

Developing Sustainable Consumer Practices: A Framework for Managing Refurbished Electronic Goods in India

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Received 22 February 2024; revised 13 June 2024; accepted 26 September 2024

This study delves into sustainable buying behaviour for refurbished electronic goods in India, driven by the increasing importance of sustainable consumption. It aims to identify key factors influencing consumer decisions, providing insights for businesses and policymakers. The research employs Interpretive Structural Modelling (ISM) and Spherical Fuzzy Analytic Hierarchy Process (SF-AHP). Eight participants from varied backgrounds contribute diverse perspectives, and a strategic methodology includes expert briefings, literature distribution, and collaborative decision-making. Fourteen sustainability drivers are identified and ranked using SF-AHP. Noteworthy factors include "Personal Financial Situation," highlighting economic influence, and ISM analysis reveals societal impact, product quality, and cost savings as central themes. Analysis such as MICMAC (Matrice d' Impacts Croisés Multiplication Appliqués à un Classement i.e., cross-impact matrix multiplication applied to classification) underscores the interconnectedness of factors, emphasizing driving forces like customer support and product upgradability. Such analysis adds complexity, highlighting driving and dependent factors, offering a holistic view of refurbished product adoption dynamics in India. The novelty lies in integrating ISM and SF-AHP methodologies, unveiling fourteen sustainability drivers, and providing insights into factors influencing consumer choices. This study offers a nuanced understanding of sustainable consumer behaviour, emphasizing economic considerations, trust-building measures, and awareness campaigns. The findings contribute actionable insights for businesses and policymakers aiming to promote the adoption of refurbished goods in the Indian market.

Keywords: Consumer behaviour, Fuzzy sets, Multi criteria decision making, Refurbished products, Remanufacturing

Introduction

In the contemporary landscape marked by escalating environmental concerns and a heightened awareness of ecological sustainability, understanding and influencing consumer behavior has emerged as a paramount consideration.¹ Consumers are becoming increasingly conscientious about their choices, actively seeking products and practices that align with principles of environmental preservation.² The significance of refurbished product adoption lies in its potential to mitigate environmental impact through reduced waste, decreased demand for new resource extraction, and the promotion of a circular economy.³ This study seeks to uncover the underlying motivations and drivers influencing consumers in their choice to embrace or resist refurbished products, ultimately shedding light on the transformative potential of sustainable consumer behavior. As the world grapples with pressing environmental challenges, understanding and promoting the adoption

of refurbished products become pivotal in fostering a more sustainable consumer landscape.⁴ Refurbished products, often overlooked in conventional consumption narratives, are gaining prominence as a viable choice for environmentally conscious consumers.⁵

The global discourse on sustainability underscores the need for sophisticated methodologies to explore and comprehend the intricacies of consumer choices.⁶ The SF-AHP, characterized by its ability to handle uncertainties and vagueness in decision-making, is a flexible tool for evaluating and prioritizing diverse factors influencing consumer preferences.^{7,8} Concurrently, Interpretive Structural Modeling (ISM) enhances our ability to unveil the complex interdependencies among these factors, providing a holistic perspective on the decision-making process.⁹⁻¹¹ The integration of these two robust methodologies forms the crux of our research, with the aim of contributing to the body of knowledge surrounding sustainable consumer behavior.

This research focuses on understanding sustainable consumer behavior, specifically in the context of

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refurbished products. The paper explores the evolving preferences of consumers, highlighting how purchasing decisions can promote positive environmental change. It also acknowledges the challenges in identifying the factors shaping consumer behavior in the refurbished products market, aiming to shed light on this unique niche.

1. To identify the primary drivers of consumer behavior in adopting refurbished products.
2. To quantify the relative importance of these drivers to provide a nuanced understanding of their impact.
3. To delineate the interrelationships among these factors, exploring the intricate web of influences that shape consumer decisions.

Literature Review

Sustainable consumer behavior involves individuals prioritizing environmentally and socially responsible choices in their consumption patterns.¹² Recent trends in sustainable consumer behavior research highlight a growing focus on refurbished products, circular economies, and innovative methodologies, showcasing an evolving landscape towards conscientious and environmentally responsible decision-making.¹³ The existing literature on consumer attitudes toward refurbished products explores the perceptions and preferences individuals have when considering previously owned items that have undergone restoration. Researchers investigate factors influencing consumer acceptance, such as perceptions of product quality¹⁴, trust in refurbishment processes¹⁵, and the role of pricing.¹⁶ Additionally, studies delve into the impact of environmental consciousness on consumers' willingness to adopt refurbished goods.¹⁷

Spherical Fuzzy AHP–ISM Integrated Framework

The Spherical Fuzzy Analytic Hierarchy Process–Interpretive Structural Modeling (AHP–ISM) Integrated Framework represents a novel and advanced approach to decision-making and system analysis. This framework combines the flexibility and descriptive power of Spherical Fuzzy Sets with the analytical precision of AHP and the structural insights provided by ISM. Spherical Fuzzy Sets offer a more comprehensive representation of uncertainty and ambiguity, allowing decision-makers to express their judgments in a more nuanced manner.¹⁸ AHP facilitates the structuring of complex decision problems by decomposing them into a hierarchy of criteria and alternatives¹⁹, while ISM helps in unveiling the interrelationships among these

elements.²⁰ ISM facilitates the establishment of interconnections among poorly communicated and structured variables in the literature, drawing insights from expert opinions and group discussions.²¹

ISM is characterized by unique features.¹¹ The determination of interrelationships among different elements is contingent on the collective judgment of a group of experts, underscoring its importance. It relies on mutual relationships to unravel the intricate structure of a set of variables. This technique furnishes a model that delineates the structure of all conceivable relationships among the variables under consideration.

Consumer Behaviour and Multicriteria Decision Making

A study proposes a streamlined framework, employing Multi-Criteria Decision-Making (MCDM) methods—AHP for criteria weights and COPRAS for ranking digital marketing technologies.²² An article investigates factors influencing online purchasing, with gender-specific variations in perceived importance.²³ Several studies are available in the literature where ISM has been applied independently in the domain of consumer behavior.^{24,25} Within the realm of empirical studies on sustainable consumer behavior, an evident gap is discerned in the absence of hierarchical interrelationships among identified factors in case of adoption of refurbished products. The current literature lacks a comprehensive understanding of how these individual elements interact within a hierarchical framework, hindering the ability to discern primary influencers and their impact on sustainable behavior. Moreover, the absence of clear rankings further compounds this limitation, leaving a critical void in our grasp of the nuanced dynamics governing the hierarchy of factors influencing sustainable consumer behavior.

The literature review reveals several research gaps related with consumer behavior and refurbished items, including

- absence of a comprehensive list of drivers,
- a scarcity of studies addressing the intersection of Multicriteria decision-making and consumer behavior in the context of refurbished products, and
- a lack of information on the interrelationship among various drivers.

