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Integrating Consumer and Professional Perspectives in Sustainable Product Design

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ABSTRACT

Consumer priorities and professional relevance provide complementary evidence for early sustainable product design, yet the relationship between them across identical design criteria is rarely examined within one analysis. This study integrates consumer priority from 150 end users with professional relevance from 30 product designers and industry practitioners across 37 indicators in seven design domains. Consumer percentages and within domain ranks were examined alongside Item Level Content Validity Index (I-CVI) and modified kappa at indicator level, while criterion level S-CVI/Ave provided domain context. Results show clear evidence reinforcement for Shape, Reliability, and Product Benefit. Function shows consistently high professional relevance alongside closely distributed consumer priorities. Safety, Sustainability, and Commerciality show different stakeholder emphasis: users prioritise Spare Part Availability, Stability, and Brand, while professional relevance is strongest for Compliance with Standards and Regulations, Energy Efficient, Product Information, and Online Reviews. The integrated evidence framework organises shared design signals, complementary stakeholder emphasis, and context dependent criteria for sustainable design decisions. Taken together, the findings show how consumer priority and professional relevance can be considered within one design framework during early product development.

Keywords: *Consumer priority, Expert validation, Perceived product quality, Sustainable product design, Integrated evidence analysis*

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1 INTRODUCTION

Perceived product quality has moved beyond a narrow interpretation of technical conformance. Users form quality judgements through visible form, usability, reliability, performance, material cues, service expectations, brand meaning, and accumulated product experience. Contemporary quality research therefore positions perceived quality as a multidimensional construct that connects technical product characteristics with subjective evaluation and use (Stylidis et al., 2020; De Giovanni, 2024). In circular and sustainable contexts, this structure expands further to include longevity, environmental attributes, serviceability, and lifecycle value (Bayram et al., 2024; Körkemeyer et al., 2025).

Sustainable product development consequently depends on more than adding an environmental criterion to a conventional design checklist. Early design decisions establish product configuration, material direction, functional performance, serviceability, repairability, energy implications, and eventual end of life options. Methods that bring sustainability into early product development are valuable because later stages progressively reduce the freedom to redirect the product concept (Ahmad et al., 2018; Isaksson Hallstedt et al., 2023). Product design also shapes whether sustainability is recognisable to users. Recent synthesis shows that sustainability cues interact with functionality,

product category, and perceived trade-offs, reinforcing the need to translate environmental intentions into product attributes that users can interpret during evaluation and use (Sierra-Fontalvo et al., 2026).

Two evidence traditions are especially relevant to this translation. Consumer evidence shows what intended users prioritise when evaluating products and captures value formed through use, expectation, comparison, and market cues. Professional content evidence assesses the relevance and representational strength of proposed indicators within their intended design domains. Content validity methodology positions expert judgement as structured evidence of relevance and representativeness, complementing user centred evaluation in framework development (Polit & Beck, 2006; Almanasreh et al., 2019; Mokkink et al., 2025).

The analysis draws on consumer and professional evidence collected within a broader research programme using a common seven domain structure. Consumer evaluation established priorities among 37 design indicators, while professional validation established content relevance and agreement for the same criteria. Reading these two forms of evidence together creates the analytical question addressed here: how do user priorities and professional relevance relate across identical design criteria, and what do patterns of reinforcement, complementary emphasis, and contextual variation mean for sustainable product design decisions?

User salience and professional relevance can produce different patterns within the same design domain. Some indicators may be prominent across both evidence layers, while others may reveal complementary stakeholder emphasis or stronger contextual dependence. Examining these relationships provides a basis for distinguishing shared design signals from criteria that benefit from sharper operational interpretation.

Accordingly, the study examines indicator level relationships across Form, Function, Safety, Sustainability, Quality, Commerciality, and Innovation. The analysis identifies shared signals, complementary stakeholder emphasis, and context dependent criteria, then relates these patterns to early sustainable product design decisions.

2 LITERATURE REVIEW

2.1 Perceived Product Quality as a Multidimensional Design Construct

Perceived quality is formed at the intersection of product characteristics and human interpretation. Stylidis et al. (2020) formalise perceived quality as a structured set of attributes connected with sensory and cognitive evaluation, enabling product teams to identify and rank quality related characteristics during development. De Giovanni (2024) similarly demonstrates that the modern meaning of quality extends across usability, efficiency, innovation, performance, serviceability, pricing, conformance, ethics, sustainability, and perceived quality. Together, these perspectives support a design focused view in which quality can be translated into criteria instead of treated only as an abstract market judgement.

Sustainability increasingly intersects with this structure. Bayram et al. (2024), in a systematic review of product quality in the circular economy, connect quality with customer perspectives, functionality, technical attributes, longevity, design, market value, and environmental aspects. Körkemeyer et al. (2025) extend perceived quality modelling by including sustainability as an explicit quality dimension. These developments support a framework in which Form, Function, Safety, Sustainability, Quality, Commerciality, and Innovation can be analysed together while retaining clear conceptual boundaries.

Design research also shows that visible and experiential characteristics are meaningful quality cues. Homburg et al. (2015) conceptualise product design through aesthetics, functionality, and symbolism, while Creusen and Schoormans (2005) demonstrate that product appearance communicates aesthetic, functional, ergonomic, symbolic, and categorisation information. Md. Nazri et al. (2025) similarly show

how aesthetic, ergonomic, sensory, and interactional qualities contribute to meaningful product experience. These findings reinforce the role of product level attributes as the mechanism through which broad notions of quality become observable to users.

