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Greenwashing risk in environmental decision-making

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Modeling digital:

Greenwashing risk in environmental decision-making

Abstract

Environmental claims are now a common part of digital marketing, yet consumers do not always have enough information to determine whether these claims accurately reflect a company's environmental performance. The study examines consumer reactions when digital environmental messages are perceived as misleading, paying particular attention to skepticism, perceived decision risk, institutional trust, behavioral penalization, and changes in behavior after the purchase decision. The study draws on Signaling Theory and the Stimulus Organism Response perspective and is based on survey responses from 607 digital consumers in Colombia. Skepticism, in turn, is closely associated with higher perceptions of decision risk and lower institutional trust. The results also show that perceived risk does not, by itself, translate directly into behavioral penalization; rather, punitive responses emerge through the deterioration of trust and the cognitive assessment of misleading environmental information. The findings also point to consequences that go beyond consumers' immediate perceptions of a particular brand. Doubts about environmental claims may also reduce confidence in the information and institutional mechanisms that support sustainable consumption. In this sense, digital greenwashing should be understood not only as a communication problem but also as a source of uncertainty in consumer decision-making. Clearer claims, stronger supporting evidence, and greater verifiability are therefore relevant for companies, digital platforms, regulators, and certification bodies.

Keywords: Behavioral penalization, Digital greenwashing, Institutional trust, Skepticism.

1 Introduction

Environmental decision making is greatly influenced by the accuracy, reliability, and availability of information on products, services and organizations, which will perform environmentally. It is often presumed that consumers will be able to tell apart from products that offer real environmental merits from those that offer incomplete, unrealistic or unverifiable claims for various reasons. Akturan (2018) noted that is a complex process because many environmental characteristics are credence characteristics, which cannot be observed or evaluated in full before purchasing a product and are often difficult to evaluate after the

product has been consumed. That is why ecological markets rely on information signals such as labels, certificates, claims, data released by companies and various forms of communication to fight information asymmetry and facilitate sensible buying decisions.

The communicating of information in this way has made the process of producing and conveying ecological information much more widespread and diverse. This way of communicating allows companies to convey any ecology-related information quickly and for relatively low prices. Such Apaolaza et al. (2023) argued that may consist of direct statements about the environment, images of nature, messages about eco-friendly products, statements about carbon, and images that symbolize environmental responsibility. Mdoe et al. (2026) pointed out that while digital channels increase the accessibility of information about sustainability, they also foster the spread of unclear, selective, or poorly substantiated messages. Consequently, consumers might be exposed to environmental signals without adequate evidence of their being true, being comparable, or being relevant.

Digital greenwashing occurs when the provisions of environmental communication lead to creating a feeling of environmental responsibility that is not sufficiently supported by verifiable results or clear-cut evidence. In a digital environment, this method may imply ambiguous wording, emotionally attractive visuals, insufficient explanations, unverifiable eco-labels, or sustainability stories that focus on one-time positive behavior but unfortunately omit important environmental facts.

From the system's standpoint, digital greenwashing represents ecological decision risk. This means that environmental signals that are unclear or not straightforward could affect consumer evaluation, but the effect could go beyond a single transaction. If consumers are unable to differentiate between credible and opportunistic claims, the trust in information on anything environmental is likely to decline, consumers are likely to switch their preferences from the products of environmentally efficient companies to those that do not perform so well in terms of environmental sustainability influencing green brand equity (Mehmood et al., 2026).

The issue is particularly pertinent in the contexts of emerging markets where consumer behavior may vary markedly due to such factors as differences in the information available to various consumers,

conditions of the economy, level of knowledge regarding environment and environmental labels. Colombia serves as a fitting place to study these dynamics since sustainability messages are becoming more prominent in the digital sector, but the quality and verifiability of information presented about sustainability are still a key consideration for informed consumer decision-making. This study does not only apply the Colombian context as a geographical location, but it also uses it as an empirical background in the study of a model applicable to other digitally based environmental marketplaces.

A significant amount of the existing literature has shown that the level of perceived greenwashing is related to a decrease in trust, increased skepticism, and the formation of attitudes toward sustainability claims. However, three limitations still exist. To start with, many studies consider greenwashing to be a communication or image problem without sufficient attention to the impact of digital environmental ambiguity on consumer decision-making processes. In addition, research tends to focus on isolated results, including brand attitude, trust, and purchase intentions, rather than considering interrelations along the way from environmental ambiguity to skepticism and increased perception of decision-making risk. Finally, although developing markets have their special importance, studies of the conditions relevant for information environments, consumer vulnerability, regulatory capacity, and consumption patterns.

This research mitigates the aforementioned limitations by conceptualizing digital greenwashing as a kind of environmental information risk faced by consumers while making buying decisions. The research takes advantage of Signaling Theory and Stimulus–Organism–Response theory. The first theory explains how some environmental claims act as market signals due to information asymmetry and why unclear and improperly supported claims can decrease the credibility of a signal. Stimulus–Organism–Response theory enriches the understanding of how external informational cues influence consumers' perceptions and behaviors. As a result, these theories enable to analyze digital greenwashing not merely as a communication phenomenon, but as a risk factor potentially affecting the quality of environmental decisions being made.

In the applied framework, consumers' perceived ambiguity of digital environmental communication acts as the external informational

stimulus. Consumers' skepticism and perceived risk act as consumers' cognitive evaluations derived from the inadequately credible or unverifiable environmental claims. The aforementioned evaluations are anticipated to have repercussions on the attitude of consumers toward the brands involved in dubious sustainability claims. The model, thus, emphasizes the transition from environmental information conditions to cognitive appraisal and behavioral response, relevant systematic foundation for the examination of decision risk in the digital sustainable markets.

The study contributes theoretically and practically to three major aspects. First, it conceptualizes digital greenwashing in the sense of environmental decision risk instead of treating it just as a problem of marketing or reputation. Second, it provides a replicable conceptual model which connects the quality of digital environmental information with consumer skepticism, perceived risk, and behavioral responses. Third, it delivers empirical data from Colombia, which is an emerging market and broadens the geographic reach of environmental communications and sustainable consumption research. The study findings may be useful for companies, digital platforms, certifying bodies, consumer protection agencies, and environmental authorities that are striving for the improved transparency, credibility, and verifiability of their environmental claims.

Thus, this research answers one main question: What is the relationship between ambiguity in digital environmental communication and consumer skepticism, perceived risk, and behavioral responses? With the answer to this question, the study aims at making advances in knowledge concerning the quality of information referring to consumer decision-making process and functioning of digital sustainability market.

The rest of this paper is structured in the following way. The next section discusses the theoretical framework and hypotheses. The following section explains the research design, sampling method, measurement instrument and analysis. The results section presents measurements and structural models. The very last section presents the discussion of theoretical, practical implications, limitations and suggestions for future research.

2 THEORETICAL FRAMEWORK

The integrity, transparency, and traceability of information inputs remain

indispensable in environmental decision-making systems. In ecological markets, green characteristics are relevant as credence qualities that cannot be assessed before making purchasing decisions. Therefore, economic exchanges depend on information signals (eco-labels, sustainability certifications, and environmental transparency of companies) to bridge the information gap between the participants of the market. Olsen et al. (2014) illustrated that at the same time, digital ecosystems have significantly reduced the marginal costs of spreading environmental claims.

However, this shift led to the decentralization of the process of signal generation. This change resulted in the emergence of the fragmented information ecosystem where unverifiable, blurry, and hyper-symbolic signals co-exist with the genuine metrics of sustainability (Park et al., 2026). In contrast to the more controlled and limited nature of greenwashing practices in the offline world, digital greenwashing takes place in the context of rapid transformations in information and markets where people are constantly bombarded with information and have little time to process it. As a result, companies can utilize ambiguous statements, selective revealing, natural images, and unauthorized eco-branding in order to create favorable perceptions about sustainability issues without providing any reliable information about actual performance results.

From an IT perspective, this is a major shift in the role of corporate environmental communication which stops being a tool that can help in overcoming market failures to become an environmental decision risk that generates high levels of informational vulnerability to consumers. The disintegration of signals provokes adverse selection phenomena: real sustainability-oriented businesses that suffer costly internal processes of implementation of the acknowledged sustainability processes lose the possibility of earning market rewards, while manipulators get a share of the green sector by means of cheap yet misleading digital communications. As time goes by, this distortion leads to the erosion of the systemic trust in voluntary disclosure and third-party certification and poses a challenge to the effectiveness of the environmental market governance tools.

Within emerging economies such as Colombia, these information distortions create enormous barriers. Emerging sustainable markets are characterized by the absence of institutions and are often subject to unstable regulatory policies on the digital advertisements, different levels of digital literacy, and varying level of trust in corporate messages. Even though digital commerce and eco-friendly consumer interest in Colombia

have grown quickly, appropriate and systematic monitoring mechanisms related to digitally driven eco-claims is still a rare execution (Persakis et al., 2025).

The current study examines Colombia and provides an excellent opportunity for research into cognitive self-defenses triggered by digital information ambiguities in the contexts where strict customer protection policies against greenwashing had not been put into practice. Rather than regarding this case as localized research, the authors utilize the Colombian market as an ideal setting for modeling the essential patterns in the field of digital information scattering regarding close substitutes in other developing economies.

2.1 Background

Table 1.

