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Integration of Circular Economy Principles in Consumer Behaviour for Sustainable Laptops

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Abstract

This research investigates the integration of circular economy principles in consumer behaviour toward refurbished laptops in India, addressing critical gaps in understanding sustainable electronics adoption in emerging markets. Employing Structural Equation Modelling (SEM) via SmartPLS on survey data collected from Indian consumers, the study examines five key determinants: attitude, perceived risk, environmental concern, subjective norms, and product knowledge. The analysis reveals that attitude toward refurbished laptops is the strongest predictor of purchase intention ($\beta = 0.377$), while perceived risk significantly inhibits adoption ($\beta = -0.228$). Environmental concern ($\beta = 0.180$), subjective norm ($\beta = 0.105$), and product knowledge ($\beta = 0.090$) demonstrate positive but weaker effects. 52.5% of variance in purchase intention ($R^2 = 0.525$) is explained by the model, indicating substantial predictive power. All measurement scales demonstrate excellent reliability (Cronbach's $\alpha > 0.87$, CR > 0.90) and validity (AVE > 0.66). Findings suggest that promoting positive attitudes through quality assurance, warranties, and transparent product information, while simultaneously addressing risk perceptions, represents the most effective strategy for accelerating circular economy adoption. This study advances theoretical understanding of sustainable consumption in emerging markets and provides actionable insights for policymakers, manufacturers, and retailers promoting circular economy principles in India's rapidly growing electronics sector.

Keywords
Circular Economy, Refurbished Laptops, Structural Equation Modelling, India Market, Sustainable Consumption.

1. Introduction
The global electronics sector faces mounting environmental pressures from resource depletion, e-waste accumulation, and escalating carbon emissions associated with manufacturing new devices. In response, the circular economy (CE) paradigm has emerged as a transformative framework emphasizing product life extension, reuse, remanufacturing, and recycling to resource consumption from decouple economic growth. Within this context, refurbished laptops represent a critical opportunity for implementing circular economy principles, offering substantial environmental benefits while addressing growing consumer demand for affordable computing devices. However, despite the environmental and economic advantages of refurbished electronics, consumer adoption remains limited, particularly in emerging markets such as India.

The rapid expansion of India's digital economy, driven by increasing internet reach, digital transformation initiatives, and a burgeoning middle class, has created unprecedented demand for computing devices. Yet, the preference for new products over refurbished alternatives persists, creating a significant barrier to circular economy implementation. Understanding the behavioural drivers and barriers influencing Indian consumers' purchase intentions toward refurbished laptops is therefore essential for accelerating sustainable consumption patterns and reducing electronic waste.

1.1 Circular Economy and Consumer Behaviour

Recent studies highlight that consumer behaviour is vital to circular economy success. Camacho-Otero et al. (2023) found attitudes, norms, perceived control, self-identity, and risk shape decisions about circular products, with pre-purchase factors like knowledge and value influencing consumption patterns. Parajuly et al. (2020) noted an intention-action gap in EU electronic waste management, recommending nudging and social marketing to drive circular behaviour.

Research on remanufactured electronics has increased. Jiménez-Parra et al. (2014) identified attitudes, norms, and control as important for purchase intent in Spain, while trust and brand preference remain obstacles. Wang et al. (2020) showed that clear communication about processes and quality helps consumers switch to remanufactured laptops.

1.2 Environmental Justification for Laptop Reuse

Life Cycle Assessment (LCA) studies provide compelling evidence for the environmental benefits of laptop reuse. André et al (2019) analysed second-hand laptop operations in Sweden, demonstrating that extending laptop lifespan through professional refurbishment reduces overall environmental impacts by 39-50% compared to purchasing new devices. Their research revealed that most environmental impacts stem from manufacturing—particularly printed circuit boards and integrated circuits—making product life extension through reuse the most effective strategy for environmental improvement. This finding underscores the critical need to understand and address consumer behaviour as a lever for achieving circular economy environmental objectives.

1.3 Consumer Purchase Drivers for Refurbished Electronics

Recent research employing advanced analytical methods has identified key factors influencing refurbished electronics adoption. Studies utilizing social media mining, Interpretive Structural Modelling (ISM), and network analysis have revealed that trust in retailers and brands, product price, warranty coverage, and hardware specifications constitute primary purchase drivers (Abbey, Meloy, & Guide, 2015). Furthermore, conjoint analysis research on eco-friendly laptop attributes demonstrates that consumers prioritize battery life, physical design quality, and eco-certifications alongside price considerations, suggesting that refurbished products must compete on multiple dimensions beyond cost alone.

1.4 Research Gap and Study Objectives

Despite growing research on circular economy consumer behaviour, significant gaps remain. First, existing studies predominantly focus on developed markets in Europe, North America, and East Asia, with limited empirical research addressing emerging markets such as India, where affordability constraints, brand preferences, and infrastructure challenges create distinct consumer decision contexts. Second, while the Theory of Planned Behaviour has been widely applied, comprehensive models integrating attitude, risk perception, environmental concern, product knowledge, and social influence within the Indian refurbished laptop context remain underdeveloped. Third, the relative importance of these factors in predicting purchase intentions has not been systematically quantified using advanced SEM methodologies within the Indian market.