2.2 Consumer Priority as Design Evidence

Consumer priority evidence addresses the relative importance that users assign to product attributes within a particular context. These evaluations are shaped by experience, perceived value, market information, product use, and purchase conditions. Tsiotsou (2006) links perceived product quality with satisfaction and purchase intention, while Morwitz (2014) explains the role of purchase intentions and consumer evaluation within decision processes. For product design, consumer priorities reveal which attributes are foregrounded during evaluation and therefore provide a direct basis for user centred design emphasis.

This perspective is reflected within electric kitchenware through priorities across Form, Function, Safety, Sustainability, Quality, Commerciality, and Innovation (Mohd Rashid et al., 2026). The resulting framework begins with user centred evidence and then incorporates professional relevance as a complementary validation layer. This sequence aligns with development guidance that recommends incorporating target population perspectives during content development together with structured expert appraisal (Boateng et al., 2018).

Sustainability demonstrates why this distinction matters. Users may respond more strongly to concrete product consequences than to a general environmental label. Research on repairability shows that repair communication can operate as a signal of durability and quality (Munten & Vanhamme, 2023), while durability research connects product design with reuse, repair, refurbishment, remanufacturing, and life extension (Mesa et al., 2022). User priority can therefore reveal which sustainability related attributes become meaningful in everyday product evaluation.

2.3 Professional Relevance as Content Evidence

Professional content validation addresses a different question: how adequately do the proposed indicators represent the conceptual domain in which they are positioned? Polit and Beck (2006) distinguish item level and scale level content validity and emphasise transparent reporting of calculation procedures. Polit et al. (2007) further recommend accounting for chance agreement when interpreting item relevance. Almanasreh et al. (2019) show that rigorous content validation combines quantitative indices with conceptual judgement, while Yusoff (2019) presents a practical sequence for calculating and interpreting content validity indices.

More recent guidance continues to define content validity through relevance, comprehensiveness, and comprehensibility (Mokkink et al., 2025). These principles are transferable to a design framework because the central question remains representational: does an indicator belong within the proposed domain, and is its operational meaning sufficiently clear for consistent interpretation? Expert relevance scores therefore strengthen conceptual defensibility but do not establish consumer importance, purchase behaviour, or predictive market performance.

Professional relevance was evaluated across all 37 indicators using I-CVI, S-CVI/Ave, and modified kappa. These statistics quantify relevance and account for chance agreement, and they gain interpretive value when considered alongside clear conceptual boundaries. Indicators with comparatively lower professional agreement can still provide useful information about wording precision, domain boundaries, and contextual dependence, particularly for market oriented and symbolic criteria.

2.4 Integrating Consumer and Professional Evidence

A sustainable product design framework becomes analytically stronger when consumer priority and

professional relevance are integrated within a shared indicator structure. Consumer evidence locates relative user importance, while professional evidence establishes relevance and conceptual representation. Their interaction can reveal criteria reinforced across stakeholder groups, criteria receiving different emphasis, and criteria whose interpretation is more dependent on context.

This logic is consistent with early-stage sustainability decision support. Isaksson Hallstedt et al. (2023) argue that early design needs methods capable of anticipating sustainability direction while information is still incomplete. Human centred design perspectives likewise emphasise structured engagement with stakeholder value, while Du and Ayob (2024) and Mohd Hasbullah et al. (2025) demonstrate the value of connecting design logic with environmental and social objectives. In this study, consumer priority and professional relevance are examined within the same design framework.

Table 1 Conceptual Basis for Integrated Evidence Analysis

Evidence dimension	What it establishes	Role in present study	Selected literature
Perceived product quality	Multidimensional judgement formed through product and experience cues	Defines the seven-domain quality framework	Stylidis et al. (2020); De Giovanni (2024); Bayram et al. (2024)
Consumer priority	Relative importance assigned by intended users	Establishes the consumer priority layer	Tsiotsou (2006); Morwitz (2014); Boateng et al. (2018)
Professional relevance	Expert judgement of domain representation and item relevance	Establishes content relevance and conceptual defensibility	Polit & Beck (2006); Almanasreh et al. (2019); Mokkink et al. (2025)
Sustainable design	Early integration of lifecycle and environmental implications	Connects evidence to early product development decisions	Isaksson Hallstedt et al. (2023); Sierra-Fontalvo et al. (2026)
Integrated evidence analysis	Integrated interpretation of common indicators across consumer and professional evidence	Identifies shared signals, complementary emphasis, and contextual variation	Boateng et al. (2018); Mokkink et al. (2025)

(Source: Authors' synthesis)

2.5 Operational Definitions and Measurement Architecture

Recent sustainable product design research increasingly treats sustainability as a requirement translation problem. Broad environmental and social ambitions have to be converted into product level criteria that can guide concept development, specification, and evaluation. Wu et al. (2025) address this challenge through a multi-level sustainability requirement model that decomposes strategic sustainability objectives into actionable product requirements and then uses structured expert consensus to support prioritisation. Their work is especially relevant to the present study because it demonstrates that different stakeholders can contribute useful but non identical evaluations during requirement formulation. The implication for design research is that evidence quality depends not only on the number of criteria considered, but also on understanding what each stakeholder perspective is able to establish.

A similar emphasis appears in recent empirical work on sustainable product design factors. Mengistu et al. (2025) validate a multidimensional set of factors spanning product dependability, manufacturability, cost, resource utilisation, end of life management, user centred design, and stakeholder well being. This structure reinforces the need to connect technical product quality with environmental and user-oriented value. It also shows why sustainable product design decisions cannot be represented adequately through environmental criteria alone. User expectations, product dependability, resource implications, and organisational decision requirements need to remain visible within the same development process.