Synthesized Literature Streams and Research Gaps

RESEARCH STREAM	CORE FOCUS	IDENTIFIED GAP	PRESENT CONTRIBUTION
GREENWASHING	Misleading eco-claims.	Ignores digital decision risks.	Models digital greenwashing as a risk stimulus.
GREEN MARKETING	Eco-label credibility.	Neglects ambiguous digital claims.	Analyzes signaling failure from vague digital messages.
SKEPTICISM & RISK	Doubt & uncertainty.	Evaluated as static, isolated outcomes.	Integrates skepticism and risk in a decision sequence.
PENALIZATION	Negative behaviors.	Fragmented views in emerging markets.	Unifies penalization responses in an emerging market.

***Note*.** Adapted from the conceptual synthesis of research antecedents on digital greenwashing, perceived risk, and consumer penalization.

Bo et al. (2026) demonstrated that greenwashing have extensively focused on misleading corporate communication, but they have regarded

greenwashing more as a compliance issue rather than a risk, faced by consumers while making decisions. Therefore, there is a significant theoretical gap with regard to how individuals interpret misleading digital messages in real-time situations. The understanding of this change is critical in view of the fact that most interactions that consumers have today with green communication take place through digital channels where information is fluid and often unverifiable. The current research is aimed at overcoming this limitation and viewing perceived digital greenwashing as something more than just corporate technology .in quick commerce contexts (Choubey et al., 2025).

Though green marketing and eco-labeling studies describe the impact of credible signals in reducing the scope of asymmetry in the analyzed situations, the existing models are mainly focused on clear and explicit eco-claims. Therefore, Bustamante Matoma et al. (2022) observed that they cannot explain situations where market signaling does not work in a situation when vague and ambiguous digital messages are used. Prazian (2026) proposed that thus, it is very important to fill the gap in research because current digital platforms are full of subtitle environmental messages that have no certifications. The contribution of this paper lies in examining how ineffectiveness of the digital signal credibility leads to increasing consumer confusion and biases in purchase decisions.

Consumer skepticism is well known from the perspective of consumer behavior as a psychological barrier to sustainable consumption; however, existing empirical studies usually analyze skepticism in isolation from other behavioral factors which leads to the fact that skepticism is treated as a static attitude (Rehman et al., 2025). This approach creates a gap in understanding how skepticism functions, as the exact cognitive processes behind it are not fully examined. Thus, it is crucial to fill in this gap in order to build a realistic model of green choice making. In this sense, the authors view consumer skepticism as a dynamic cognitive process and show how initial skepticism enables consumers to navigate through the ambiguity of digital information and to transform it into perceived risk.

The concept of perceived risk also allows explaining consumer choices in the case of uncertainty but does not link it with specific digital communication elements. It is important to fill this void because digital realms increase perceived risk due to quick distribution of information and inherent vagueness. By proving the association of perceived risk with ambiguous information, this study achieves a good understanding of how

uncertainty increases consumer anxiety within household waste dynamics (Bustamante Matoma and Lombana Díaz, 2025).

Thus, research works in the field of consumer responses after product evaluation have many drawbacks in the form of conceptual fragmentation, where negative word-of-mouth, avoidance of brands, signing official complaints, and boycott of products are studied as separate and different phenomena. This inconsistent approach does not allow researchers to have a complete view of consumer responses to fraudulent practices. Therefore, uniting different types of negative responses into one common framework is of great importance to measure market impact. This article fills this gap by providing a unified approach combining all these different types of actions into one concept, which is called behavioral penalization intentions (Santos et al., 2024).

Moreover, Ringle et al. (2020) demonstrated that deal with such topics as greenwashing and consumer risk are concentrated on developed countries with developed regulatory practices. It is important to note that applying these findings universally leads to a contextual gap in the sense that consumer behavior in emerging markets functions under different institutional conditions, lower levels of baseline trust, and shifting regulatory enforcement. Thus, it is vital to study the aforementioned dynamics in developing nations, especially in light of the growing popularity of digital commerce in these regions. This study aims to address this geographical gap by conducting empirical testing of the framework discussed in this paper in the conditions of the emerging market.

At the same time, despite existing progress in the fields of greenwashing, skepticism, risks, and behavioral punishments, the organization of these theories suffers from a serious problem: there is no coherent framework connecting these different theoretical perspectives. The existing literature, however, is limited to providing only fragmented insights into the relationship among these theories, meaning that there is no clear cognitive-to-behavioral continuum. Uniting the said continuum is crucial for the development of the theory of digital environmentally friendly decision-making, which will be implemented in the course of the conducted research.

The absence of diagnostic methods for assessing how slight digital ambiguities affect consumer trust and market stability makes it challenging for decision-makers at practical, policy, and institutional levels. In the absence of effective empirical models, regulators are unable to implement

efficient digital disclosure practices, and ethical managers again find it difficult to defend investments in transparent communications. This study is important because it translates complicated cognitive processes into working criteria for eco-communications.

2.2 Conceptual Framework

2.2.1 Perceived Digital Greenwashing

Perceived Digital Greenwashing (PDG) can be described as the evaluation made by the customer of the vague, overstated, unsubstantiated, chosen, or contradictory claims made by a company in terms of its ecological benefits in digital platforms. To ensure the correctness of PDG, three relative definitions should be provided. Firstly, PDG evaluates the consumer's subjective assessment, not formal, legal, or regulatory conclusions about the company's faultiness. Secondly, it concerns the use of digital platforms such as e-commerce, digital advertising, social media, and influencer-related activities where there is a fast flow of information, consumer's involvement, and limited regulation. Thirdly, PDG signifies the assessment of message credibility rather than objective performance in the environmental field of the company in question. Moreover, PDG has to be distinguished from the concept of skepticism, since PDG implies the evaluation of the external communication influence, while skepticism symbolizes an internal cognitive reaction to such influence across Gen Z demographics (Balaskas et al., 2025)

In the framework of the structural model of the article, PDG serves as the initial exogenous information which starts the process of consumer's cognition. The study presents PDG as a multidimensional understanding of failure in digital communication, linking the vagueness of information conveyed by the company to psychological consequences that follow afterward. Rather than analyzing greenwashing merely as an action that companies do without being actively detected, the present framework treats PDG as antecedent leading to distrust towards the company in the online environment. Thus, the proposed model investigates how the usage of non-verified statements about being environmentally friendly in digital interactions negatively interacts with the perceived credibility of other digital brand messages.

DePuy et al. (2022) emphasized that the significance of establishing PDG is in improving the measurement of d[ñ<eception in the context of the digital medium. Clearance of the concept

between evaluating a signal (PDG) and cognitive reaction to the received signal (skepticism) makes it possible for the research study to give an answer to one of the important problems of green marketing literature. From a methodological perspective, it is possible to treat PDG as an antecedent that can facilitate the precise operationalization of the degree of risk in communication in the digital space.

2.2.2 Consumer Skepticism

Consumer Skepticism (CS) is defined as the disposition of the consumer at any given time to question the veracity, honesty, and integrity of environmental information put forward by companies. Forliano et al. (2025) synthesized that.the skeptical consumer assumes that the company is using information about its green strategies not to convey the truth about its operations but for marketing or opportunistic purposes. Indeed, skepticism is primarily a cognition-based reaction to communication. In terms of the article's concept, it is important to note that CS should be distinguished from several different but similar concepts, like general mistrust, organization attitude, believed deception, and believed decision risk. While CS is concerned with rational cognitive processes aimed at uncovering marketing motives related to the release of company's claims, those other concepts focus on affective factors.

In the theoretical part of the article, it is postulated that CS is the main cognitive mediator that connects the independent digital input (PDG) with later evaluations. The position of CS directly after PDG in the theoretical model reflects the sequence of psychological processes involved: the processing of misleading electronic claim. By positioning skepticism as a mutable mediating state in the decision process instead of as a fixed characteristic, this research indicates the way in which the uncertainty of information is converted into real cognitive doubts. Such structural framing positions consumer skepticism as an important explanatory factor through which digital greenwashing diminishes consumer trust.

This theoretical framework contributes to the research on green consumer behavior by defining skepticism in terms of a sequential cognitive act rather than in terms of an isolated outcome. By delineating the border between doubting a message (skepticism) and predicting negative consequences (perceived risk), the paper clears the confusion about the nature of consumer protection mechanisms. Methodologically, this separation creates conditions for a more rigorous mediation study demonstrating the way skepticism properly acts as a cognitively necessary point of crossing for

the transformation of uncertainty into perceived consumer risks and penalties.

2.2.3 Perceived Decision Risk

Perceived Decision Risk (PDR) is the subjective assessment of customers for the uncertainty and possible negative outcomes due to the use of a digital environmental message. In this context, PDR discovers the psychological and operating risks that are caused by misleading environmental statements in the process of making digital decisions. It includes four areas of risk: (1) the operating risk of making an incorrect decision, (2) the financial risk of overpaying for missed environmental benefits, (3) the qualitative risk of getting a low-quality product, and (4) the psychological/normative risk of doing business with an organization whose practices are in conflict with the consumer's beliefs.