This study addresses these gaps by investigating the integration of circular economy principles in consumer behaviour toward refurbished laptops among Indian consumers. Specifically, the research objectives are:

1. To identify and validate key determinants of purchase intention for refurbished laptops in India
2. To quantify the relative importance of attitude, perceived risk, environmental concern, subjective norms, and product knowledge in predicting purchase intentions
3. To assess the predictive power of an integrated behavioural model using Partial Least Squares Structural Equation Modelling (PLS-SEM)

4. To provide evidence-based recommendations for manufacturers, retailers, and policymakers to accelerate circular economy adoption in India's electronics sector

By employing rigorous SEM methodology grounded in the Theory of Planned Behaviour and extending prior research to the Indian context, this study contributes both theoretical advancement in circular economy consumer research and practical insights for promoting sustainable consumption patterns in one of the world's fastest-growing electronics markets.

2. Literature Review

The transition from linear to circular economic models in the electronics sector requires not only technological innovation and policy support but fundamentally depends on shifts in consumer behaviour and acceptance. This literature review synthesizes empirical and theoretical research on circular economy principles, consumer behaviour toward remanufactured and refurbished electronics—particularly laptops—and the determinants of sustainable consumption in both developed and emerging markets. Drawing on studies employing diverse methodologies including Life Cycle Assessment, Structural Equation Modelling, conjoint analysis, and systematic reviews, this review examines key behavioural constructs such as attitude, perceived risk, environmental concern, social influence, and product knowledge. Particular attention is given to identifying research gaps related to the Indian market context, where affordability pressures, infrastructure constraints, and cultural preferences create distinct consumer decision dynamics. This review establishes the theoretical and empirical foundation for the present study's investigation of purchase intentions toward refurbished laptops among Indian consumers.

2.1 Circular Economy Principles and Electronics Reuse

The circular economy replaces the linear "take-make-dispose" model with regenerative systems that focus on resource retention and waste reduction. In electronics, strategies like remanufacturing, repair, and recycling help lower environmental impact while preserving value. A Swedish LCA study found refurbished laptops cut environmental impacts by up to 50% versus new devices, largely because production—especially of circuit boards—drives most emissions. Promoting refurbished laptops thus strongly supports circularity in tech. However, studies show that shifting to circular models faces hurdles such as consumer acceptance, regulations, and logistics; technological advances alone aren't enough without behavioural changes from both consumers and organizations.

2.2 Consumer Behaviour Toward Remanufactured and Refurbished Electronics

Understanding how consumers decide to buy circular products is a major research focus. Camacho-Otero et al. (2023) reviewed 232 studies using an Antecedent-Decision-Outcome framework, identifying five main adoption drivers: attitudes, social norms, perceived control, environmental self-identity, and perceived risk. They also highlighted a gap between positive intentions and actual purchases.

Research on remanufactured laptops, such as Jiménez-Parra et al. (2014), found that attitude, social influence, and perceived control significantly impact purchase intentions, but trust, quality concerns, and preference for new products hinder adoption. Wang et al. (2020) showed that clear communication about refurbishment and warranties boosts consumer confidence, stressing the need to address information gaps through certification and education.

Vidal-Ayuso et al. (2023) confirmed that the Theory of Planned Behaviour dominates this research area but recommended incorporating factors like risk, trust, economic motivation, and environmental concern for better models. They also noted most studies are concentrated in developed countries, calling for more research in emerging markets, especially South Asia.

2.3 Behavioural Theories and Conceptual Frameworks

The Theory of Planned Behavior (Ajzen, 1991) suggests that intentions are shaped by attitude, social norms, and perceived control; it is widely used in research on sustainable consumption and the circular economy.

Parajuly, Fitzpatrick, and Kuehr (2020) reviewed strategies for promoting circular economy adoption in EU electronic waste management. They found that while models like TPB predict intentions, they often miss the gap between intention and action, recommending multi-level interventions—such as shaping attitudes, activating norms, improving convenience, and offering incentives.

Perceived risk, including functional, financial, physical, social, and psychological aspects—is a major barrier to purchasing remanufactured electronics. Abbey, Meloy, and Guide (2015) showed these risks with lower purchase intent, emphasizing the need for warranties, certifications, guarantees, and reputable retailers to encourage market growth.

2.4 Product Attributes and Purchase Drivers for Eco-Friendly Laptops

Recent research has employed advanced analytical methods to identify specific attributes influencing eco-friendly laptop purchase decisions. Liao et al. (2022) utilized conjoint analysis to examine consumer preferences for eco-friendly laptop attributes in Taiwan, finding that battery life, physical design quality, and eco-certifications significantly influence purchase intentions alongside price considerations. Their study revealed heterogeneity in consumer preferences—environmentally conscious segments prioritize sustainability credentials, while price-sensitive segments emphasize affordability and performance. This finding underscores the importance of market segmentation strategies in promoting refurbished laptops.