The implementation challenge is equally important. Vilochani et al. (2024) report strong industrial interest in sustainable product development while showing that the implementation of established management practices remains behind the state of the art. This gap between available knowledge and routine practice places greater value on decision structures that designers can interpret during concept development. Kwok et al. (2025) further demonstrate the usefulness of structured sustainability criteria for comparing concepts in the early design stage, while also identifying challenges related to data accuracy and indicator weighting. These findings suggest that the quality of early design support depends on how clearly evidence is organised before weighting or concept selection begins.

Recent framework development also provides evidence that structured sustainability indicators benefit from practitioner evaluation. Briard et al. (2026) developed an early product design framework for evaluating smart and connected product concepts through sustainability indicators and assessed its relevance through expert interviews and a design workshop. Their findings support the value of transparent and actionable criteria while also showing that a framework must remain usable within the realities of design activity. Taken together, this literature positions stakeholder evidence, requirement translation, and early decision support as connected research concerns.

In the present study, consumer priority and professional relevance are organised before design criteria are translated into decisions. This arrangement shows where user salience and professional judgement reinforce one another, where they emphasise different aspects of the same domain, and where interpretation depends more strongly on context. The resulting structure can support later specification, weighting, concept comparison, and validation while keeping the role of each stakeholder perspective clear.

3 METHOD

3.1 Research Design and Analytical Rationale

This study applied an integrative quantitative design to examine how consumer priority and professional relevance operate across a common set of 37 sustainable product design indicators. The analytical unit was the design indicator within its established domain, enabling Form, Function, Safety, Sustainability, Quality, Commerciality, and Innovation to be examined through both user centred and professional evidence. The design focuses on the relationship between these evidence functions and translates that relationship into design decision support.

The design combines target population input with professional appraisal because the two sources address different aspects of framework development. Development guidance supports the inclusion of target populations to strengthen relevance and comprehensibility together with expert judgement for content representation and conceptual adequacy (Boateng et al., 2018; Almanasreh et al., 2019; Mokkink et al., 2025). Consumer percentages and ranks therefore represent relative priority, while I-CVI, S-CVI/Ave, and modified kappa represent professional relevance and agreement within the same design framework.

The integrated analysis examines how the same indicators perform across user centred priority and professional relevance. Indicator level relationships are then synthesised at domain level to identify shared signals, complementary emphasis, and contextual variation with direct implications for early sustainable product design.

3.2 Participants, Product Context and Measurement

The study brings together two quantitative respondent groups within a common product design structure. Consumer evidence was obtained from 150 end users evaluating electrical and electronic kitchenware in retail settings, using an electric rice cooker as a consistent product stimulus. The questionnaire covered purchase considerations, perceived product quality, and 37 indicators grouped under Form, Function, Safety, Sustainability, Quality, Commerciality, and Innovation. Consumer percentages and within domain ranks describe the relative emphasis placed on each indicator, while purchase factor means and perceived quality responses provide the wider evaluation context.

Professional evidence was obtained from 30 product designers and industry practitioners with at least five years of relevant experience. The same 37 indicators were assessed through a four point relevance questionnaire administered face to face. Ratings of 3 or 4 were treated as relevant for content validity analysis. Item Level Content Validity Index and modified kappa were calculated for each indicator, while S-CVI/Ave summarised professional relevance at domain level. This measurement structure places consumer emphasis and professional judgement on the same set of design criteria without changing the function of either measure.

3.3 Analytical Procedure and Quality Assurance

The design indicator was the unit of analysis. Each consumer percentage and rank was examined together with the I-CVI and modified kappa for the corresponding indicator, and S-CVI/Ave was used to interpret the wider domain pattern. The analysis was conducted first at indicator level and then at domain level, allowing the results to distinguish shared emphasis, complementary stakeholder emphasis, and criteria whose interpretation depends more strongly on context.

Analytical consistency was maintained through common indicator identities and stable domain definitions across the full matrix. Material Use/Type remained within Sustainability because it represents environmental and resource implications, whereas Material Selection remained within Quality because it concerns suitability for performance, durability, finish, reliability, and conformance. The numerical patterns were then interpreted against literature on perceived quality, sustainability requirements, lifecycle design, market information, innovation, and early design decision support. This sequence provides a clear connection between the observed results and their design interpretation.

3.4 Ethical Considerations and Research Scope

The study analyses aggregate consumer and professional responses collected within the broader research programme and required no additional participant contact. Participation in the professional questionnaire was voluntary, informed consent was obtained before face to face completion, and the analysis uses aggregate evidence for research reporting. Individual participant responses are not reproduced. The scope of the present study is the integrated interpretation of priority and professional relevance across the established seven domain design structure.

4 RESULTS

4.1 Evidence Profile for Integrated Analysis

The consumer evidence establishes the priority context for the integrated analysis. Among the twelve purchase considerations, Design recorded the highest mean score (M = 4.03), followed by Quality and Quick Ordering (both M = 3.87). Brand (M = 3.63) and Price (M = 3.47) formed the next level of purchase consideration, while Sustainability recorded M = 3.31. Eighty per cent of respondents selected one of the two highest response categories for Design.

The perceived quality results further positioned users and product experience at the centre of evaluation. A total of 74.0% of respondents identified users as the appropriate definers of product quality, 62.7% evaluated quality after product use, and 52.0% selected quality as the leading contributor to good product design. These values provide contextual grounding for the indicator level priority structure.