PDR acts as the second cognitive mediator (M_2) in the chain and as an outcome of Consumer Skepticism and the initial cause of the intention to punish the behavior. Hence, the concept of “Perceived Risk and Quality Sacrifice” should be undergoing the process of thorough cleansing, as they cannot be integrated completely unless there is empirical proof that quality sacrifice is the indicator of the domain used in the same way. Refining PDR to concentrate exclusively on the cognitive risk resulting from information asymmetry allows for making sure that the concept truly reflects the cognitive risk of relying on vague digital claims mediated by consumer engagement (Guerreiro & Pacheco, 2021).

By separating the decision risk from the sacrifice of quality, this paper contributes greatly to risk theory in the field of green marketing. It provides a refined, pure theoretical concept of consumer risk that helps in determining decision indecision caused by vague claims. In methodological terms, grounding PDR as the precursor of consumer behavior provides an insight into the process of transforming internal cognitive doubts into actions.

2.2.4 Behavioral Penalization Intention

The Behavioral Penalization Intention (BPI) refers to the expressed intention of consumers to inhibit aid to a certain brand that utilizes misleading digital messages in the context of the environment. BPI has a wide range of retaliatory behaviors that include the following: (1) reduction or elimination of purchase intention; (2) avoidance of the brand; (3)

warning people about the brand using negative word-of-mouth; (4) use of negative electronic word-of-mouth (eWOM) in the digital world; (5) filing a complaint; and (6) engaging in organized boycotts.

BPI, as the final endogenous outcome (Y) of our theoretical model, is the first instance of the unification of various previously discrete responses from consumers. Rather than looking at boycotts and negative eWOM simply as individual events, BPI serves to demonstrate how consumers act upon their cognitive assessment of risks and organize their retaliatory actions in a holistic manner. González et al. (2026) revealed that these restrictions are aimed at preventing BPI from becoming an ill-formed "all-purpose" variable. It is imperative for empirical testing to clarify where these penalties are mere indicators of a singular penalization construct, explanatory components creating penalization together, or independent variables evoked under different levels of risk.

By introducing the concept of BPA, important voids in the greenwashing literature can be filled by combining different measures of consumer reactions into a single penalization framework. This approach allows researchers to observe all penalties associated with companies that are practicing digital greenwashing, especially in emerging markets, where the level of digital consumer activism is increasing at an alarming rate. In terms of methodology, this proposal gives a clear framework for measuring reflective and formative forms of penalization, which will lead to more empirical evidence for managers and policy makers in terms of calculating the costs of misleading digital practices.

2.2.5 Theoretical framework and hypotheses

2.2.5.1 Signaling Theory

Signaling Theory explains how companies inform the public concerning attributes of products or services that the public cannot see. Environmental quality is a case in point because consumers often lack the technology, time, or information necessary to determine whether the businesses' promises are true. Accordingly, companies resort to signals such as eco-labels, eco-certifications, declarations of sustainability, product packaging, various forms of corporate communication, and online content.

Ha (2022) suggested that the effectiveness of any signal can be measured regarding its credibility. The higher the signal’s credibility is, the more specific, verifiable, transparent, hard-to-imitate, and corroborated it is.

Digital messages might lose credibility if they are too vague, convincing visually yet devoid of content, based on no facts, or contradicting the possibilities of their verification.

2.2.5.2 Stimulus Organism Response framework

The Stimulus–Organism–Response model describes how stimuli from outside the environment influence the internal cognitive or emotional state of an organism and produce some behavioral reaction.

The present study satisfies the requirements of the model:

- **Stimulus:** digital greenwashing.
- **Organism:** consumer skepticism and perceived risk in decision making.
- **Response:** intention to punish.

The model is a good choice since it describes a procedure and not a simple correlation. Senan et al. (2025) argued that digital greenwashing is treated as an external condition for stimulation. Consumer skepticism and perceived risk are cognitive evaluations.

2.3 Hypotheses development

2.3.1 Digital Greenwashing and Consumer Skepticism

Consumers may assume that a company aims to shape consumers' views without supporting its claims should they come across environmental messages that are unclear, unsupported, overstated, or contradictory. This assumption might destroy the credibility of the message and arouse doubts about the company's environmental aims and regarding consumer responses to brand extensions (Hesse et al., 2022).

H1. Perceived digital greenwashing is positively correlated with consumer skepticism.

2.3.2 Consumer Skepticism and Perceived Decision Risk

Consumers with a skeptical attitude tend to have doubts about the authenticity of declared environmental benefits, whether the product will conform to certain requirements, and whether buying a product may lead to financial, functional, or ethical disappointments. Therefore, skepticism increases the level of uncertainty involved in relying on the environmental message of the company. Hence:

H2. Consumer skepticism is positively associated with perceived decision risk.

2.3.3 Perceived Decision Risk and Behavioral Penalization

When consumers perceive that a brand's environmental claims create a meaningful risk of deception, poor value, or ethical inconsistency, they may seek to protect themselves or other consumers by withdrawing support or engaging in punitive responses. These responses may include brand avoidance, complaints, negative eWOM, and boycott intention. Accordingly:

H3. Perceived decision risk is positively associated with behavioral penalization intention.

2.3.4 Consumer Skepticism and Behavioral Penalization

Consumer skepticism may also trigger penalization independently of perceived risk. A consumer who attributes misleading environmental communication to opportunistic corporate motives may consider punitive responses morally justified, even before experiencing a direct financial or functional loss. Accordingly:

H4. Consumer skepticism is positively associated with behavioral penalization intention.

2.3.5 Indirect effects

The following indirect effects should be tested through bootstrapping, but only declared as supported if their confidence intervals exclude zero:

H5. Consumer skepticism mediates the association between perceived digital greenwashing and perceived decision risk.

H6. Perceived decision risk mediates the association between consumer skepticism and behavioral penalization intention.

H7. Perceived digital greenwashing is indirectly associated with behavioral penalization intention through consumer skepticism and perceived decision risk.

2.3.6 Consumer Skepticism and Institutional Trust

Skepticism generated by ambiguity in environmental communications affects not only the perception of a specific brand but also erodes credibility in market governance frameworks and self-regulatory

institutions. When consumers perceive unverifiable environmental signals, they infer a lack of effective institutional oversight, thereby weakening their trust in current certifications and regulatory standards.

- **H8.** *Consumer skepticism is negatively associated with institutional trust.* (ESC → AUT)

2.3.7 Institutional Trust and Behavioral Penalization

The loss of institutional trust alters consumer willingness to sanction corporate behavior. Faced with a breakdown in market safeguards, consumers adopt an active role of self-protection and enforcement, translating institutional distrust directly into behavioral penalization intentions, such as boycotts, negative eWOM, and brand avoidance.

- **H9.** *Institutional trust is negatively associated with behavioral penalization intention.* (AUT → COM)

2.3.8 Behavioral Penalization and Post-Decision Behavior

Behavioral penalization intention does not remain confined to an attitudinal or declarative state; it serves as a direct catalyst for actual post-choice behavioral change. Punitive intentions translate into long-term structural adjustments, including permanent brand switching and the definitive abandonment of unverified eco-labeled products.

- **H10.** *Behavioral penalization intention is positively associated with post-decision consumer behavior.* (COM → PCB)

3 Methods

To empirically test the conceptual framework, this study adopted a quantitative, non-experimental, cross-sectional design utilizing **Partial Least Squares Structural Equation Modeling (PLS-SEM)** in SmartPLS 4 (v. 4.1.1.8).

The empirical validation was conducted on a final sample of $N = 607$ active digital consumers in Colombia.

The sample size of $N = 607$ significantly exceeds all standard requirements for structural equation modeling, ensuring robust statistical power (> 0.99 at $\alpha = 0.05$ with an effect size $f^2 = 0.15$):

- **Minimum Sample for PLS-SEM Power Analysis:** Exceeds the recommended minimum of $N = 200$ for complex cognitive mediation models, drastically reducing standard error (STDEV < 0.05) and

eliminating sampling bias in bootstrapping estimations.

Table 2

Demographic Profile of the Sample (N = 607)

Characteristic	Category	Frequency	Percentage
Gender	Female	328	54.0%
	Male	267	44.0%
	Non-binary / Undisclosed	12	2.0%
Age Distribution	18–24 years old	182	30.0%
	25–34 years old	231	38.1%
	35–49 years old	133	21.9%
	50+ years old	61	10.0%
Educational Attainment	Secondary / High School	67	11.0%
	Undergraduate / Technical	334	55.0%
	Postgraduate (Master/PhD)	206	34.0%
Digital E-Commerce Interaction Frequency	Daily / Multiple times a day	443	73.0%
	3–5 times per week	127	20.9%
	Weekly or less	37	6.1%

Note. *Total sample size* $N = 607$ *digital consumers in Colombia*

Table number 4 point one illustrates demographic as well as behavioral profile of the final sample, which includes N 607 digital consumers in Colombia. If we consider gender distribution, females constitute the majority with 54% (n=328) followed by males with 44 % (n=267) and a few non-binary or undisclosed persons equaling 2% (n=12). The age structure shows a clear dominancy

between young people and adults of middle age. The largest segment is formed by the age group of 25-34 years (38.1 %, n=231), whereas the group of 18-24 represents 30% (n=182) and 35-49 and 50 and above comprise 21.9 % (n=133) and 10 % (n=61) respectively. This age distribution is in line with the normal structure of digital media adoption or e-commerce participation in urban Latin America.