Building upon the insights gleaned from the literature review, the research methodology is crafted to address identified gaps and extend our understanding of sustainable consumer behaviour, particularly in the realm of refurbished products.

Research Methodology

In this study, sustainable buying behaviour of refurbished product was used for the case development. In addressing the challenge of modeling and ranking drivers associated with the purchase of refurbished products, the chosen methodology involves the integration of ISM and SF-AHP. To ascertain the optimal approach, a thorough examination of prior studies utilizing ISM and AHP methodologies was conducted, drawing insights from the works of Lee²⁶ and Kumar & Rahman.²⁷ The literature underscores the importance of engaging a diverse group of experts, including customers, retailers, distributors, suppliers, and academia, to

identify sustainability drivers.²⁸ The overall research methodology in depicted in Fig. 1.

Factor Identification

Eight experts, including six from various areas of the supply chain and two academics with over a decade of experience, participated in this study. Multiple sessions were carefully organized to achieve the study's objectives. The data in Table 1 shows the list of identified drivers/factors.

Spherical Fuzzy AHP

In the realm of decision-making, fuzzy sets have emerged as a means to address uncertainties. Recently, the development of SFS has drawn the

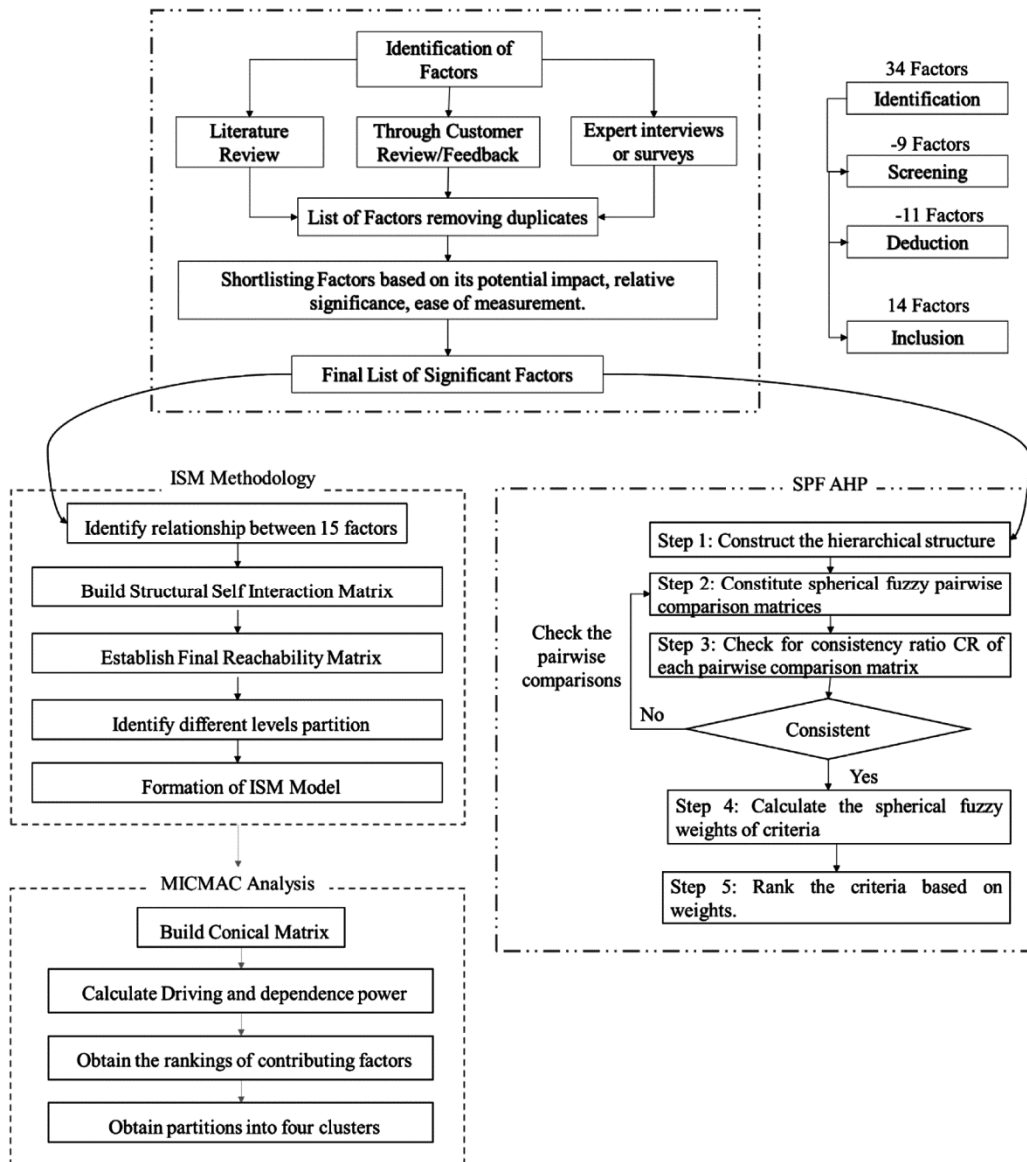


Fig. 1 — Research Methodology

Table 1 — Details of factors identified

S N	Factor	Description
1	Cost Savings ²⁹	One of the primary reasons consumers opt for refurbished products is the potential for cost savings compared to new items.
2	Perceived Quality/reliability ³⁰	Consumers may consider the perceived quality of refurbished products, including the extent to which they are restored to a like–new condition.
3	Warranty and guarantees ³¹	The availability and terms of warranties or guarantees on refurbished products can significantly influence consumer confidence in their reliability.
4	Trust/Brand Reputation ³²	The trust/reputation of the brand associated with the refurbished product can impact consumer confidence and adoption.
5	Upgradability ³³	Some consumers may prefer refurbished products if they can easily upgrade or customize them to suit their specific needs.
6	Awareness and Education ³⁴	Consumer knowledge about the benefits of refurbished products and the refurbishment process can affect their willingness to adopt such items.
7	Previous Experience ³⁵	Positive or negative experiences with refurbished products in the past can shape consumers' attitudes and behaviours toward future purchases.
8	Social Influence ³⁶	Recommendations from friends, family, or online communities can influence consumers' decisions to adopt refurbished products.
9	Personal Financial Situation ³⁷	Individual financial circumstances may play a role in the decision–making process, with budget–conscious consumers being more inclined to choose refurbished items.
10	Online Reviews and Ratings ³⁸	Positive reviews and high ratings for refurbished products can build consumer trust and increase the likelihood of adoption
11	Security and Privacy Concerns ³⁹	For certain electronic devices, concerns about data security and privacy may influence consumers' decisions to choose new over refurbished products.
12	Product Lifecycle ⁴⁰	Consumers may be more inclined to choose refurbished products if they believe the product still has a significant portion of its lifecycle remaining.
13	Perceived Social Status ⁴¹	Consumer perception of owning refurbished products in relation to social status or image.
14	Customer Support ⁴²	The quality of customer support and after–sales service for refurbished products can impact consumers' confidence in their purchase decision.

interest of researchers. Introduced by Gundogdu *et al.*^{43,44} SFS is an extension of fuzzy sets that combines Pythagorean fuzzy sets (PFS) and Neuromorphic sets.⁴⁵ SFS enables decision–makers to express their uncertain opinions through following settings.