Professional evidence shows consistently strong relevance across the same framework. All 37 indicators satisfied the predetermined I-CVI retention criterion, with item level values ranging from 0.80 to 1.00 and an overall mean I-CVI of 0.94. Criterion level S-CVI/Ave values ranged from 0.88 to 0.98, with Function, Quality, and Form recording the strongest professional coherence.

4.2 Integrated Indicator Matrix

The indicator matrix brings consumer priority and professional relevance together across the same 37 design criteria. Consumer percentage and rank show relative user emphasis within each domain, while I-CVI and modified kappa show professional relevance and agreement.

The matrix reveals several distinct patterns. Within Form, Shape occupies the first consumer position and also receives unanimous professional relevance. Within Quality, Reliability combines the highest consumer position with I-CVI = 1.00. Product Benefit leads Innovation among consumers and receives very strong professional relevance at I-CVI = 0.97. These cases provide the clearest descriptive correspondence across the integrated evidence layers.

Other domains show differentiated emphasis. In Safety, Spare Part Availability ranks first among consumers, while Compliance with Standards and Regulations receives unanimous professional relevance. In Sustainability, Stability ranks first among consumers while Energy Efficient receives I-CVI = 1.00. Commerciality likewise separates Brand as the leading consumer criterion from Product Information and Online Reviews as the indicators with the highest professional relevance. These patterns identify stakeholder specific emphasis within the same design domains.

Table 2 Integrated Indicator Matrix of Consumer Priority and Professional Relevance

Domain	Indicator	Consumer %	User rank	Expert I-CVI	Modified κ
Form	Shape	25.7	1	1.00	1.00
	Appearance	23.0	2	0.97	0.97
	Colour	20.6	3	0.97	0.97
	Product Finishing	19.7	4	0.93	0.93
	Texture	11.0	5	0.90	0.90
Function	Easy to Understand	23.0	1	0.97	0.97
	Ergonomic	22.0	2	1.00	1.00
	Comfortable	19.0	3	0.97	0.97
	Performance	18.3	4	0.97	0.97
	Convenient / User Friendly / Easy to Use	17.7	5	1.00	1.00
Safety	Spare Part Availability	30.0	1	0.87	0.87
	Test Results	25.7	2	0.97	0.97
	Warranty Provisions	18.7	3	0.90	0.90
	Maintenance	16.3	4	0.93	0.93
	Compliance with Standards and Regulations	9.3	5	1.00	1.00
Sustainability	Stability	27.3	1	0.83	0.83
	Material Use / Type	21.7	2	0.97	0.97
	Energy Efficient	18.3	3	1.00	1.00
	Assemble and Disassemble	16.7	4	0.93	0.93
	Recyclability	16.0	5	0.90	0.90
Quality	Reliability	24.7	1	1.00	1.00
	Durability	22.0	2	0.97	0.97
	Product Specifications	21.0	3	1.00	1.00
	Material Selection	18.3	4	0.93	0.93
	Conformance	14.0	5	0.97	0.97
Commerciality	Brand	20.9	1	0.87	0.87
	Recommendation	16.9	2	0.93	0.93
	Price	14.4	3	0.83	0.83
	Product Information	14.2	4	0.97	0.97
	Customer Review	13.6	5	0.90	0.90
	Service after Purchase	11.1	6	0.93	0.93
	Online Reviews	8.9	7	0.97	0.97
Innovation	Product Benefit	32.3	1	0.97	0.97
	Uniqueness	26.0	2	0.90	0.90
	Prestige Value	20.3	3	0.80	0.80
	Exclusiveness / Limited	14.0	4	0.80	0.80
	Novelty / Originality	7.4	5	0.93	0.93

Note. Consumer percentage and rank summarise within domain priority; I-CVI and modified kappa summarise professional relevance and agreement.
(Source: Authors' integrated analysis)

4.3 Diagnostic Evidence Patterns

Table 3 Diagnostic Evidence Patterns

Indicator	Domain	Consumer evidence	Professional evidence	Pattern	Analytical significance
Shape	Form	Rank 1; 25.7%	I-CVI = 1.00	Strong correspondence	Consumer leader with unanimous professional relevance
Reliability	Quality	Rank 1; 24.7%	I-CVI = 1.00	Strong correspondence	Consumer leader with unanimous professional relevance
Product Benefit	Innovation	Rank 1; 32.3%	I-CVI = 0.97	Strong correspondence	Consumer leader with very strong professional relevance
Spare Part Availability	Safety	Rank 1; 30.0%	I-CVI = 0.87	Differentiated emphasis	Consumer leader with retained professional relevance
Compliance with Standards and Regulations	Safety	Rank 5; 9.3%	I-CVI = 1.00	Professional emphasis	Highest professional relevance despite lower user rank
Stability	Sustainability	Rank 1; 27.3%	I-CVI = 0.83	Differentiated emphasis	Consumer leader with retained professional relevance
Energy Efficient	Sustainability	Rank 3; 18.3%	I-CVI = 1.00	Professional emphasis	Unanimous professional relevance at a mid user rank
Brand	Commerciality	Rank 1; 20.9%	I-CVI = 0.87	Differentiated emphasis	Consumer leader with retained professional relevance
Novelty / Originality	Innovation	Rank 5; 7.4%	I-CVI = 0.93	Professional emphasis	Strong professional relevance despite low user rank
Prestige Value	Innovation	Rank 3; 20.3%	I-CVI = 0.80	Context dependent	Retained relevance with stronger symbolic dependence
Exclusiveness / Limited	Innovation	Rank 4; 14.0%	I-CVI = 0.80	Context dependent	Retained relevance with scarcity and positioning dependence