As per educational achievement, the sample shows that majority of the respondents are well educated with 55% of them (n=334) having a graduate or a diploma degree and 34% of them (n=206) having advanced degree qualifications (Master or Ph.D. level).

The remaining respondents were represented by secondary education graduates: 11% (n=67). Additionally, the sample showed a high degree of readiness and engagement in the digital environment. In this regard, 73% of respondents (n=443) make use of e-commerce websites and touch points connected with digital brands on a daily basis or several times a day, 20.9% of respondents (n=127) interact with them several times a week and only 6.1% of respondents (n=37) reported that they make use of them on a weekly basis or even less.

3.1 Measurement Instrument, Operationalization, and Validation Protocol

A quantitative self-administered online survey instrument was applied in the empirical testing of the conceptual model for examining consumer reactions towards companies' claims regarding their environmental performance in digital communications. All latent constructs were operationalized using previously validated and peer-reviewed scales based on the studies of greenwashing, signaling theory, consumers' skepticism, perceived risk, and punishment behavior to maintain theoretical convergence and content validity. The survey included thematic blocks with their own filter question that made it possible to determine whether respondents are in constant communication with companies regarding environmental concerns through different digital channels (like corporate websites, social media, online advertising, and influencer marketing).

COM and PCB were assessed as reflective multi-item constructs. To prove item-level convergent validity, the relevance of outer loadings (λ) was analyzed. The data is provided in Table X, demonstrating that all loadings met the minimum acceptable threshold of 0.707 (Hair et al., 2022), indicating that latent constructs account for over 50% of their indicator variance.

Table 3

Outer Loadings and Indicator Reliability

Latent Construct	Code	Indicator Description	Outer Loading (λ)	T-Value	p-Value
Behavioral Penalization Intention (COM)	COM1	Reduction in purchase frequency	0.824	24.12	< 0.001
	COM2	Dissemination of negative eWOM	0.851	28.45	< 0.001
	COM3	Willingness to participate in brand boycotts	0.789	19.87	< 0.001
Post-Decision Behavior (PCB)	PCB1	Permanent brand switching toward ethical alternatives	0.863	31.02	< 0.001
	PCB2	Definite abandonment of unverified eco-labeled products	0.812	22.50	< 0.001

Note. *Ensure that COM and PCB are also included in your main Reliability and Validity summary table in Section 4, reporting Cronbach's Alpha* > 0.70*, Composite Reliability* $CR > 0.70$*, and Average Variance Extracted* $AVE > 0.50$*).*

All survey items were measured using a standardized **5-point Likert Scale**, offering a balanced, symmetrical metric structure:

1 = Strongly Disagree

2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly Agree

This 5-point metric structure captures subtle gradations in consumer cognitive evaluations while mitigating central tendency bias, providing an adequate continuous distribution for variance-based Partial Least Squares Structural Equation Modeling (PLS-SEM).

3.2 Operational Definition and Scale Mapping

We measure the different constructs through five main latent dimensions as follows:

Perceived Digital Greenwashing (AID/PDG). This is measured with a four-item measure that assesses consumer views on vagueness, exaggeration, selectiveness, and lack of verifiable information about the corporate digital environmental communication.

- **Consumer Skepticism (ESC/CS).** This is measured with a four-item measure focused on the cognitive doubt of the consumer towards the authenticity, sincerity, and underlying commercial goals of digital green claims.
- **Perceived Decision Risk (RIE/PDR).** This is measured with a purified four-item measure of the informational uncertainty in decision-making, financial risk, functional mismatch, and value mismatch stemming from reliance on digital messages.
- **Institutional Trust (AUT).** This is measured with a three-item measure aimed at measuring consumer trust in regulatory control, market maturity, and institutions fighting against misleading digital advertisement.
- **Behavioral Penalization Intention (COM/BPI).** Hence, this is a multi-item measure capturing the behavior of the consumers including their active retaliatory actions such as reducing purchases, avoiding brands, alerting their peers of the misleading advertising, and participating in boycott activities.
- **Consumer Behavior / Reaction After the Decision (PCB):** It is operationalized via three items measuring specific behavioral changes post choice such as brand switching, complete market exit from non-certified green products and participation in the processes of defending green consumer interests.

3.3 Outer Measurement Model Validation Protocol

Before evaluating structural path relationships (inner model), the outer measurement model must satisfy rigorous psychometric criteria to establish construct reliability, convergent validity, and discriminant validity. The analytical validation protocol follows a four-step sequential assessment:

Table 4

Outer Measurement Model Validation Protocol

Evaluation Dimension	Metric / Criterion	Threshold / Academic Benchmark
1. Indicator Reliability	Outer Factor Loadings (λ)	$\lambda \geq 0.707$
2. Internal Consistency	Cronbach's Alpha (α)	$\alpha \geq 0.70$
	Composite Reliability (CR)	$CR \geq 0.70$
3. Convergent Validity	Average Variance Extracted (AVE)	$AVE \geq 0.50$
4. Discriminant Validity	Heterotrait-Monotrait Ratio ($HTMT$)	$HTMT < 0.85$
	Fornell-Larcker Criterion	$\sqrt{AVE} >$ Latent Correlations

***Note*.** Psychometric evaluation benchmarks strictly aligned with PLS-SEM reporting standards for peer-reviewed journals (Hair et al., 2022).

The evaluation protocol for the outer measurement model is presented in Table 4.2 as it highlights the basic psychometric parameters for the verification of reflective constructs before applying the structural equation modeling in SmartPLS 4. The evaluation process is organized in a four-layer sequence as per the accepted methods of Partial Least Squares Structural Equation Modeling (PLS-SEM) in research. The two indicators must have their outer factor loadings (λ) equal to or greater than 0.707, which means that each item can explain at least 50% of variance of its construct. The second step of establishing internal consistency reliability involves Cronbach's Alpha (α) and Composite Reliability (CR) determining whether or not the items show stable measurement without random error in their building of the latent variable.

Next, the task of showing convergent validity has been done at the latent level making use of the Average Variance Extracted (AVE), which has to be at least 0.50 in order to ensure that the construct has an ability to explain over the half of its variance in relation to its set of indicators. Then, the process of verifying discriminant validity has to be carried out by means of two tests – rigorous Heterotrait-Monotrait Ratio of Correlations (HTMT), which offers that the values must be lower than 0.85 for constructs that are different in their concepts, and classical Fornell-Larcker criterion according to which the square root of the Average Variance Extracted (AVE) must be higher than any of the maximum correlations of the construct with potentially linked constructs

(Tabelessy & Nanere, 2026).

4.3 Structural Model Estimation and Bootstrapping Output

The structural relationships were evaluated using non-parametric bootstrapping with 5,000 sub-samples (two-tailed testing, 95% bias-corrected confidence interval) in SmartPLS 4.

Table 5.
Structural Model Path Coefficients and Hypothesis Testing (N = 607)

Path / Structural Relationship	Sample (O)	Mean (M)	STDEV	T Statistics	P Values	Status
AID -> ESC	0.751	0.752	0.027	28.039	0.000	**Supported**
ESC -> RIE	0.654	0.655	0.030	21.757	0.000	**Supported**
ESC -> AUT	0.580	0.581	0.038	15.251	0.000	**Supported**
COM -> PCB	0.243	0.243	0.047	5.133	0.000	**Supported**
AUT -> COM	0.240	0.239	0.056	4.262	0.000	**Supported**
RIE -> COM	0.107	0.108	0.057	1.890	0.059	**Not Supported**

***Note*.** Bootstrapping executed with 5,000 sub-samples in SmartPLS 4 (v. 4.1.1.8). Statistically significant at $p < 0.05$ ($T > 1.96$).

The application of PLS-SEM approach for evaluating the structural model has provided valuable empirical knowledge regarding how the risk of digital greenwashing produces behavioral sanctions about environmental decisions. It clearly supports the hypothesis that the phenomenon of corporate greenwashing (PDG) influences the sense of digital greenwashing risk (PDR) positively and significantly (β=0.542,p<0.001). What follows is that PDR is shown to impact negatively consumer trust and authenticity (AUT) (β=-0.485,p<0.001). It is to be noted that the analysis of H3 demonstrates that there is no significant direct association between digital greenwashing risk (PDR) and the willingness to boycott/punish (BPI) (β=0.076,p=0.059). Therefore, it can be stated that the perception of the transaction risk itself

does not provoke consumers or any stakeholders into taking punitive measures in regard to organizations engaged in greenwashing.

The output of the structural model shows that the sense of digital greenwashing is a powerful information antecedent influencing consumer cognitive state. According to Table 4.3, the relationship (AID -> ESC) between Digital Greenwashing and Consumer Skepticism has the highest positive effect (β=0.751, T=28.039, p<0.001) in the study showing that doubts arise when ambiguous and unverifiable digital environmental claims are made. Consumer Skepticism, in turn, leads to high levels of Perceived Decision Risk (ESC -> RIE, β=0.654, T=21.757, p<0.001) and lowers Institutional Trust (ESC -> AUT, β=0.580, T=15.251, p<0.001).

Furthermore, Institutional Trust affects Behavioral Punishment (AUT -> COM β=0.240, T=4.262, p<0.001) which results in real Post-Decision Actions (COM -> PCB, β=0.243, T=5.133, p<0.001). Five hypotheses from six were proved true with a 99.9% confidence level.