Definition 1. A SFS \tilde{A}_S of a universe of discourse P can be stated as (Eq. (1) , Eq. (2))

$$\tilde{A}_S = \{ \{p, \mu_{\tilde{A}_S}(p), v_{\tilde{A}_S}(p), \pi_{\tilde{A}_S}(p) \mid p \in P \} \}, \dots (1)$$

Where,

$$\begin{aligned} \mu_{\tilde{A}_S}(p): P \rightarrow [0,1], v_{\tilde{A}_S}(p): P \rightarrow [0,1], \pi_{\tilde{A}_S}(p): P \rightarrow [0,1] \\ \text{and} \\ 0 \leq \mu_{\tilde{A}_S}^2(p) + v_{\tilde{A}_S}^2(p) + \pi_{\tilde{A}_S}^2(p) \leq 1, \forall p \in P \end{aligned} \dots (2)$$

The membership degree, non–membership degree, and hesitancy degree of p to \tilde{A}_S are denoted by $\mu_{\tilde{A}_S}(p)$, $v_{\tilde{A}_S}(p)$, and $\pi_{\tilde{A}_S}(p)$, respectively, for each p in P. Numerical operations have been developed by examining the relationship between SFS and PFS.

Definition 2. The following definitions pertain to basic operators for two Spherical Fuzzy Sets (SFSs) (Eqs. (3–6)) from universes of discourse P1 and P2,

represented as $\tilde{A}_S = (\mu_{\tilde{A}_S}, v_{\tilde{A}_S}, \pi_{\tilde{A}_S})$ and $\tilde{B}_S = (\mu_{\tilde{B}_S}, v_{\tilde{B}_S}, \pi_{\tilde{B}_S})$, respectively, in this research paper. Let P₁ and P₂ denote the two universes of discourse:

Addition

$$\tilde{A}_S \oplus \tilde{B}_S = \left\{ \left(\mu_{\tilde{A}_S}^2 + \mu_{\tilde{B}_S}^2 - \mu_{\tilde{A}_S}^2 \mu_{\tilde{B}_S}^2 \right)^{\frac{1}{2}}, v_{\tilde{A}_S} v_{\tilde{B}_S}, \left((1 - \mu_{\tilde{B}_S}^2) \pi_{\tilde{A}_S}^2 + (1 - \mu_{\tilde{A}_S}^2) \pi_{\tilde{B}_S}^2 - \pi_{\tilde{A}_S}^2 \pi_{\tilde{B}_S}^2 \right)^{\frac{1}{2}} \right\} \dots (3)$$

Multiplication

$$\tilde{A}_S \otimes \tilde{B}_S = \left\{ \mu_{\tilde{A}_S} \mu_{\tilde{B}_S}, \left(v_{\tilde{A}_S}^2 + v_{\tilde{B}_S}^2 - v_{\tilde{A}_S}^2 v_{\tilde{B}_S}^2 \right)^{\frac{1}{2}}, \left((1 - v_{\tilde{B}_S}^2) \pi_{\tilde{A}_S}^2 + (1 - v_{\tilde{A}_S}^2) \pi_{\tilde{B}_S}^2 - \pi_{\tilde{A}_S}^2 \pi_{\tilde{B}_S}^2 \right)^{\frac{1}{2}} \right\} \dots (4)$$

Scalar Multiplication ($\lambda > 0$)

$$\lambda_* \tilde{A}_S = \left\{ \left(1 - (1 - \mu_{\tilde{A}_S}^2)^\lambda \right)^{\frac{1}{2}}, v_{\tilde{A}_S}, \left((1 - \mu_{\tilde{A}_S}^2)^\lambda - (1 - \mu_{\tilde{A}_S}^2 - \pi_{\tilde{A}_S}^2)^\lambda \right)^{\frac{1}{2}} \right\} \dots (5)$$

Power of $\tilde{A}_S (\lambda > 0)$

$$\tilde{A}_S^\lambda = \left\{ \mu_{\tilde{A}_S}^\lambda, \left(1 - \left(1 - v_{\tilde{A}_S}^2\right)^\lambda\right)^{\frac{1}{2}}, \left(\left(1 - v_{\tilde{A}_S}^2\right)^\lambda - \left(1 - v_{\tilde{A}_S}^2 - \pi_{\tilde{A}_S}^2\right)^\lambda\right)^{\frac{1}{2}} \right\} \dots (6)$$

Definition 3. To facilitate aggregation, the SWAM (Eq.(7)) indicating spherical weighted arithmetic means defined as follows, where the $w = (w_1, w_2, \dots, w_n)$ has values in the range $[0,1]$ and satisfies the condition $\sum_{i=1}^n w_i = 1$.

$$\begin{aligned} SWAM_w(\tilde{A}_{S1}, \tilde{A}_{S2}, \dots, \tilde{A}_{Sn}) &= w_1\tilde{A}_{S1} + w_2\tilde{A}_{S2} + \dots + w_n\tilde{A}_{Sn} \\ &= \& \left\{ \left[1 - \prod_{i=1}^n \left(1 - \mu_{\tilde{A}_{Si}}^2\right)^{w_i} \right]^{\frac{1}{2}}, \right. \\ &\quad \left. \prod_{i=1}^n v_{\tilde{A}_{Si}}^{w_i}, \left[\prod_{i=1}^n \left(1 - \mu_{\tilde{A}_{Si}}^2\right)^{w_i} - \prod_{i=1}^n \left(1 - \mu_{\tilde{A}_{Si}}^2 - \pi_{\tilde{A}_{Si}}^2\right)^{w_i} \right]^{\frac{1}{2}} \right\} \end{aligned} \dots (7)$$

The SF–AHP method encompasses following steps:

Step 1: Establish the structure of the model.

The top–level represents the model's goal, which is determined by a scoring index. The second level consists of n criteria that are utilized to evaluate the alternatives defined in the third level of the structure.

Step 2: Formulate pairwise comparison matrices using linguistic terms (as demonstrated in Table 2):

The calculation of the score indices (SI) for each alternative is performed using Eqs 8 & 9.

$$SI = \sqrt{\left| 100 * \left[\left(\mu_{\tilde{A}_s} - \pi_{\tilde{A}_s} \right)^2 - \left(v_{\tilde{A}_s} - \pi_{\tilde{A}_s} \right)^2 \right] \right|} \dots (8)$$

for AM, VH, HI, SM, and EI.