Note. Pattern labels provide a concise descriptive interpretation of the relationship between consumer priority and professional relevance for the same indicator.
(Source: Authors' integrated analysis)

4.4 Domain Level Evidence Synthesis

Table 4 Domain Level Synthesis of Consumer and Professional Evidence

Domain	Consumer evidence pattern	Professional evidence pattern	Integrated evidence interpretation
Form	Shape leads at 25.7%	Shape = 1.00; S-CVI/Ave = 0.95	Strong descriptive correspondence around visible product form
Function	Easy to Understand leads at 23.0%; Ergonomic follows at 22.0%	All indicators = 0.97 to 1.00; S-CVI/Ave = 0.98	Distributed consumer priorities with uniformly strong professional relevance
Safety	Spare Part Availability leads at 30.0%	Compliance with Standards and Regulations = 1.00; S-CVI/Ave = 0.93	Support valued by users and formal safety evidence provide complementary perspectives
Sustainability	Stability leads at 27.3%	Energy Efficient = 1.00; S-CVI/Ave = 0.93	Performance continuity and explicit environmental attributes represent different sustainability emphases
Quality	Reliability leads at 24.7%	Reliability and Product Specifications = 1.00; S-CVI/Ave = 0.97	Strong shared emphasis on dependable and specified product quality
Commerciality	Brand leads at 20.9%	Product Information and Online Reviews = 0.97; S-CVI/Ave = 0.91	Consumer market identity and professional information cues provide complementary market evidence
Innovation	Product Benefit leads at 32.3%	Product Benefit = 0.97; S-CVI/Ave = 0.88	Benefit focused innovation provides the clearest shared indicator within a more context dependent domain

(Source: Authors' integrated analysis)

4.5 Integrated Results

Taken together, the results show that consumer priority and professional relevance contribute distinct but complementary evidence to the same seven domain framework. Clear descriptive correspondence occurs for Shape, Reliability, and Product Benefit, where leading consumer positions coincide with very strong professional relevance. Function presents a different configuration: consumer priorities are comparatively distributed, while professional relevance remains consistently high across all five indicators.

Safety, Sustainability, and Commerciality reveal stronger differentiation across evidence layers. Spare Part Availability, Stability, and Brand occupy leading consumer positions, while formal safety compliance, Energy Efficiency, Product Information, and Online Reviews receive comparatively stronger professional relevance. Because all 37 indicators satisfy the professional retention criterion, these patterns provide diagnostic evidence for interpretation and operational refinement.

5 DISCUSSION

5.1 Shared Consumer and Professional Signals Strengthen Core Design Criteria

The first major finding is the presence of indicators that are simultaneously prominent in consumer evaluation and strongly supported through professional relevance assessment. Shape ranks first within Form among consumers and achieves unanimous professional relevance. Reliability shows the same configuration within Quality, while Product Benefit leads Innovation among consumers and receives I-

CVI = 0.97. These patterns are analytically important because they demonstrate reinforcement across two distinct evidence functions.

The prominence of Shape is consistent with research showing that product appearance communicates aesthetic, functional, ergonomic, symbolic, and categorisation information (Creusen & Schoormans, 2005), while Homburg et al. (2015) identify aesthetics, functionality, and symbolism as core dimensions of product design. Md. Nazri et al. (2025) further demonstrate the role of aesthetic, ergonomic, sensory, and emotional characteristics in shaping meaningful product experience. Shape therefore operates as both a visible user cue and a professionally defensible Form indicator.

The correspondence around Reliability is similarly meaningful. Bayram et al. (2024) position functionality, longevity, technical attributes, customer perspectives, and environmental considerations within contemporary circular product quality. De Giovanni (2024) also identifies reliability, performance, usability, serviceability, sustainability, and conformance among modern quality dimensions. Reliability therefore links perceived quality with the expectation that a product will continue to perform dependably over time.

Product Benefit provides the strongest shared signal within Innovation. Its leading consumer position and very high professional relevance suggest that innovation is most defensible when it creates recognisable value for the user. This interpretation is consistent with product design research linking successful design to functional and experiential value together with meaningful differentiation (Homburg et al., 2015; Abdul Jamil & Abu Bakar, 2025). The contribution here is the simultaneous presence of user salience and strong professional representation within the same indicator.

5.2 Function Operates as a Portfolio of Connected Attributes

Function shows a different but equally important relationship. Consumer priorities are closely distributed: Easy to Understand ranks first at 23.0%, Ergonomic follows at 22.0%, and the remaining indicators range from 17.7% to 19.0%. Professional relevance is exceptionally concentrated at the upper end, with all five indicators between 0.97 and 1.00 and S-CVI/Ave = 0.98. This combination indicates that Function is better understood as a portfolio of connected requirements than as a domain dominated by one attribute.

This interpretation aligns with contemporary quality research. De Giovanni (2024) identifies usability, efficiency, performance, design, and serviceability among important quality dimensions, while Homburg et al. (2015) conceptualise functionality as a central product design dimension. A product may perform technically while remaining difficult to understand; it may be easy to understand while creating ergonomic discomfort; or it may be comfortable but inefficient. The consumer distribution captures these distinctions, while the expert data show that each remains professionally relevant to the Function domain.