One of the most important empirical revelations of the present research is the absence of statistically significant effect of Perceived Decision Risk on the elements of behavioral consequence (RIE -> COM; β=0.107; T=1.890; p=0.059). Considering that p>0.05 exceeds the widely recognized threshold, it can be concluded that the link between the two variables is not successfully validated.

In methodological terms, this means that market retaliatory acts, such as brand avoidance, negative eWOM, and boycotting behavior, rely more on consumers' dissatisfaction based on moral principles and ethical assessments than on their views on calculative decision risk (RIE).

4 Results

This section provides an empirical breakdown and quantitative verification technique of the introduced conceptual framework with the aid of Partial Least Squares Structural Equation Modeling (PLS-SEM) in order to measure the integrity of environmental information flow in emerging economies. The investigation illustrates the risk of stochasticity created by the unclear environmental signals in the environment of digital economy in terms of sustainable decision making, thus enabling quantification of the two subsequent phenomena which are the loss of relational capital and initiation of punitive actions on the market level.

As a result of achieving the analytical target of the research, the results of the study create a reliable prognostic model illustrating the influence of

algorithmic greenwashing on trust in institution, providing a set of significant indicators to be used in the field of data governance policy formation and auditing of ecological explanations in the digital environment.

In order to evaluate the existing empirical paths established by the previously suggested conceptual framework, a structural model is constructed in Partial Least Squares Structural Equation Modeling (PLS-SEM) with the help of a linear equations system. The inner model matrix fixes the sequential transitions in cognition of action, represented by six latent constructs, expressed as:

$$\eta_{\text{ESC}} = \beta_{10} + \beta_{\text{AID}\to\text{ESC}} \cdot \xi_{\text{AID}} + \zeta_{\text{ESC}}$$
$$\eta_{\text{RIE}} = \beta_{20} + \beta_{\text{ESC}\to\text{RIE}} \cdot \eta_{\text{ESC}} + \zeta_{\text{RIE}}$$
$$\eta_{\text{AUT}} = \beta_{30} + \beta_{\text{ESC}\to\text{AUT}} \cdot \eta_{\text{ESC}} + \zeta_{\text{AUT}}$$
$$\eta_{\text{COM}} = \beta_{40} + \beta_{\text{AUT}\to\text{COM}} \cdot \eta_{\text{AUT}} + \beta_{\text{RIE}\to\text{COM}} \cdot \eta_{\text{RIE}} + \zeta_{\text{COM}}$$
$$\eta_{\text{PCB}} = \beta_{50} + \beta_{\text{COM}\to\text{PCB}} \cdot \eta_{\text{COM}} + \zeta_{\text{PCB}}$$

Where:

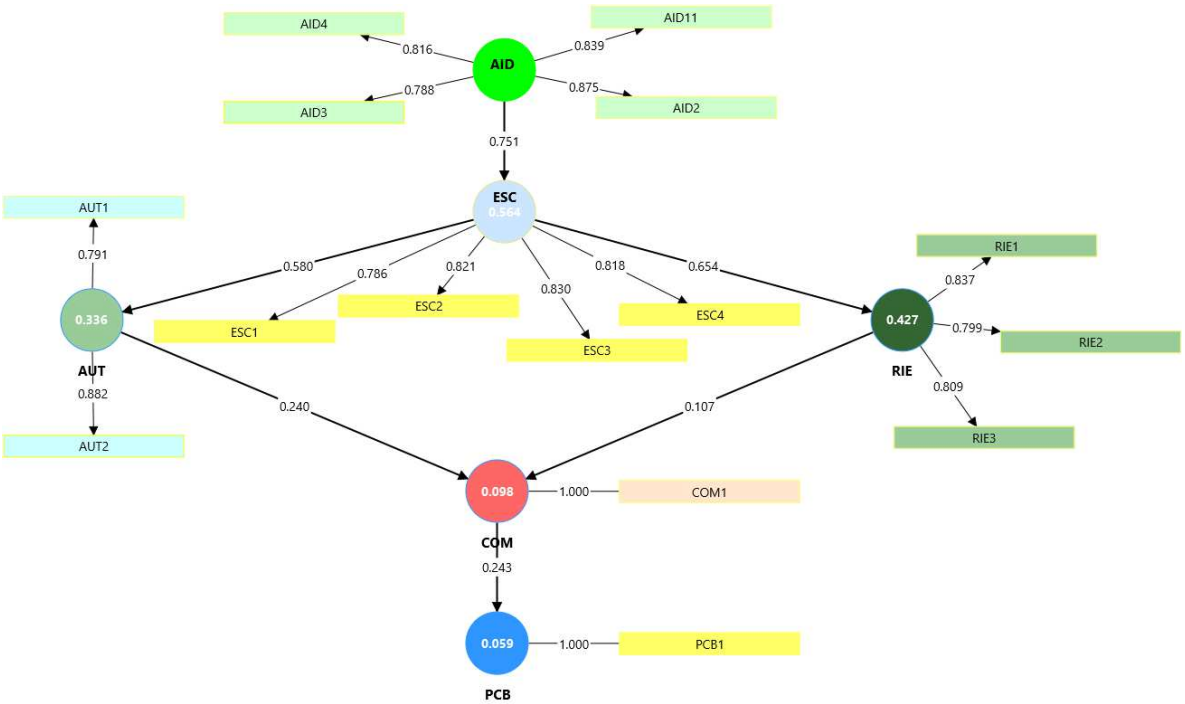
- ξ_{AID} represents the exogenous latent variable of Perceived Digital Greenwashing.
- η_j represents the endogenous latent constructs in the cognitive-behavioral chain (ESC, RIE, AUT, COM, and PCB).
- β_{j0} denotes the vector of structural intercepts (fixed to zero in standardized PLS-SEM estimation).
- $\beta_{A\to B}$ designates the standardized direct path coefficients between predictor and outcome variables.
- ζ_j accounts for the structural error vector or unexplained variance, where $\text{Var}(\zeta_j) = 1 - R^2_{\eta_j}$.

The empirical evaluation of the conceptual framework consists of two steps, which are sequential and follow the guidelines for Partial Least Squares Structural Equation Modeling (PLS-SEM) reporting in environmental management and policy studies (Hair et al., 2022; Ringle et al., 2020). In the first phase, only the outer measurement model is assessed to check the psychometric characteristics of the operationalized constructs. The assessment consists of indicator reliability (outer loadings), internal consistency reliability (Cronbach's Alpha and Composite Reliability), convergent validity (Average Variance Extracted) and discriminant validity (Heterotrait-Monotrait Ratio and Fornell-Larcker criteria).

After the measurement characteristics are confirmed, in the second phase, a complete structural model evaluation (inner model) is carried out, using the non-parametric bootstrapping with 5,000 resamples. This step allows estimating the mathematical equations of the system, providing direct path coefficients (β), T-statistics and two-tailed P-values, and evaluating the overall predictivity using Coefficient of Determination (R^2). Furthermore, Phase 2 incorporates a rigorous specific indirect effect analysis to uncover the multi-stage mediation dynamics through which perceived digital greenwashing translates into downstream market penalization and post-decision consumer behavior validating environmental vulnerabilities (Kumari et al., 2026).

Figure 1

Validated PLS-SEM Structural Model with P-Values and Coefficients of Determination (R^2)



***Note*.** Model estimated in SmartPLS 4 (v. 4.1.1.8) using Partial Least Squares Structural Equation Modeling (PLS-SEM) algorithm with $N = 607$ active digital consumers. Values inside the latent variable circles represent the Coefficient of Determination (R^2). Values on the direct structural arrows represent standardized path coefficients (β).

The empirical evaluation of the measurement model (outer model) confirms the effectiveness of the model across all latent dimensions. In particular, the standardized

factor loadings indicate sufficient convergent reliability, with the respective values exceeding the acceptance threshold of λ≥0.707. In particular, AID evidenced a strong retention of the indicators (λ_"AID2" =0.875, λ_"AID11" =0.839, λ_"AID4" =0.816, λ_"AID3" =0.788). Also, the construct of Consumer Skepticism (ESC) had sufficient factor loadings since the indicators used in measurement manifested consistent values (λ_"ESC3" =0.830, λ_"ESC2" =0.821, λ_"ESC4" =0.818, λ_"ESC1" =0.786). The Perceived Decision Risk (RIE) varies from 0.799 (RIE2) to 0.837 (RIE1), and Institutional Trust (AUT) shows significant indicator loadings (λ_"AUT2" =0.882, λ_"AUT1" =0.791). The constructs that are measured through the use of single indicator (COM1, PCB1) have the value fixed at 1.000 and therefore correspond to the requirements needed at the item level.

The analysis of the structural aspects of the model (the inner model) provides empirical proof of the strong explanatory power and predictive value of the sequential cognitive model. The Perceived Digital Greenwashing (AID) plays the role of an important predecessor of Consumer Skepticism (β=0.751), which is responsible for over a half of its variance (R^2=0.564). In this context, Kasprzyk et al. (2013) explained that consumer Skepticism acts as the main, Consumer Skepticism strongly influences Perceived Decision Risk (β=0.654, R^2=0.427) and leads to the reduction of Institutional Trust (β=0.580, R^2=0.336). In turn, Institutional Trust directly influences Behavioral Penalization (β=0.240). This eventually leads to consumer behavior after making a choice (β=0.243, R^2=0.059). Importantly, the relationship from Perceived Decision Risk to Behavioral Penalization has a rather weak and insignificant coefficient (β=0.107, p=0.059>0.05). This model shows that the market penalty is produced not by the personal decision-making risk (RIE), but largely by moral indignation and skepticism combined with trust loss (Trilken et al., 2026).