Table 2 — Linguistic measures of importance for pairwise comparison

Definition	(μ, v, π)	ScoreIndex (SI)
Absolutely more importance (AM)	(0.9,0.1,0.0)	9
Very high importance (VH)	(0.8,0.2,0.1)	7
High importance (HI)	(0.7,0.3,0.2)	5
Slightly more importance (SM)	(0.6,0.4,0.3)	3
Equally importance (EI)	(0.5,0.4,0.4)	1
Slightly lower importance (SL)	(0.4,0.6,0.3)	1/3
Low importance(LI)	(0.3,0.7,0.2)	1/5
Very low importance (VL)	(0.2,0.8,0.1)	1/7
Absolutely low importance (AL)	(0.1,0.9,0.0)	1/9

$$\frac{1}{SI} = \frac{1}{\sqrt{\left| 100 * \left[\left(\mu_{\tilde{A}_s} - \pi_{\tilde{A}_s} \right)^2 - \left(v_{\tilde{A}_s} - \pi_{\tilde{A}_s} \right)^2 \right] \right|}} \dots (9)$$

for SL, LI, VL, and AL.

Step 3: It involves assessing the consistency of each pairwise comparison matrix using the classical consistency check. The Consistency Ratio (CR) threshold of 10% is utilized for this purpose (Eq. 10).

$$CR = \frac{CI}{RI} \dots (10)$$

The Consistency Index (CI) is calculated using Eq.11 as follows:

$$CI = \frac{\lambda_{max} - n}{n - 1} \dots (11)$$

where, the maximum eigenvalue of the matrix, denoted as λ_{max} , is used in conjunction with the number of criteria (n) in the calculation. The Random Index (RI) used in Eq. 10 is determined by considering the number of criteria utilized in the research study.

Step 4: It involves obtaining the fuzzy weights for both the criteria and alternatives. The weights of each alternative with respect to each criterion are obtained using Eq. 7.

Step 5: At this stage, there are two viable methods for performing the computation. The initial method involves employing the score function outlined in Eq. 12 to deconstruct the criteria weights and obtain a crisp value.

$$S(\tilde{w}_j^S) = \sqrt{\left| 100 * \left[\left(3\mu_{\tilde{A}_s} - \frac{\pi_{\tilde{A}_s}}{2} \right)^2 - \left(\frac{v_{\tilde{A}_s}}{2} - \pi_{\tilde{A}_s} \right)^2 \right] \right|} \dots (12)$$

Next, the normalization of criteria weights is carried out using Eq. 13, followed by the application of spherical fuzzy multiplication described in Eq. 14.

$$\bar{w}_j^S = \frac{S(\tilde{w}_j^S)}{\sum_{j=1}^n S(\tilde{w}_j^S)} \dots (13)$$

$$\begin{aligned} \tilde{A}_{Sij} &= \bar{w}_j^S * \tilde{A}_{Si} = \\ &\left(1 - \left(1 - \mu_{\tilde{A}_{Si}}^2 \right)^{\bar{w}_j^S} \right)^{1/2}, v_{\tilde{A}_{Si}}^{\bar{w}_j^S} \left(\left(1 - \mu_{\tilde{A}_{Si}}^2 \right)^{\bar{w}_j^S} - \left(1 - \mu_{\tilde{A}_{Si}}^2 - \pi_{\tilde{A}_{Si}}^2 \right)^{\bar{w}_j^S} \right)^{1/2} \end{aligned} \dots (14)$$

The calculation of the final ranking score (\tilde{F}) for each alternative A_i is performed using Eq. 15:

$$\tilde{F} = \sum_{j=1}^n \tilde{A}_{Sij} = \tilde{A}_{Si1} + \tilde{A}_{Si2} + \dots + \tilde{A}_{Sin} \dots (15)$$

Interpretive Structural Modelling

In the ISM approach, it is assumed that system components are interdependent and can be organized into a hierarchical structure. Creating a logical diagram involves the following systematic steps:

Step 1: Develop Structural Self-Interaction Matrix (SSIM)

To generate the SSIM matrix, expert opinions were gathered to establish relationships between the factors under consideration. The SSIM matrix formed, with following relationships:

'V' indicates that the i^{th} factor aims to achieve the j^{th} factor.

'A' indicates that the j^{th} factor aims to achieve the i^{th} factor.

'X' signifies mutual improvement between factors i and j .

'O' denotes no discernible relationship between the factors.

This matrix serves to map out and understand the interdependencies among the factors crucial for developing SSIM.

Step 2 and 3 – Preparing Initial and Final Reachability Matrix (RM)

Based on the rules provided for transforming the SSIM matrix into a RM, the following steps were followed:

- 'V' in CellSSIM(i, j) translates to CellRM(i, j) = 1 and CellRM(j, i) = 0.
- 'A' in CellSSIM(i, j) translates to CellRM(i, j) = 0 and CellRM(j, i) = 1.
- 'X' in CellSSIM(i, j) translates to CellRM(i, j) = 1 and CellRM(j, i) = 1.
- 'O' in CellSSIM(i, j) translates to CellRM(i, j) = 0 and CellRM(j, i) = 0.

The initial reachability matrix (IRM) was created following the described guidelines. After eliminating indirect links, the final version of the Reachability Matrix (RM) was produced.

Step 4– Level partitions

The reachability set was defined by identifying rows in the matrix where there is a '1' in the i^{th} row, while the antecedent set was formed based on columns where there is a '1' in the j^{th} column. The intersection set, which includes common factors between the reachability set and antecedent set, was computed for all factors. This set is referred to as the intersection set.

Each factor in the i^{th} row that shares elements with the intersection set is assigned to level I. Subsequently, the factor is removed, and the intersection set is recalculated. This process repeats until all factors are appropriately categorized into levels. These levels, denoted as level I to level V, illustrate the progression from initial to final iterations of level partitioning. These levels play a crucial role in constructing the diagram and finalizing the ISM model.

Step 5: Replacing criteria nodes with relationship and Forming ISM

The level partitions are essential for constructing the ISM depicted in Fig. 2, where factors are interconnected based on their relationships with each other.

MICMAC Analysis

The MICMAC analysis assesses the driving power and dependence of factors contributing to the problem or goal. Driving power is calculated by summing the rows of the final reachability matrix, while dependence power is determined by summing the columns. The MICMAC analysis is depicted in Fig. 3.

Results and Discussions

Analysis of Spherical Fuzzy AHP

The Spherical Fuzzy Pairwise Comparison Matrix and result from the DF-AHP model is shown in Table 3 and Table 4 respectively. The ranks of the criteria are provided in Table 5.