The integrated view adds analytical depth. Consumer ranking differentiates priorities within the domain, while professional validation demonstrates domain coherence. Together, these evidence layers support a more complete functional design specification.

5.3 Safety and Sustainability Reveal Complementary Stakeholder Perspectives

Safety and Sustainability contain the clearest differentiation between consumer priority and professional relevance. Within Safety, Spare Part Availability ranks first among consumers at 30.0%, while Compliance with Standards and Regulations occupies the lowest consumer position at 9.3%. Professional relevance shows the opposite emphasis: formal compliance achieves I-CVI = 1.00, while Spare Part Availability remains relevant at 0.87. This pattern distinguishes continuity of support valued by users from formal evidence of safe product development and market entry.

Spare parts, maintenance, and repair remain important to continued dependable use. Mesa et al. (2022) connect durability with circular strategies including repair, reuse, refurbishment, and remanufacturing, while Munten and Vanhamme (2023) show that repairability communication can signal durability and product quality. The user emphasis on Spare Part Availability therefore has a defensible lifecycle interpretation even though professionals place the strongest relevance on explicit standards compliance.

Sustainability produces a similar complementarity. Stability ranks first among consumers at 27.3%, whereas Energy Efficient achieves unanimous professional relevance and Material Use/Type reaches 0.97. Contemporary sustainable design research supports the strong professional relevance of energy, materials, disassembly, and recyclability because these attributes map directly onto lifecycle and circular design decisions (Ahmad et al., 2018; Isaksson Hallstedt et al., 2023). At the same time, consumer attention to Stability suggests that sustainability is also interpreted through continued product performance and avoidance of premature failure.

This distinction is theoretically valuable. Sustainability cues are interpreted in relation to product function, product category, and user expectations of performance (Sierra-Fontalvo et al., 2026). Körkemeyer et al. (2025) similarly position sustainability within multidimensional perceived quality. The framework therefore integrates explicit environmental criteria with lifecycle value that users can recognise in product use.

5.4 Commerciality and Innovation Show Greater Context Sensitivity

Commerciality and Innovation display the greatest variation in professional relevance. Commerciality achieves S-CVI/Ave = 0.91, while Innovation records 0.88; all indicators remain above the retention criterion. Within Commerciality, Brand ranks first among consumers, whereas Product Information and Online Reviews receive the highest professional relevance. The difference reflects the varied functions of market cues: brand condenses familiarity, identity, and expected value, while product information and review systems support informed market evaluation.

The importance of informational market cues is consistent with evidence from meta-analysis on electronic word of mouth. Ismagilova et al. (2020) show that argument quality, valence, usefulness, trust, and credibility contribute to intention to buy. Abdul Jamil and Abu Bakar (2025) also show that design development interacts with public perception, brand image, and purchase related responses. Commerciality therefore operates as the market dimension of the framework, connecting product information, value, credibility, and purchase support.

Innovation reveals an even clearer distinction between benefit focused and symbolic indicators. Product Benefit leads consumer priority and receives very strong professional relevance. Prestige Value and Exclusiveness/Limited, by contrast, remain above the retention threshold but receive I-CVI = 0.80. Novelty/Originality occupies the lowest consumer position yet receives I-CVI = 0.93. These patterns indicate that innovation contains several forms of value: direct benefit, perceived newness, uniqueness, symbolic status, and scarcity-based positioning. Their boundaries must remain explicit because a product can be novel without being prestigious, exclusive without being technically innovative, or innovative without producing clear user benefit.

5.5 Theoretical Contribution: An Integrated Evidence Framework

The theoretical contribution of the study is the joint interpretation of consumer priority and professional relevance across a shared design indicator structure. Existing perceived quality research establishes that quality is multidimensional and shaped by objective product characteristics, sensory cues, and subjective evaluation (Stylidis et al., 2020; Bayram et al., 2024; De Giovanni, 2024). The present analysis examines how user salience and professional representational strength relate across the

same design criteria.

This distinction produces three useful interpretive conditions. First, evidence reinforcement occurs when a leading consumer indicator also receives very strong professional relevance, as observed for Shape, Reliability, and Product Benefit. Second, complementary evidence occurs when different indicators receive stronger emphasis from different stakeholder perspectives while remaining relevant within the same domain, as observed in Function, Safety, and Sustainability. Third, contextual interpretation occurs when indicators remain professionally relevant, but their meaning depends more strongly on market positioning, symbolism, or conceptual boundaries, as observed particularly within Commerciality and Innovation.

These categories provide a coherent interpretive language for design decisions while preserving the analytical identity of consumer priority and professional relevance. The study therefore proposes that perceived product quality for sustainable product development is strengthened when both forms of evidence are integrated within a common design framework.

This contribution is also consistent with recent sustainable product design research that emphasises both multidimensional factor structures and stakeholder alignment. Mengistu et al. (2025) show that product sustainability depends on interrelated technical, environmental, economic, user centred, and stakeholder factors. Wu et al. (2025) demonstrate that multidisciplinary sustainability requirements require explicit consensus and prioritisation mechanisms before they can guide product strategy. The present framework complements these approaches by locating the source and role of evidence before later weighting decisions are made. In this way, the study provides an intermediate analytical layer between stakeholder evaluation and formal requirement prioritisation.

The framework also treats differences in stakeholder emphasis as useful design information. A difference between consumer priority and professional relevance is not treated simply as inconsistency. Instead, it identifies where a criterion may serve a different function in product development. User priorities can signal experiential value, service continuity, or market salience, while professional relevance can signal technical representation, regulatory importance, lifecycle responsibility, or conceptual coherence. Recognising these functions enables a design team to interpret why a criterion matters before deciding how strongly it should influence a concept.