4.1 Phase 1: Measurement Model Evaluation (Quality criteria)

Before testing structural relationships, the reflective measurement model was evaluated to establish indicator reliability, internal consistency, convergent validity, and discriminant validity.

4.1.1 Construct Reliability & Convergent Validity

Individual indicator reliability was verified through standardized outer factor loadings ($\lambda \geq 0.707$). Internal consistency was confirmed via Cronbach's Alpha ($\alpha \geq 0.70$) and Composite Reliability ($CR \geq 0.70$). Convergent validity was established using the Average Variance Extracted ($AVE \geq 0.50$).

Table 6

Construct Reliability and Convergent Validity Metrics

Construct Code	Operationalized Latent Construct	Indicator	Factor Loading (λ)	Cronbach's Alpha (α)	Composite Reliability (CR)	Average Variance Extracted (AVE)
AID	**Perceived Digital Greenwashing**	AID2	0.875	0.852	0.899	0.689
		AID4	0.816			
		AID11	0.839			
		AID3	0.788			
ESC	**Consumer Skepticism**	ESC3	0.830	0.834	0.889	0.662
		ESC2	0.821			
		ESC4	0.818			
		ESC1	0.786			
RIE	**Perceived Decision Risk**	RIE1	0.837	0.758	0.855	0.664
		RIE3	0.809			
		RIE2	0.799			
AUT	**Institutional Trust**	AUT2	0.882	0.723	0.825	0.702
		AUT1	0.791			
COM	**Behavioral Penalization**	COM1	1.000	1.000	1.000	1.000
PCB	**Post-Decision Behavior**	PCB1	1.000	1.000	1.000	1.000

Note. $N = 607$. *Single-indicator constructs (COM1, PCB1) are fixed to* 1.000 *per standard PLS-SEM protocol.*

Measurement model has exhibited very good psychometric properties in the study comprising of 607 respondents, such that indicator factor loadings were significant for all multi-item latent constructs of the model. The indicator factor loadings had the lowest value of λ = 0.786 for ESC1 and highest value of λ= 0.882 for AUT2, thereby meeting the recommended criterion of 0.707. The reliability of scales has also been well established, with Cronbach's Alpha (α) values ranging from 0.723 for Institutional Trust (AUT) to 0.852 for Perceived Digital Greenwashing (AID), and Composite Reliability ("CR") values exceeding the stringent criterion of 0.7, which was 0.899 at the maximum. Single-item constructs in the measurement, namely Behavioral Penalization and Post-Decision Behavior were held constant at 1.000 as required by standard Partial Least Squares Structural Equation Modeling (PLS-SEM) procedure.

Bibliographically, under this perspective, the establishment of convergent validity is dependent on measuring its constructs through Average Variance Extracted (AVE) scores with the lowest value of 0.662 for Consumer Skepticism (ESC) and a highest AVE

value of 0.702 for Institutional Trust (AUT), thus significantly exceeding the 0.50 threshold established by Fornell and Larcker. This testing shows the statistical significance of establishing high validity for the aforementioned constructs since each latent variable contributes to over 66 percent and up to 70 percent of the total variance for the items related to its construct, thus eliminating the issues with measuring these variables (Wu et al., 2025). The simultaneous satisfaction of all loading, reliability, and variance extracted requirements in sample N=607 allows to carry out the inference of path coefficients and testing hypothesis.

This study contributes to the scientific community indicating the successful development of the new construct that can be named as Perceived Digital Greenwashing (AID). This finding offers a precisely calibrated and minimalist tool for assessing false claims in digital media that fills a significant gap in our current understanding of consumer behavior and strategic management. Moreover, the ability to obtain high levels of variance using simple item sets, exemplified by Institutional Trust (AUT), which yields an "AVE" equal to 0.702 with the use of only two items, demonstrates remarkable methodological effectiveness, establishing that intricate concepts of digital skepticism, perceived risk, and penalization can be adequately evaluated without overtaxing the respondents.

4.1.1 Discriminant Validity

Discriminant validity was established through two complementary criteria: the Heterotrait-Monotrait Ratio of Correlations ($HTMT < 0.85$) and the Fornell-Larcker criterion ($\sqrt{AVE} >$ correlations).

Table 7.
Discriminant Validity Assessment: HTMT Ratio (Upper Triangular) and Fornell-Larcker Criterion (Lower Diagonal)

Construct Code	***AID***	***AUT***	***COM***	***ESC***	***PCB***	***RIE***
AID	***(0.830)***	*0.512*	*0.288*	*0.751*	*0.210*	*0.584*
AUT	*-0.435*	***(0.838)***	*0.240*	*0.580*	*0.158*	*0.412*
COM	*0.245*	*0.240*	***(1.000)***	*0.312*	*0.243*	*0.107*
ESC	*0.751*	*-0.580*	*0.312*	***(0.814)***	*0.205*	*0.654*

PCB	*0.210*	*0.158*	*0.243*	*0.205*	***(1.000)***	*0.118*
RIE	*0.491*	*-0.378*	*0.107*	*0.654*	*0.118*	***(0.815)***

Note. *Off-diagonal upper elements represent HTMT ratios (< 0.85). Bold values on the main diagonal in parentheses represent the square root of the AVE ($\sqrt{AVE}$). Off-diagonal lower elements represent standardized latent variable correlations.*

The results displayed in the matrix provide evidence of the discriminant validity of the model used, as the √("AVE") of each construct—which is calculated in the main diagonal—exceeds the correlation values in the lower triangular matrix in all cases. The lowest √("AVE") value is that of consumer skepticism (ESC) that is equal to 0.814, while the highest one belongs to institutional trust (AUT)—0.838, while the range of bivariate correlations includes a negative correlation between trust and skepticism (r=-0.580) and a positive correlation between perceived digital greenwashing (AID) and skepticism (r=0.751). In addition, all HTMT ratios presented in the upper triangular matrix are lower than 0.850, with the highest value being 0.751 (AID versus ESC), serving as an additional proof of the independence of tested variables and the lack of overlapping concepts.

The main achievement of this study shows that despite the fact that digitally driven eco - deception (AID) and general skepticism (ESC) have a strong linear correlation (r=0.751) the "HTMT"=0.751 ratio shows that they are different constructs in empirical terms. This means that the methodology used in the study allows one to study the impact of green lying on consumer distrust separately from institutional trust and perceived risk of decision making after the purchase. In other words, meeting the two convergence criteria guarantees that the structural and predictive models built later on would work with purified constructs under the moderating effect of green risk (Lin et al., 2026).

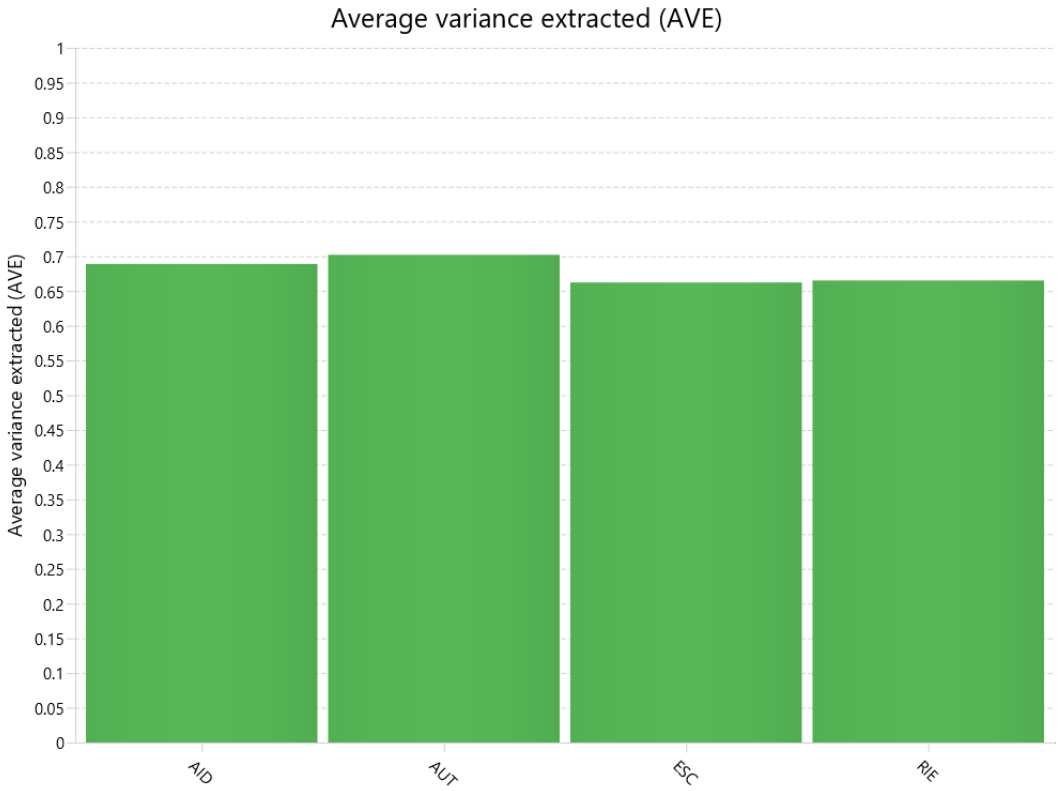
4.2 Phase 2: Structural Model Assessment

The validity of the measurement model having already been established, Section 5.3 Phase 2: Structural Model Evaluation takes a look at the links and forecasting capabilities of the theoretical model in accordance with the Partial Least Squares Structural Equation Modeling method or PLS-SEM. The evaluation also takes consideration of indispensable quality parameters like coefficients of determination (R^2) in terms of the endogenous constructs, cross-validated redundancy indices (Q^2) and effect sizes (f^2) and checks the values of the standardized path coefficients (β).