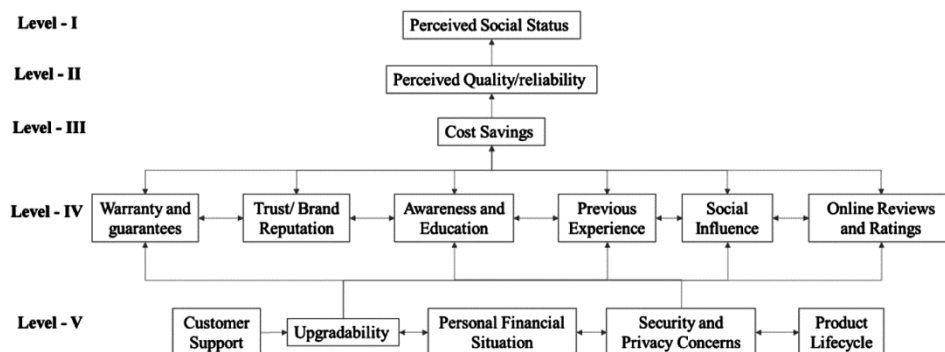


Fig. 2 — Hierarchical Interpretive Structural Model based on identified criteria

At the top, "Personal financial situation" leads with a weight of 0.092, emphasizing the critical role of economic factors in driving consumer decisions toward refurbished products. "Previous experience" follows closely at 0.086, showing that positive past interactions significantly impact future buying choices. "Security and privacy concerns" rank third

with 0.085, highlighting the importance of safety in building trust. "Warranty and guarantees" come in fourth (0.078), underscoring the need for reliable post-purchase support, while "Cost savings" at fifth (0.077) reinforces the influence of financial benefits. Both "Trust/Brand reputation" and "Customer support" share sixth place (0.073), reflecting the value of brand image and after-sales service. "Perceived social status" (0.068) indicates societal influences, followed by "Awareness and education" (0.067) and "Product lifecycle" (0.066). Lower-ranked criteria include "Online reviews and ratings" (0.064), "Social influence" (0.059), and the lowest, "Perceived quality/reliability" and "Upgradability" (0.056), signalling a focus on quality and product adaptability.

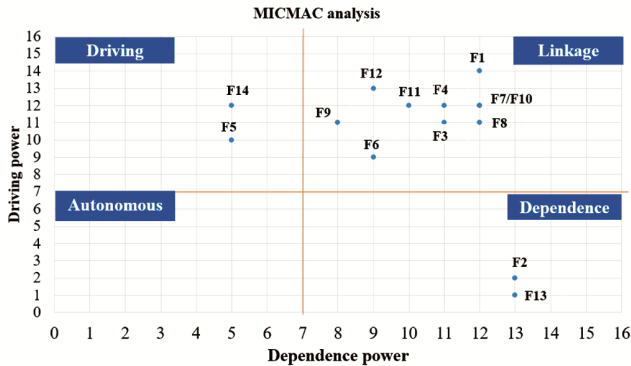


Fig. 3 — Classification of factors as per MICMAC analysis

Table 3 — Spherical fuzzy pairwise comparison matrix of identified criteria

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
C1	EI	HI	SM	SL	SM	VH	EI	VH	SL	LI	VL	SL	EI	SM
C2	LI	EI	LI	VL	LI	EI	LI	SL	AL	EI	SL	SM	HI	SL
C3	SL	HI	EI	EI	VH	VH	LI	SL	EI	LI	VL	VH	EI	EI
C4	SM	VH	EI	EI	HI	SM	SL	EI	VL	EI	HI	SL	EI	VL
C5	SL	HI	VL	LI	EI	SL	LI	LI	VL	SL	LI	HI	VL	SL
C6	VL	EI	VL	SL	SM	EI	EI	HI	SL	SM	EI	SM	SM	EI
C7	EI	HI	HI	SM	HI	EI	EI	VH	SM	HI	EI	SM	HI	SM
C8	VL	SM	SM	EI	HI	LI	VL	EI	LI	EI	VL	SL	EI	LI
C9	SM	AM	EI	VH	HL	SM	SL	HI	EI	VH	SM	SM	EI	EI
C10	HI	EI	HI	EI	SM	SL	LI	EI	VL	EI	LI	LI	SL	SL
C11	VH	SM	VH	LI	HI	EI	EI	VH	SL	HI	EI	SM	SM	EI
C12	SM	SL	VL	SM	LI	SL	SL	SM	SL	HI	SL	EI	EI	SM
C13	EI	LI	EI	EI	VH	SL	LI	EI	EI	SM	SL	EI	EI	SM
C14	SL	SM	EI	VH	SM	EI	SL	HI	EI	SM	EI	SL	SL	EI

Table 5 — Ranking of identified Criteria with associated weights

Rank	Criteria	Crisp Weights
1	Personal financial situation	0.092
2	Previous experience	0.086
3	Security and privacy concerns	0.085
4	Warranty and guarantees	0.078
5	Cost savings	0.077
6	Trust/Brand reputation	0.073
7	Customer support	0.073
8	Perceived social status	0.068
9	Awareness and education	0.067
10	Product lifecycle	0.066
11	Online reviews and ratings	0.064
12	Social influence	0.059
13	Perceived quality/reliability	0.056
14	Upgradability	0.056

Table 4 — Criteria and associated weights obtained from SF-AHP model

Criteria	Spherical fuzzy weights			Defuzzified values	Crisp weights
	Membership (μ)	Non-Membership (ν)	Degree of hesitancy(π)		
C1	0.573	0.423	0.278	15.808	0.077
C2	0.435	0.558	0.286	11.617	0.056
C3	0.581	0.407	0.275	16.043	0.078
C4	0.554	0.427	0.300	15.118	0.073
C5	0.428	0.587	0.245	11.613	0.056
C6	0.516	0.458	0.322	13.858	0.067
C7	0.638	0.344	0.281	17.742	0.086
C8	0.458	0.528	0.294	12.270	0.059
C9	0.675	0.315	0.259	18.949	0.092
C10	0.487	0.496	0.300	13.110	0.064
C11	0.633	0.355	0.270	17.640	0.085
C12	0.501	0.495	0.300	13.522	0.066
C13	0.523	0.437	0.334	14.009	0.068
C14	0.556	0.419	0.318	15.078	0.073

Table 6 — Structural self interaction matrix (SSIM) between identified criteria/factors

S N	Factors/Drivers	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Cost savings	–	V	V	A	A	O	X	X	X	X	A	V	O	O
2	Perceived quality/reliability		–	A	A	O	A	A	A	O	A	A	O	V	A
3	Warranty and guarantees			–	V	O	O	O	O	A	O	O	A	O	X
4	Trust/ Brand reputation				–	O	A	V	V	O	A	V	O	V	A
5	Upgradability					–	O	O	O	O	O	V	A	O	A
6	Awareness and education						–	A	V	O	A	V	O	O	O
7	Previous experience							–	V	O	X	V	O	V	A
8	Social influence								–	O	X	O	O	V	O
9	Personal financial situation									–	O	O	O	V	O
10	Online reviews and ratings										–	A	A	V	A
11	Security and privacy concerns											–	A	O	A
12	Product lifecycle												–	V	V
13	Perceived social status													–	O
14	Customer support														–