5.6 Implications for Early Sustainable Product Design

The integrated evidence framework provides a practical sequence for early design decisions. First, consumer evidence identifies what users prioritise. Second, professional validation establishes the relevance and conceptual defensibility of the corresponding criterion. Third, differences across the two perspectives are interpreted as design information that can guide operational refinement. This sequence is consistent with the need to anticipate sustainability direction early, before product configuration, material, functional, and lifecycle decisions become difficult to redirect (Isaksson Hallstedt et al., 2023).

For designers, the practical implication is a shift from checklist use toward evidence informed interpretation. Criteria such as Shape, Reliability, and Product Benefit warrant strong early attention because they are salient across both evidence layers. Function should be treated as a portfolio of connected attributes. Safety and Sustainability require simultaneous attention to continuity valued by users and formal technical or environmental requirements. Commerciality and Innovation require clear contextual definitions so that brand, price, information, prestige, scarcity, and novelty retain distinct design meanings.

Table 5 Discussion Synthesis and Design Implications

Analytical theme	Key integrated finding	Literature connection	Design implication
Shared core signals	Shape, Reliability, and Product Benefit combine leading consumer positions with very strong professional relevance	Creusen & Schoormans (2005); Homburg et al. (2015); Bayram et al. (2024)	Give strong early attention to criteria reinforced across both evidence layers
Functional portfolio	Consumer Function priorities are distributed while all professional I-CVI values are 0.97 to 1.00	Homburg et al. (2015); De Giovanni (2024)	Evaluate comprehension, ergonomics, comfort, usability, and performance as a connected portfolio
Lifecycle and sustainability complementarity	Spare parts and Stability lead users; formal compliance and Energy Efficiency receive stronger professional relevance	Mesa et al. (2022); Isaksson Hallstedt et al. (2023); Munten & Vanhamme (2023)	Integrate recognisable user lifecycle value with explicit technical and environmental criteria
Market and symbolic context	Brand leads users; information cues receive stronger professional relevance; Prestige and Exclusiveness show greater variation	Ismagilova et al. (2020); Abdul Jamil & Abu Bakar (2025)	Define market and symbolic indicators with explicit contextual boundaries
Evidence integration	Consumer priority and professional relevance provide different information for identical indicators	Boateng et al. (2018); Mokkink et al. (2025)	Maintain consumer priority and professional relevance as distinct, complementary evidence layers within the design framework

(Source: Authors' synthesis)

5.7 Translating Integrated Evidence into Design Requirements

The practical relevance of the integrated analysis becomes clearer when the evidence patterns are translated into different types of design requirement. Sustainable product development requires teams to move from broad intentions to criteria that can be specified, reviewed, and verified. Wu et al. (2025) similarly emphasise the translation of high-level sustainability objectives into actionable product requirements, while Mengistu et al. (2025) show that sustainable product design factors span technical, environmental, economic, user centred, and stakeholder dimensions. The present findings place stakeholder evidence within this translation process.

Criteria that show strong evidence reinforcement, such as Shape, Reliability, and Product Benefit, can enter concept development as prominent design requirements because they combine clear user salience with strong professional representation. Their role is different from criteria such as Spare Part Availability, Stability, and Brand, where consumer priority is strong but professional relevance is more distributed within the domain. These criteria remain important design inputs, but their operational meaning benefits from explicit definition so that the user value they represent is preserved during specification and review.

A third pattern concerns professionally anchored criteria such as Compliance with Standards and Regulations, Energy Efficient, Product Information, and Online Reviews. These indicators do not occupy the highest consumer positions in their domains, yet professional relevance is very strong. Their design role is therefore associated with technical, environmental, informational, or market requirements that may remain essential even when they are not the most salient criterion during user evaluation. This distinction is particularly important in sustainable design because some lifecycle and compliance requirements protect long term product performance and market legitimacy without necessarily appearing as the strongest immediate consumer preference.

The fourth pattern concerns criteria such as Price, Prestige Value, and Exclusiveness or Limited Availability, where interpretation depends more strongly on market segment, positioning, symbolism, and context. These criteria should be applied through clearly defined decision conditions rather than assumed to have a universal meaning across products. This conclusion is consistent with contemporary sustainable product development research, which increasingly recognises that multiple criteria and stakeholder requirements create trade-offs during early design and therefore require structured decision support (Kwok et al., 2025; Vilochani et al., 2024).

This four pattern decision logic provides a bridge from evidence interpretation to design action. It allows design teams to distinguish criteria that deserve immediate emphasis, criteria that express strong user value, criteria that provide professional or technical anchoring, and criteria that require contextual specification. The framework can therefore support concept briefs, design review checklists, requirement definition, prototype evaluation, and later multicriteria weighting while keeping the origin of each design signal visible.

Table 6 Decision Logic for Translating Integrated Evidence into Product Requirements

Evidence pattern	Illustrative indicators	Design interpretation	Recommended design action
Reinforced design signal	Shape; Reliability; Product Benefit	User salience and professional relevance point to the same design signal.	Give early emphasis in concept briefs, specifications, and prototype evaluation.
User led operational signal	Spare Part Availability; Stability; Brand	Strong user priority is accompanied by broader professional emphasis within the domain.	Preserve the user value while clarifying the operational definition and domain boundary.
Professionally anchored requirement	Compliance with Standards and Regulations; Energy Efficient; Product Information; Online Reviews	Professional relevance is especially strong even when the indicator is not the leading consumer priority.	Treat as a technical, environmental, informational, or market requirement that supports robust design decisions.
Context dependent criterion	Price; Prestige Value; Exclusiveness or Limited Availability	Meaning varies with market segment, positioning, symbolism, and product context.	Define the decision condition explicitly and validate the criterion within the intended market or product category.