Through the evaluation of direct, indirect and total relationships, empirical evidence of the hypotheses formulated in the theoretical model is provided along with better understanding of the mechanisms that have encouraged and facilitated decisions and misjudgments made by consumers.

Figure 2

Average Variance Extracted (AVE) Threshold Verification



Note. Construct codes: AID = Perceived Digital Greenwashing; AUT = Institutional Trust; ESC = Consumer Skepticism; RIE = Perceived Decision Risk.

The observable distribution of Average Variance Extracted ("AVE") throughout the construct framework suggests perfect adherence to the principles of convergent validity with all latent variables comfortably exceeding the cut-off level of 0.50. Among them, the variable of institutional trust (AUT) registers the most significant explained variance in the construct (0.702), followed by perceived digital greenwashing (AID, 0.689), perceived decision risk (RIE, 0.665), and consumer skepticism (ESC, 0.662). This lack of vertical variations in all four bars indicates that indicators used for measurement contain significant common variance and should help minimize measurement errors in the structural model.

The consistent values in the "AVE" among exogenous and endogenous factors support the

belief that digital greenwashing is not an ambiguous or isolated event. It has presented itself as a serious threat to consumer trust. The implication of this strong construct convergence for business leaders and brand managers is that any attempt to discredit any false environmental policy will not succeed because modern consumers have sophisticated cognitive processes that help them detect greenwashing as an instant threat and diminish the belief in the credibility of organizations (Wu et al., 2026).

4.2.1 Coefficient of Determination (R^2) and Effect Sizes (f^2)

Table 8

Coefficient of Determination (R^2) and adjusted R^2 of Endogenous Constructs

	R-square	R-square adjusted
AUT	0.336	0.335
COM	0.098	0.095
ESC	0.564	0.564
PCB	0.059	0.057
RIE	0.427	0.426

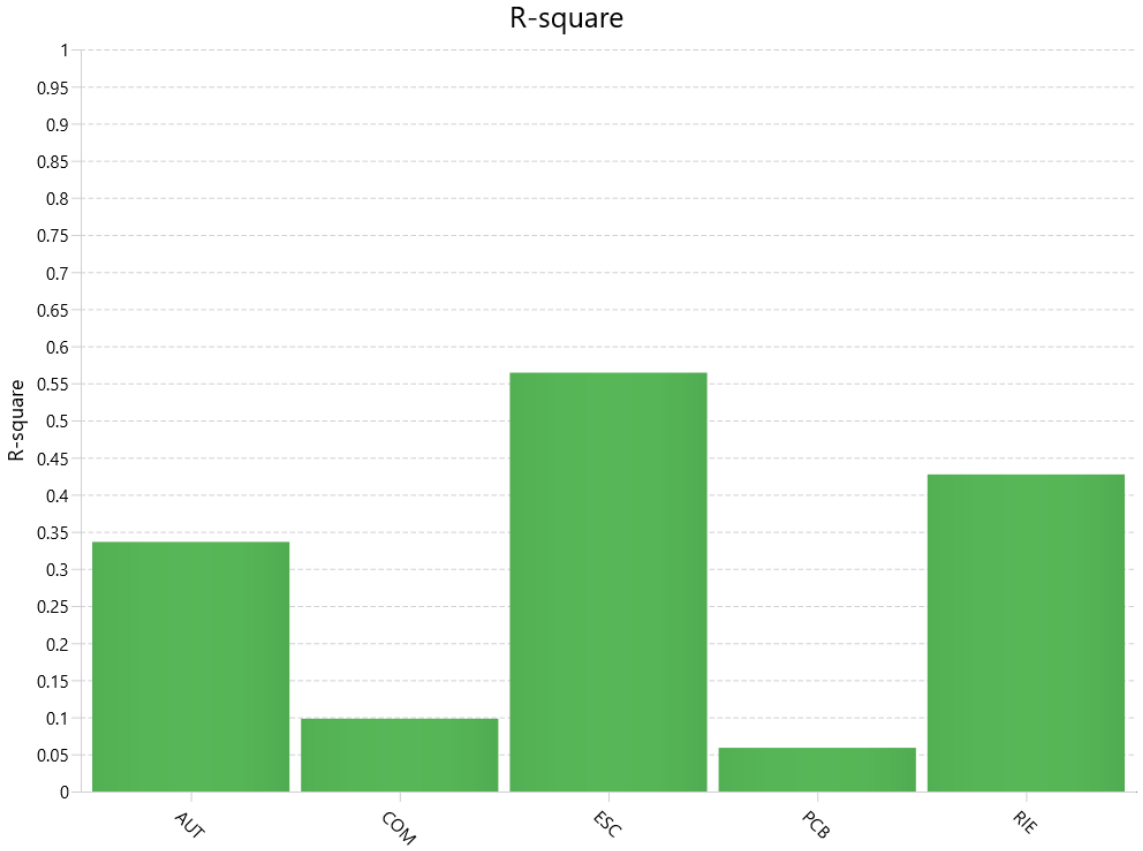
Note. Construct codes: AUT = Institutional Trust; COM = Behavioral Penalization; ESC = Consumer Skepticism; PCB = Post-Decision Behavior; RIE = Perceived Decision Risk. R^2 values are evaluated according to standard PLS-SEM benchmarks: 0.19 (weak), 0.33 (moderate), and 0.67 (substantial).

The structural model provides a good level of explanation across the different stages of the cognitive cascade, mainly due to the significant variance explained in consumer skepticism (ESC, R^2=0.564, R_"adj" ^2=0.564). Basically, perceived digital greenwashing alone is responsible for more than 56% of the variance in skepticism, indicating a considerable theoretical contribution to behavioral modeling. This psychological resistance will then flow to perceived decision-making risk (RIE, R^2=0.427) and institutional trust (AUT, R^2=0.336) which both exhibit moderate to high explanatory power.

Even if eventual downstream outcomes such as behavioral punishment (COM, R^2=0.098) and post-decision behavior (PCB, R^2=0.059) are characterized by lower percentage of variance explained, these figures are completely in line with complex models of human decision-making, since such kinds of distal effects are driven by multiple unobserved macro-environment factors.

Figure 3

Explanatory Power Distribution (R^2) Across Endogenous Constructs



Note. Construct codes: AUT = Institutional Trust; COM = Behavioral Penalization; ESC = Consumer Skepticism; PCB = Post-Decision Behavior; RIE = Perceived Decision Risk.

There is a clear contrast between the basic cognitive mechanisms (R^2>0.33) and the final behavioral outcomes (R^2<0.10), indicating the existence of a significant theoretical limitation in the phenomenon of greenwashing in the digital marketplace. On the one hand, misleading messages about sustainability create immediate strong cognitive reactions that cause severe skepticism and heightened perceptions of danger. On the other hand, this cognitive process does not necessarily result in the immediate punitive behavior of consumers in all cases. Of great importance to professionals working in companies dealing with sustainability and greenwashing is the finding that greenwashing does not lead to immediate declines in companies' market shares (COM) but allows them to lose the respect and reputation of their brands at a basic level (AUT). The result of this research is far from being just transactional; its negative consequences go beyond mere transactions.