Table 7 — Final reachability matrix (FRM) between identified criteria/factors

S N	Factors/Drivers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Driving Power
1	Cost savings	1	1	1	1*	1*	1*	1	1	1	1	1*	1	1*	1*	14
2	Perceived quality/reliability	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2
3	Warranty and guarantees	1*	1	1	1	1*	0	1*	1*	0	1*	1*	0	1*	1	11
4	Trust/ Brand reputation	1	1	1*	1	0	1*	1	1	1*	1*	1	1*	1	0	12
5	Upgradability	1	1*	1*	0	1	0	1*	1*	1*	1*	1	1*	0	0	10
6	Awareness and education	1*	1	0	1	0	1	1*	1	0	1*	1	0	1*	0	9
7	Previous experience	1	1	1*	1*	0	1	1	1	1*	1	1	1*	1	0	12
8	Social influence	1	1	1*	1*	0	1*	1*	1	1*	1	0	1*	1	0	11
9	Personal financial situation	1	1*	1	1*	0	0	1*	1*	1	1*	0	1*	1	1*	11
10	Online reviews and ratings	1	1	1*	1	0	1	1	1	1*	1	1*	1*	1	0	12
11	Security and privacy concerns	1	1	1*	1*	0	1*	1*	1*	1*	1	1	1*	1*	0	12
12	Product lifecycle	1*	1*	1	1*	1	1*	1*	1*	0	1	1	1	1	1	13
13	Perceived social status	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
14	Customer support	1*	1	1	1	1	1*	1	1*	0	1	1	0	1*	1	12
	Dependence power	12	13	11	11	5	9	12	12	8	12	10	9	13	5	

* represents transitive links

structured hierarchy of factors influencing sustainable consumer behaviour in adopting refurbished products in India. At the top, "Perceived social status" occupies Level I, highlighting the significant role of societal perceptions in consumer decisions. This factor is closely linked to Level II, where "Perceived quality/reliability" emerges as key, indicating that consumer trust in the quality of refurbished products is vital in shaping their purchasing choices. At Level III, "Cost savings" stands out, underscoring the strong influence of economic considerations in driving sustainable consumption. This hierarchy illustrates

how social, quality, and financial factors collectively shape consumer behaviour in this market.

At Level IV, a cluster of interconnected factors shapes the decision-making process for adopting refurbished products. These include "Warranty and guarantees," which offer reassurance about product reliability, and "Trust/Brand reputation," which helps build consumer confidence. "Awareness and education," "Previous experience," "Social influence," and "Online reviews and ratings" also influence decisions, reflecting how knowledge, past encounters, and societal perceptions impact consumer choices.

Table 8 — Level Partitioning of identified factors

FN	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,2,3,4,5,6,7,8,9,10,11,12,13,14,	1,3,4,5,6,7,8,9,10,11,12,14,	1,3,4,5,6,7,8,9,10,11,12,14,	III
2	2,13,	1,2,3,4,5,6,7,8,9,10,11,12,14,	2	II
3	1,2,3,4,5,7,8,10,11,13,14,	1,3,4,5,7,8,9,10,11,12,14,	3,4,5,7,8,10,11,14,	IV
4	1,2,3,4,6,7,8,9,10,11,12,13,	1,3,4,6,7,8,9,10,11,12,14,	3,4,6,7,8,9,10,11,12,	IV
5	1,2,3,5,7,8,9,10,11,12,	1,3,5,12,14,	5,9,11,12,	V
6	1,2,4,6,7,8,10,11,13,	1,4,6,7,8,10,11,12,14,	4,6,7,8,10,11,	IV
7	1,2,3,4,6,7,8,9,10,11,12,13,	1,3,4,5,6,7,8,9,10,11,12,14,	3,4,6,7,8,9,10,11,12,	IV
8	1,2,3,4,6,7,8,9,10,12,13,	1,3,4,5,6,7,8,9,10,11,12,14,	3,4,6,7,8,9,10,12,	IV
9	1,2,3,4,7,8,9,10,12,13,14,	1,4,5,7,8,9,10,11,	9,12,14,	V
10	1,2,3,4,6,7,8,9,10,11,12,13,	1,3,4,5,6,7,8,9,10,11,12,14,	3,4,6,7,8,9,10,11,12,	IV
11	1,2,3,4,6,7,8,9,10,11,12,13,	1,3,4,5,6,7,10,11,12,14,	,9,11,12,	V
12	1,2,3,4,5,6,7,8,10,11,12,13,14,	1,4,5,7,8,9,10,11,12,	5,11,12,14,	V
13	13,	1,2,3,4,6,7,8,9,10,11,12,13,14,	13	I
14	1,2,3,4,5,6,7,8,10,11,13,14,	1,3,9,12,14,	5,11,14,	V

Table 9 — Ranking obtained after application of MICMAC analysis

Factor	Factors/problems	Depen Pow	Driv Pow	Driv/Depen Pow	MICMAC rank
1	Cost savings	12	14	1.17	6
2	Perceived quality/reliability	13	2	0.15	13
3	Warranty and guarantees	11	11	1.00	8
4	Trust/ Brand reputation	11	12	1.09	7
5	Upgradability	5	10	2.00	2
6	Awareness and education	9	9	1.00	8
7	Previous experience	12	12	1.00	8
8	Social influence	12	11	0.92	12
9	Personal financial situation	8	11	1.38	4
10	Online reviews and ratings	12	12	1.00	8
11	Security and privacy concerns	10	12	1.20	5
12	Product lifecycle	9	13	1.44	3
13	Perceived social status	13	1	0.08	14
14	Customer support	5	12	2.40	1

At Level V, factors like "Upgradability," "Personal financial situation," "Security and privacy concerns," "Product lifecycle," and "Customer support" emphasize the importance of adaptability, financial considerations, security assurances, environmental awareness, and post-purchase support. These specific elements illustrate the comprehensive decision-making process that consumers undertake when considering the adoption of refurbished products, focusing on both practical and emotional factors. The rank as per MICMAC analysis is given in Table 9.

The MICMAC analysis unveils a multifaceted landscape of factors influencing the adoption of refurbished products. The Linkage group factors illustrate the intricate relationships among various elements, emphasizing the need for a holistic approach to address drivers. The Driving group factors, with their high influence and low dependency, stand out as key drivers that can independently shape consumer decisions. Meanwhile, the Dependent group

factors underscore the impact of broader market forces and societal trends on adoption. Understanding these dynamics is crucial for businesses and policymakers aiming to promote the acceptance of refurbished products, offering valuable insights for targeted interventions and strategies to overcome drivers and foster greater consumer confidence in this growing market segment.