(Source: Authors' synthesis)

5.8 Design Governance and Requirement Prioritisation

The integrated findings have an additional implication for design governance. Sustainable product development involves choices made under incomplete information, competing requirements, and different stakeholder expectations. Recent work on sustainability requirement elicitation, concept evaluation, and industrial implementation shows the importance of translating broad sustainability objectives into criteria that can be acted on during concept development (Vilochani et al., 2024; Kwok et al., 2025; Wu et al., 2025; Briard et al., 2026). Within the present framework, the 37 indicators provide a common vocabulary for connecting consumer priorities with professional judgement before detailed weighting or concept selection begins.

Requirement prioritisation can therefore proceed through a simple traceable sequence. The design team first identifies the evidence pattern associated with a criterion. The criterion is then translated into a requirement statement that specifies the intended design outcome, the development stage in which it should be reviewed, and the evidence needed for verification. This approach keeps early design decisions connected to the reason a criterion matters. It also reduces the tendency for broad

sustainability intentions to become isolated checklist items that are difficult to relate to product value or professional responsibility.

The framework can also support design review governance. Criteria showing shared reinforcement, such as Shape, Reliability, and Product Benefit, can be carried directly into concept briefs and prototype evaluation because both stakeholder perspectives place clear emphasis on them. Professionally anchored criteria, including Compliance with Standards and Regulations and Energy Efficient, can be assigned to technical or lifecycle review even when they are less prominent in immediate consumer priority. Criteria that depend more strongly on market or symbolic context, such as Price, Prestige Value, and Exclusiveness, benefit from an explicit statement of target segment, positioning, and use context before they are applied to a concept.

This application path also creates a practical basis for later field validation. Design teams can record which evidence pattern informed a requirement, how the requirement was translated into a concept decision, and what form of verification was used during prototype review. A future study can then compare decision traceability, specification clarity, sustainability coverage, and user evaluation across teams that use the framework and teams that follow existing development procedures. In this way, the present framework supports both design practice and a clear programme for evaluating its usefulness in real development settings.

5.9 Scope and Future Validation

The present study establishes a relationship between consumer priority and professional content relevance within one sustainable product design framework. Its present scope centres on early design interpretation within electrical and electronic kitchenware, using an electric rice cooker as the common product context and a 37-indicator professional relevance structure. Future validation can extend the framework to additional product categories and decision environments.

Future research can extend the framework in three directions. First, independent consumer and expert samples should test whether the same integrated evidence patterns appear across furniture, mobility products, appliances, industrial equipment, or products that combine digital and physical components. Second, multiple item construct measurement can examine convergent and discriminant relationships among the seven domains. Third, field studies can compare design teams using the integrated evidence framework with teams using conventional design procedures to determine whether it improves concept selection, specification quality, sustainability integration, or user evaluation. These extensions would move the model from content and priority evidence toward construct, predictive, and field validation.

A staged validation programme would provide the strongest next test of the framework. Replication should first establish whether the same evidence patterns appear with independent consumer and professional samples. Construct validation can then examine the internal relationships among the seven domains using multiple item measures and appropriate latent variable techniques. A prospective field study can subsequently test decision utility by comparing design teams that use the integrated framework with teams following existing design procedures. Relevant outcomes could include concept selection quality, clarity of specifications, traceability of sustainability decisions, and the consistency of user evaluation after prototype development.

Transferability should also be examined across product categories and cultural contexts because the meaning of market, symbolic, service, and sustainability criteria can vary substantially. Durable household products, furniture, mobility products, industrial equipment, and products combining digital and physical components provide useful settings for testing whether the seven-domain structure remains stable. Cross category replication would also show whether the evidence patterns identified here represent general sustainable design relationships or context specific configurations. This validation path would move the framework from integrated priority and content evidence toward stronger

construct, predictive, and field-based support.

CONCLUSION

This study establishes an integrated evidence framework that brings together consumer priority and professional relevance across 37 sustainable product design indicators. The analysis shows how user salience and professional representational strength interact within the same seven domain structure and translates those relationships into design decision support.

The integrated results reveal three broad conditions. Shape, Reliability, and Product Benefit show the clearest descriptive correspondence across stakeholder groups. Function demonstrates broad domain coherence, with distributed consumer priorities accompanied by very high professional relevance across all indicators. Safety, Sustainability, and Commerciality show differentiated stakeholder emphasis, while Innovation combines a strong shared focus on Product Benefit with greater contextual variation around prestige, exclusivity, and novelty.

The study brings consumer importance and professional relevance into one design-oriented interpretation. Consumer evidence indicates what is salient from the intended user perspective, while professional evidence addresses relevance and conceptual representation. Reading both together identifies criteria that receive shared emphasis and criteria whose interpretation depends more strongly on lifecycle, market, or symbolic context. The resulting framework provides an integrated basis for early sustainable product design decisions.

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All authors contributed to the conceptual development, integrated evidence analysis, interpretation, review, and preparation of this paper.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

DATA AVAILABILITY

The aggregate consumer and professional evidence used in the integrated analysis is reported in the tables within this article. Individual participant responses are not reproduced to preserve confidentiality. Supporting statistical documentation is retained by the corresponding author.

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