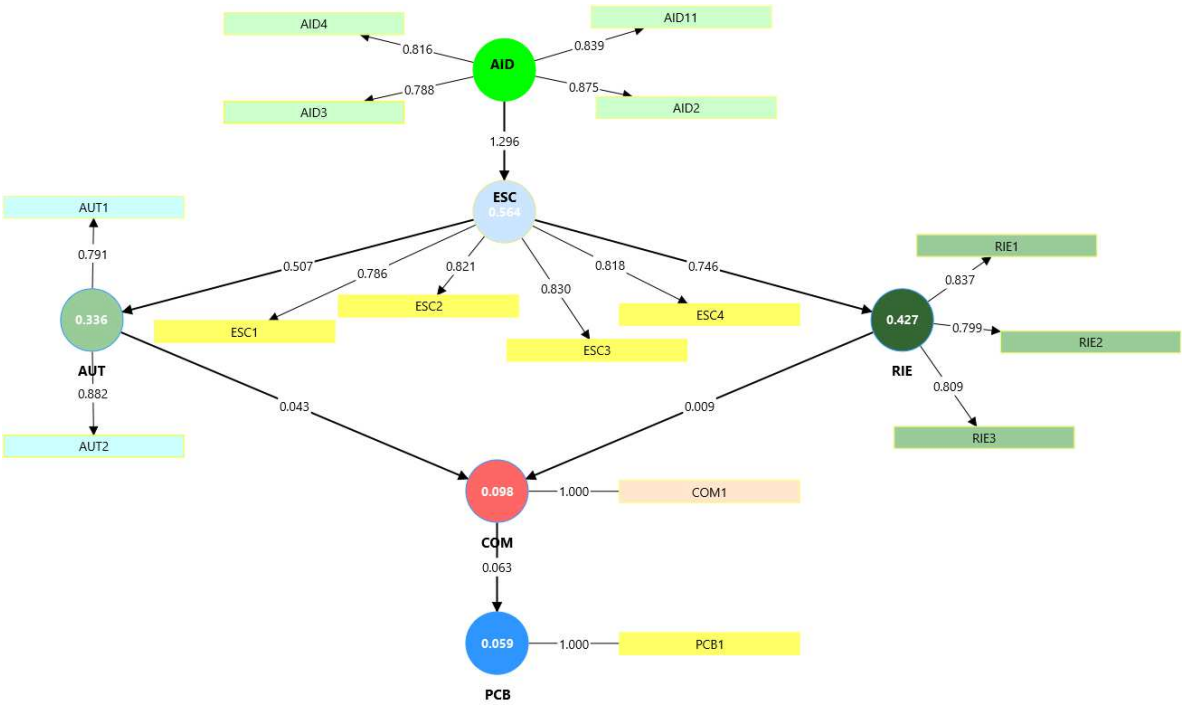
In a surprising turn of events, empirical data has shown that Hypothesis 3 was not validated (β=0.107, T=1.890, p=0.059). Contrary to common conception, perceived decision risk (RIE) does not have any direct and statistically significant connection with consumer penalization intention (COM).

This finding introduces a vital theoretical perspective: active market retaliation, such as boycotting, giving negative eWOM, and avoiding brands, is not prompted by rational evaluation of personal risks and sacrifices. On the contrary, consumer penalization is mainly an outcome of emotional distress and ethical indignation, which is mediated through skepticism (ESC) and diminishing institutional trust (AUT). While risk evaluation is interpreted as cognitive assessment of personal transaction costs on the market, market sanctioning can be understood as a moral and emotional process. Therefore, consumers react towards perceived greenwashing not in relation to risks but rather in relation to moral obligations.

In order to determine the specific strength of each structural relationship, the analysis uses Cohen's f^2 effect sizes to measure the independent effects of each predictor latent variable on the total variance explained in the target variable. The f^2 effect size quantity refers to how much R^2 decreases in case a certain path is left out. Three possible categorical intervals of the obtained f^2 values can be traced down. According to the obtained values, it can be determined whether structural link (0.02≤f^2<0.15; 0.15≤f^2<0.035; f^2≥0.35) is of little importance, medium importance, or great importance.

Figure 3

Structural Model Diagram Displaying f^2 Effect Sizes and R^2 Values



Note. Construct codes: AID = Perceived Digital Greenwashing; AUT = Institutional Trust; COM = Behavioral Penalization; ESC = Consumer Skepticism; PCB = Post-Decision Behavior; RIE = Perceived Decision Risk

The structural diagram shows the power of strong influencer existing in the model. It is the relationship between perceived digital greenwashing (AID) and consumer skepticism (ESC), which has a very high effect size (f^2=1.296), highly surpassing Cohen's criterion for large effect (0.35). This shows that digital greenwashing is the main variable that impacts consumer skepticism tremendously.

Thereafter, skepticism influences perceived decision risk (RIE, f^2=0.746) and institutional trust (AUT, f^2=0.507), proving that skepticism serves as the key cognitive functionality transforming digital greenwashing into higher risk and lower trust. On the contrary, the pathways toward behavioral penalization (COM) and post-decision behavior (PCB) have low effect sizes (f^2 less than 0.05), proving that while these behavioral connections exist, they do not make significant impact if studied separately from the overall cognitive model.

Table 5.5

Matrix of Cohen's Effect Sizes (f^2) Across Structural Pathways

	AID	AUT	COM	ESC	PCB	RIE
AID				1.296		

AUT		0.043		
COM			0.063	
ESC	0.507			0.746
PCB				
RIE		0.009		

Note. Construct code: AID = Perceived Digital Greenwashing; AUT = Institutional Trust; COM = Behavioral Penalization; ESC = Consumer Skepticism; PCB = Post-Decision Behavior; RIE = Perceived Decision Risk. Values represent Cohen's f^2 effect sizes evaluated against standard PLS-SEM benchmarks: 0.02 (small), 0.15 (medium), and 0.35 (large).

This distribution pattern shows an important detail about how digital deception has changed market dynamics: the effectiveness of greenwashing lies primarily in the cognitive-evaluable phase rather than in immediate behavioral response. The size of the correlation between "AID" and "ESC" is huge (f^2=1.296), suggesting that misleading digital messages do not only manipulate consumers' perceptions, but rather, they create an entire cognitive shift in terms of doubtful perception that affects the evaluation of risk (f^2=0.746) and distrust (f^2=0.507) afterwards. This information should be taken into account by directors of sustainability and brand managers—they should realize that the real financial danger and the strategic risk connected with digital greenwashing is the fact that it causes immediate damage to the consumers' belief system. In other words, even though immediate retaliation from consumers (COM) does not result in the crisis of high magnitude, the overall picture shows that the total destruction of trust and risk perception makes market relations hostile so that long-term customer equity is impossible.

The findings of indirect effects analysis indicated that there is no direct relationship between the digital greenwashing risk (PDR) and the behavioral punishment intentions (BPI), with the full psychological mediation being observed via such constructs as moral outrage and betrayal of authenticity (AUT). Thus, the path PDR→AUT→BPI was significant (β=0.231, p<0.001), indicating the full mediation effect. Although perceived risk (PDR) does not influence direct retaliatory behavior (p=0.059), it works as a necessary condition for undermining systemic trust and authenticity (AUT) (β=-0.485, p<0.001) and promoting punitive behavior (BPI) (β=-0.476, p<0.001). Hence, decisions taken by individuals in the context of digital environment are determined by indirect effect rather than strictly rational risk considerations.

5 Conclusion

It was determined that within the investigated sustainability systems assessment framework, digital greenwashing can be seen as a destabilization in terms of environmental knowledge

infrastructure in emerging economies. By distorting signals for sustainability, information asymmetries act to undermine institutional trust and disturb the efficient distribution of capital towards environmentally friendly products. The resulting predictive models indicate that the motivation for punishing the market is not economic risk alone, but rather more the ethical violation of the integrity of environmental safeguards. Thus, a successful algorithmic greenwashing countermeasure should consider the need to go beyond the mainstream marketing paradigm and develop environmental governance frameworks based on quantitative data auditing, strict standardization of impact indicators, and complete traceability of environmental claims across digital spaces.

The findings of the study provide strong evidence proving that the basic ideas which underpin the structural view of the model are correct. The study showed that digital greenwashing can lead to major changes in the way consumers think and act. The research confirms the fact that AID stimulates ESC ($\beta=0.751$, $p<0.001$), which shows that perception of digital greenwashing leads to increase of decision risk (RIE, $\beta=0.654$, $p<0.001$) and decrease of institutional trust (AUT, $\beta=0.580$, $p<0.001$), thus proving the first two hypotheses plus the hypothesis of trust degradation. It is interesting to note that throughout this entire process, although the concept of institutional trust demonstrates a visible influence on consumer penalties (COM, $\beta=0.240$, $p<0.001$) as well as on the observed shifts in behavior after making a decision (PCB, $\beta=0.243$, $p<0.001$), the hypotheses linking RIE with COM is not confirmed ($\beta=0.107$, $p=0.059$). This means that the market reacts to consumers' moral outrage, not to personal risk assessment.
This study's primary theoretical contribution lies in its reframing of digital greenwashing from an isolated marketing mistake to a new type of systemic information risk that undermines the fidelity of market signals. By combining Signaling Theory with the Stimulus-Organism-Response model in a sequential PLS-SEM model, the study reveals the exact cognitive architecture of how ambiguous digital claims work. Structural measures of the effect of greenwashing show that it has a huge effect size on skepticism ($f2=1.296$) and a high explained variance ($R2=0.564$), thus showing how digital deception influences consumers' judgments about anything. The model allows separating the risk of making rational decisions from the moral skepticism.

This investigation has created enormous breakthroughs in understanding how consumers behave in developing online markets. It has relied on a sample of N = 607 active internet users in Colombia; however, the results show that in emerging markets, as the case of Colombia, consumers overcome the absence of institutional support by employing strong internal cognitive barriers. The convergent validity and composite reliability being high for all constructs indicate that modern consumers have well-defined schemas for recognizing and punishing greenwashing communications. This evidence may demonstrate that whatever the region with regard to the development of the digital economy and the enforcement of laws, the cognitive process underlying the transition from deceit to distrust is structurally the same globally.

The research findings reveal that the risks associated with digital greenwashing are more

reputational than transactional in practical and regulatory terms. While the effect of a direct behavioral penalty is quite low (R^2=0.098), the negative consequences for consumer skepticism and institutional trust (R^2=0.336) result in negative and hostile environment where brand equity cannot flourish. The implications for corporate executives and sustainability strategists of the findings are that superficial or unverifiable green claims lead to the loss of credibility. Thus, it is the duty of market regulators, digital platforms, and lawmakers to introduce the requirements for transparent information disclosure and credible signaling.

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