The MICMAC analysis reveals a nuanced landscape of factors influencing the adoption of refurbished products. Within the Linkage group, "Cost savings", "Warranty and guarantees", and "Trust/Brand reputation" are pivotal. "Cost savings" is a major motivator, with moderate influence and dependency, showing that financial benefits are crucial in consumer decisions. Similarly, "Warranty and guarantees", and "Trust/Brand reputation" provide essential reassurance and build consumer confidence. Therefore "Awareness and education", "Previous experience", "Online reviews and ratings",

“Security and privacy concerns”, and “Product lifecycle” further influence consumer behaviour, emphasizing the need for effective communication and support to address various consumer concerns.

In the Driving group, “Upgradability” and “Customer support” emerge as key drivers. “Upgradability” holds significant influence with minimal dependency, underscoring its role in attracting consumers to refurbished products. “Customer Support”, with high driving power and low dependency, is crucial for fostering consumer trust and adoption. Conversely, factors in the Dependent group, such as “Perceived quality/reliability” and “Perceived social status”, are more susceptible to external influences, reflecting broader market dynamics and societal trends. This analysis provides valuable insights for businesses and policymakers to craft strategies that address these diverse factors and enhance the appeal of refurbished products.

Managerial Implications

For businesses and policymakers, the study offers actionable insights to enhance strategies for promoting the adoption of refurbished products. Recognizing the paramount influence of personal financial situations, the importance of creating economic incentives is evident. Focusing on building trust through warranty policies, brand reputation, and customer support can mitigate drivers. Moreover, targeted awareness and education campaigns, considering online reviews and ratings, can play a crucial role in shaping positive consumer perceptions. The findings suggest that a holistic approach, addressing the interconnectedness of factors, is essential for successful interventions.

Conclusions

This research explores sustainable buying behaviour of refurbished electronic goods in India, using an integrated ISM and SF-AHP methodology. It identifies key factors influencing consumer decisions, such as economic considerations, past experiences, security concerns, and warranty policies. ISM analysis reveals a hierarchy where societal influence, product quality, and cost savings emerge as major drivers, while MICMAC analysis underscores the interconnected nature of these factors, highlighting customer support and product upgradability as key forces. Despite offering valuable insights, this research is limited to the Indian market and expert

opinions may introduce bias. Consumer behaviour also evolves over time, which a cross-sectional design may not fully capture. Future studies should consider temporal changes and compare different regions and cultures. Using real-time data and investigating the role of emerging technologies like blockchain and AI on consumer perceptions in refurbished products are recommended for a more comprehensive understanding.

References

- 1 Vu N T & Anh M H, Consumer perception and behavior in the context of sustainable fashion: A comprehensive analysis of emerging trends and impacts, *J Hum Behav Soc Sci*, **3(1)** (2019) 1–14.
- 2 Rathore B, Aligning profitability and environmental responsibility: A study on sustainable marketing strategies, *Eduzone Int Peer Rev Ref Multidiscip J*, **6(2)** (2017) 7–15.
- 3 Ghisellini P, Ripa M & Ulgiati S, Exploring environmental and economic costs and benefits of a circular economy approach to the construction and demolition sector A literature review, *J Clean Prod*, **178** (2018) 618–643, <https://doi.org/10.1016/j.jclepro.2017.11.207>.
- 4 Agrawal R, Wankhede V A, Kumar A & Luthra S, Analysing the roadblocks of circular economy adoption in the automobile sector: Reducing waste and environmental perspectives, *Bus Strat Environ*, **30(2)** (2021) 1051–1066, <https://doi.org/10.1002/bse.2669>.
- 5 van Langen S K, Vassillo C, Ghisellini P, Restaino D, Passaro R & Ulgiati S, Promoting circular economy transition: A study about perceptions and awareness by different stakeholders groups, *J Clean Prod*, **316** (2021) 128166, <https://doi.org/10.1016/j.jclepro.2021.128166>.
- 6 Teng Z, He Y & Qiao Z, Exploring the synergistic effects of digitalization and economic uncertainty on environmental sustainability: An investigation from China, *Sustain*, **15(15)** (2023) 11997, <https://doi.org/10.3390/su151511997>.
- 7 KutluGündoğdu F & Kahraman C, A novel spherical fuzzy analytic hierarchy process and its renewable energy application, *Soft Comput*, **24** (2020) 4607–4621, <https://doi.org/10.1007/s00500-019-04222-w>.
- 8 Dogan O, Process mining technology selection with spherical fuzzy AHP and sensitivity analysis, *Expert Syst Appl*, **178** (2021) 114999, <https://doi.org/10.1016/j.eswa.2021.114999>.
- 9 Joshi M, Uncovering issues impacting mobile banking performance using ISM–MICMAC approach, *J Sci Ind Res*, **82(11)** (2023) 1184–1192.
- 10 Joshi M & Deshpande V, Enhancing ergonomics in automotive cylinder head manual lapping: Workstation assessment and design, *J Sci Ind Res*, **82(9)** (2023) 915–924, <https://doi.org/10.56042/jsir.v82i9.504>.
- 11 Joshi M & Deshpande V, Application of interpretive structural modelling (ISM) for developing ergonomic workstation improvement framework, *Theor Issues Ergon Sci*, **24(1)** (2023) 88–110, <https://doi.org/10.1080/1463922X.2022.2044932>.
- 12 White K, Habib R & Hardisty D J, How to SHIFT consumer behaviors to be more sustainable: A literature review and guiding framework, *J Mark*, **83(3)** (2019) 22–49, <https://doi.org/10.1177/0022242919825649>.

