or input) must correspond with the tools and resources available (i.e., an external conditions, or input) to ensure a successful and rewarding CE behaviors. Recognizing and addressing the interplay between these system levels enables more precise tailoring of initiatives, such as a business' provision of DIY repair kits or product design mandates related to material content for enhanced recycling.

Third, the PUxCEB Model demonstrates how to distinguish between inputs (i.e., conditions) as mediators, moderators, and determinants, and introduces the notion of qualifiers. The literature shows that effort can be perceived as worthwhile when aligned with prevailing social and individual norms and values [13, 101]. Advantageous value and expectations may even render reduced product functionality acceptable [106]—hence, have a moderating effect. By introducing the notion of a qualifying variable, the PUxCEB Model extends this understanding, it posits that social values and norms, in addition to serving as a moderator, also serve as qualifiers of the mediator (i.e., decide what the mediating variable consists of of the relationship between CE behaviors and the quality of the experience. This dual function of sociocultural factors constitutes a novel contribution. Acknowledging this dual function is critical for the integrated design of CE strategies aimed at enhancing the overall PUxCEB quality (Table 3), such as how campaigns to promote societal values of care may cause individuals' product-repair and maintenance skills to be status-filled. Overall, insights into the interplay between these variable types pave the way for the design of strategic initiatives for experience optimization. We suggest that moderators are particularly impactful.

Fourth, distinguishing outputs (i.e., area-specific frictions and rewards) from longer-term well-being outcomes (e.g., life satisfaction and belonging) (Fig. 2) constitutes a novel approach; existing frameworks tend to jump directly from behavior to well-being, or treat well-being as a broad, undifferentiated outcome (see [86]). The PUxCEB model's eight output areas provide a structured “middle layer” (Fig. 2) that can be used to map how specific CE experiences accumulate and interact to influence well-being over time, offering a more granular pathway from behavior to well-being (Fig. 2; see “Future Research”). This granularity is important, given the complexity of the topic and unforeseen future developments of sustainability transitions.

In terms of **Practical Implications**, the Model offers a holistic, expert-vetted approach for practitioners to understand and test the implications of specific conditions and their combinations (e.g., access to local transportation to a repair shop or social norms around manual labor) for the quality of the individual's experience. Also, the Model can be used to design synergistic interventions across areas and components that maximize relative rewards while minimizing frictions, resulting in an overall output in which the frictions are perceived as acceptable, or even negligible, relative to the rewards obtained.

The scope of the PUxCEB Model is limited by its treatment of individual differences and socioeconomic inequalities. In practice, product users are not passive recipients of contextual influences but possess pre-existing motives, identities, and stable traits that can resist or differentially respond to external conditions. This simplification may therefore contrib-

ute to heterogeneous empirical findings when the model is applied in contexts that appear externally similar. In addition, the model omits feedback loops, including how behavior can reshape personal factors or even the individual's external environment [46], which may reduce its explanatory power, particularly for dynamic processes unfolding over time. **Future Research** should develop the PUXCEB Model to incorporate individual heterogeneities, such as differences in personality traits, preferences, ability disparities, and financial circumstances, to elucidate the implications of CE adoption and delineate conditions enabling predominantly positive CE behavioral experiences across diverse product user profiles. Place-based iterations of the model can also be used, accounting for factors such as available public transportation and community resources. It can also be applied outside the context of durable consumer products, such as food. The sociocultural variability, especially in the Global South, may influence what is to be considered salient components. As such, the Model should be tested in contexts outside the EU, UK, and US, within which the model was developed. Also, the Model may be explored for its capacity to act as a bridge concept towards the development of more systematic well-being concepts that are relevant to CE behaviors that include both short (i.e., in the moment) and more long-term well-being outcomes (e.g., psychological need satisfaction over time) (Fig. 2). Lastly, the PUXCEB should be expanded by adding more distal system levels, such as meso (e.g., business) and macro (e.g., ideology) levels (e.g., [107]). This provides a tool for systematically capturing how the behavior of higher system components and processes (e.g., economic principles and ideologies) impacts the product user at the innermost system level. Moreover, feedback loops can be integrated to allow for the model to depict dynamic CE transitions over time (e.g., [46]). As for quantitative validation and sector-specific testing, we propose ideas in Section "Practical and Academic Applications of the PUXCEB Model".

Finally, while the PUXCEB Model provides a structured overview of product users' experience with CE behaviors, it ultimately constitutes a simplification, particularly from the perspectives of practice theory and socio-materiality (e.g., [108–110]). Herin, consumer experiences are deeply embedded in broader systems, infrastructures, and cultural norms and frictions and rewards are intrinsic to complex social structures, not merely variables to be managed. Nonetheless, for policy environments that prioritize objectivist approaches (e.g., [108, 111]), the PUXCEB model, although simplified, constitute a valuable tool as it is offering a nuanced entry point into the complexities of CE behavior experiences to aid policymakers and other key descension-makers. The model also encourages ongoing critical engagement and empirical refinement across diverse contexts, fostering dialogue with broader systemic and structural approaches to sustainable consumption.

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Declarations

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Authors and Affiliations

Sahra Svensson-Hoglund¹  · M. Joseph Sirgy² · Jennifer D. Russell¹ · Vicki J. Little³ · Alexandra Ganglmair-Wooliscroft⁴ · Dave Webb^{5,6} · Ben Wooliscroft⁷ · Ahmet Ekici⁸ · Grace B. Yu⁹

✉ Sahra Svensson-Hoglund
svenssonhoglund@vt.edu

¹ Department of Sustainable Biomaterials, Virginia Polytechnic Institute and State University, 230 Cheatham Hall, Blacksburg, VA 24061, USA

² Pamplin College of Business, Virginia Polytechnic Institute & State University, 880 W Campus Dr, Blacksburg, VA 24061, USA

³ The Business School, RMIT University, 702 Nguyen Van Linh Blvd, District 7, HCMC, Vietnam

⁴ Massey Business School, Massey University Auckland, 151 Dairy Flat Highway, Albany, Auckland 0632, New Zealand

⁵ UWA Business School, University of Western Australia, M264, Perth, WA 6009, Australia

⁶ Sunway Business School, Sunway University, No. 5, Jalan Kolej, Bandar Sunway, 46150 Petaling Jaya, Selangor, Malaysia

⁷ Faculty of Business, Economics and Law, Auckland University of Technology, Wellesley Street East, Auckland Central, Auckland 1010, New Zealand

⁸ Faculty of Business Administration, Bilkent University, 06800 Ankara, Türkiye

⁹ Department of Business Administration, Duksung Women's University, 33 Samyang-Ro 144-Gil, Dobong-Gu, Seoul, Republic of Korea