- 13 Harms R & Linton J D, Willingness to pay for eco-certified refurbished products: The effects of environmental attitudes and knowledge, *J Ind Ecol*, **20(4)** (2016) 893–904, <https://doi.org/10.1111/jiec.12301>.
- 14 Schniederjans M J, Cao Q & Olson J R, Consumer perceptions of product quality: Made in China, *Qual Manag J*, **11(3)** (2004) 8–18, <https://doi.org/10.1080/10686967.2004.11919118>.
- 15 Mugge R, Safari I & Balkenende R, Is there a market for refurbished toothbrushes? An exploratory study on consumers' acceptance of refurbishment for different product categories, in *Prod Lifetimes Environ* (IOS Press) 2017, 293–297.
- 16 Zhang Y, He Y, Yue J & Gou Q, Pricing decisions for a supply chain with refurbished products, *Int J Prod Res*, **57(9)** (2019) 2867–2900, <https://doi.org/10.1080/00207543.2018.1543968>.
- 17 Bigliardi B, Filippelli S & Quinto I, Environmentally-conscious behaviours in the circular economy An analysis of consumers' green purchase intentions for refurbished smartphones, *J Clean Prod*, **378** (2022) 134379, <https://doi.org/10.1016/j.jclepro.2022.134379>.
- 18 Akram M & Ashraf M, Multi-criteria group decision-making based on spherical fuzzy rough numbers, *Granul Comput*, **8(6)** (2023) 1267–1298, <https://doi.org/10.1007/s41066-023-00412-y>.
- 19 Vidal L A, Marle F & Bocquet J C, Using a Delphi process and the Analytic Hierarchy Process (AHP) to evaluate the complexity of projects, *Expert Syst Appl*, **38(5)** (2011) 5388–5405, <https://doi.org/10.1016/j.eswa.2010.10.016>.
- 20 Attri R, Dev N & Sharma V, Interpretive structural modelling (ISM) approach: An overview, *Res J Manag Sci*, **2319(2)** (2013) 1171.
- 21 Warfield J W, Developing interconnected matrices in structural modeling, *IEEE Trans Syst Man Cybern*, **4(1)** (1974) 51–81, <https://doi.org/10.1109/TSMC.1974.5408524>.
- 22 Mukul E, Büyüközkan G & Güler M, Evaluation of digital marketing technologies with MCDM methods, in *Proc 6th Int Conf New Ideas Manag Econ Account* (France Paris) 2019, 19–21.
- 23 Srivastava P R, Sharma A, Yadav R S, Sharma S K & Kaur I, Online store attribute preferences: A gender based perspective and MCDM approach, *Int J Strategic Decis Sci*, **9(2)** (2018) 70–84, doi: 10.4018/IJSDS.2018040105.
- 24 Fatima Z, Siddiqui M A M & Farooqi R, Determinants of green consumer behaviour among Indian consumers: An ISM approach, *Vision*, (2022), <https://doi.org/10.1177/09722629221131100>.
- 25 Singh S & Gupta A, An ISM modeling for factors affecting the purchase of green products, *J Modelling Manag*, **16(1)** (2021) 103–123, <https://doi.org/10.1108/JM2-05-2019-0099>.
- 26 Lee S, Drivers for the participation of small and medium-sized suppliers in green supply chain initiatives, *Supply Chain Manage Int J*, **13(3)** (2008) 185–198.
- 27 Kumar D & Rahman Z, Modelling relationship marketing strategies for sustainability adoption, *Int J Intercult Inf Manag*, **3(4)** (2013) 277–291, <https://doi.org/10.1504/IJIM.2013.059971>.
- 28 Brito M P D, Carbone V & Blanquart C, Towards a sustainable fashion retail supply chain in Europe: Organization and performance, *Int J Prod Econ*, **114(2)** (2008) 534–555, <https://doi.org/10.1016/j.ijpe.2007.06.012>.
- 29 Leard B, Consumer inattention and the demand for vehicle fuel cost savings, *J Choice Model*, **29** (2018) 1–16, <https://doi.org/10.1016/j.jocm.2018.08.002>.
- 30 Oliveira A S D, Souki G Q, Silva D D, Silva M A R & Medeiros F D A D S, Impacts of service guarantees on consumers' perceived quality and satisfaction in e-commerce, *Int J Qual Reliab Manage*, **40(10)** (2023) 2559–2580, <https://doi.org/10.1108/IJQR-06-2022-0175>.
- 31 Sun J J, Bellezza S & Paharia N, Buy less buy luxury: Understanding and overcoming product durability neglect for sustainable consumption, *J Mark*, **85(3)** (2021) 28–43, <https://doi.org/10.1177/0022242921993172>.
- 32 Rani N S A & Suradi Z, International brand vs local brand: An evaluation of brand trust brand reputation customer satisfaction and purchase intention of Malaysian customers, *J Bus Retail Manage Res*, **11(3)** (2017) 179–185.
- 33 Pialot O, Millet D & Bisiaux J, Upgradable PSS: Clarifying a new concept of sustainable consumption/production based on upgradability, *Clean Prod*, **141** (2017) 538–550, <https://doi.org/10.1016/j.jclepro.2016.08.161>.
- 34 Hasibuan F U & Judijanto L, The influence of education consumer awareness and government regulation on sustainable consumption behavior: A case study on ciawitali market in garut regency west, *Sci J Econ Entrepreneurship*, **1(03)** (2023) 109–119, <https://doi.org/10.58812/wsjee.v1i03.406>.
- 35 Alshurideh M, Nicholson M & Xiao S, The effect of previous experience on mobile subscribers' repeat purchase behaviour, *Eur J Soc Sci*, **30(3)** (2012) 366–376.
- 36 Batinic B & Appel M, Mass communication social influence and consumer behavior: two field experiments, *J Appl Soc Psychol*, **43(7)** (2013) 1353–1368, <https://doi.org/10.1111/jasp.12090>.
- 37 Katona G, Consumer behavior: Theory and findings on expectations and aspirations, *Am Econ Rev*, **58(2)** (1968) 19–30.
- 38 Leon R D, Hotel's online reviews and ratings: A cross-cultural approach, *Int J Contemp Hosp Manage*, **31(5)** (2019) 2054–2073, <https://doi.org/10.1108/IJCHM-05-2018-0413>.
- 39 Neama G Alaskar R & Alkandari M, Privacy security risk and trust concerns in e-commerce, in *Proc 17th Int Conf Distributed Comput Network* (Singapore) 2016, 1–6, <https://doi.org/10.1145/2833312.2850445>.
- 40 Eslami S P, Ghasemaghaei M & Hassanein K, Understanding consumer engagement in social media: The role of product lifecycle, *Decis Support Syst*, **162** (2022) 113707, <https://doi.org/10.1016/j.dss.2021.113707>.
- 41 Yurchisin J & Johnson K K, Compulsive buying behavior and its relationship to perceived social status associated with buying materialism self-esteem and apparel-product involvement, *Fam Consum Sci Res J*, **32(3)** (2004) 291–314, <https://doi.org/10.1177/1077727X03261178>.
- 42 Jerath K, Kumar A & Netessine S, An information stock model of customer behavior in multichannel customer support services, *Manuf Serv Oper Manage*, **17(3)** (2015) 368–383, <https://doi.org/10.1287/msom.2015.0523>.

- 43 KutluGündoğdu F & Kahraman C, Spherical fuzzy sets and decision making applications, In Intelligent and Fuzzy Techniques in Big Data Analytics and Decision Making, in *Proceedings of the INFUS 2019 Conference Istanbul Turkey* (Springer International Publishing) 2020, 979–987, https://doi.org/10.1007/978-3-030-23756-1_116.
- 44 Gündoğdu F K, Principals of spherical fuzzy sets, in *Intelligent and Fuzzy Techniques in Big Data Analytics and Decision Making: Proceedings of the INFUS 2019 Conference Istanbul Turkey* (Springer International Publishing) 2020, 15–23, https://doi.org/10.1007/978-3-030-23756-1_4.
- 45 Kahraman C & Gündoğdu F K, Decision making with spherical fuzzy sets, *Stud Fuzziness Soft Comput*, **392** (2021) 3–25, https://doi.org/10.1007/978-3-030-45461-6_1.