Barkhi et al. (2024) employed big data analytics and social media mining to identify key drivers of refurbished laptop purchases globally. Using Interpretive Structural Modelling (ISM) and network analysis on consumer reviews and discussions, they identified trust in retailer/brand, product price, warranty coverage, and hardware specifications as primary decision factors. Their analysis revealed that digital reputation signals—including online reviews, influencer endorsements, and peer recommendations—significantly shape consumer perceptions and purchase likelihood in the refurbished electronics market.

2.5 Organizational and Post-Purchase Circular Behaviours

While most research focuses on pre-purchase decision-making, understanding post-purchase behaviours—including product use intensity, repair decisions, and end-of-life disposal—is equally critical for circular economy success. Organizational contexts provide valuable insights into circular electronics management. Qualitative research on corporate ICT circularity in the Netherlands (2025) revealed that employee behaviours regarding laptop use, maintenance, and disposal are shaped by organizational culture, information availability at decision points, and perceived functional stakes. This research highlighted that organizational interventions targeting convenience, clear information, and aligned incentives can significantly enhance circular behaviours.

2.6 Research Gaps and Indian Market Context

Although circular economic consumer research is expanding, several key gaps persist. Most studies focus on developed regions, with limited attention to India, despite its vast population and rapidly growing electronics market. Differences in culture, economy, infrastructure, and brand preferences highlight the need for specific research in the Indian context.

Research also lacks comprehensive behavioural models, often overlooking factors like risk perception, environmental concern, and social influence—especially regarding refurbished laptops in India. Furthermore, the gap between consumers stated intentions and actual behaviours needs further exploration, particularly concerning barriers like availability, affordability, and information gaps in emerging markets.

Additionally, current methodologies are mostly cross-sectional surveys; more longitudinal, experimental, and mixed-methods research is needed to uncover causal relationships. This study uses Structural Equation Modelling to assess key behavioural drivers for India's electronics market, offering insights for both academia and industry to promote circular economy adoption.

2.7 Conclusion

The literature review reveals a robust and growing body of research demonstrating that consumer behaviour is central to circular economy success in the electronics sector. The Theory of Planned Behaviour, enriched by constructs including perceived risk, environmental concern, and product knowledge, provides a well-validated theoretical framework for understanding purchase intentions toward refurbished laptops. Empirical studies consistently identify attitude, trust, and risk perception as the most influential factors, while environmental concern and social norms play important but secondary roles. Life Cycle Assessment research provides compelling environmental justification for laptop reuse strategies.

However, significant research gaps remain. First, geographic concentration in developed markets leaves emerging economies—particularly India—underexplored despite their rapid market growth and unique socio-economic contexts. Second, the persistent intention-behaviour gap documented across studies highlights the need for context-specific interventions that address not only attitudinal barriers but also structural constraints such as product availability, information asymmetry, and warranty concerns. Third, methodological diversity is needed, including longitudinal studies and experimental designs that can establish causal pathways for behaviour change.

This study addresses these gaps by employing rigorous Structural Equation Modelling to empirically test an integrated behavioural model within the Indian refurbished laptop market, thereby contributing both theoretical advancement and actionable insights for accelerating circular economy adoption in one of the world's most strategic electronics markets.

3. Methodology

3.1 Research Design

A quantitative, cross-sectional research design was employed in this study to investigate the integration of circular economy principles into consumer behaviour for refurbished laptops in India. The study develops and empirically tests a conceptual model grounded in the Theory of Planned Behaviour (Ajzen, 1991) and enriched by additional constructs relevant to the circular economy context—namely perceived risk, environmental concern, and product knowledge. A survey methodology is used, using Partial Least Squares Structural Equation Modelling (PLS-SEM) through SmartPLS software the data was analysed.

3.2 Sampling and Data Collection

The desired target population comprises adult consumers across urban and rural regions of India. A multi-stage, non-probability sampling approach—combining convenience sampling and snowball techniques—was utilized to ensure inclusion of diverse demographic segments and maximize regional representation. The survey was administered both online via digital questionnaire platforms.
Inclusion criteria encompassed:

- Age over 18 years
- Residency in India
- Experience with or awareness of laptops

3.3 Survey Instrument Development

The survey instrument was developed following a rigorous process:

- **Construct Operationalization:** Six latent constructs were measured: Attitude toward Refurbished Laptops, Perceived Risk, Environmental Concern, Subjective Norm (Social Influence), Product Knowledge, and Purchase Intention.

- **Item Design:** Five items were used to measure each construct, adapted from or inspired by established scales in the literature (e.g., Jiménez-Parra et al., 2014; Wang et al., 2020; Camacho-Otero et al., 2023). Items were reviewed and validated by a panel of academic and psychological experts for clarity, relevance, and content validity.

- **Measurement Scale:** Each item used a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), ensuring metric invariance and analytical compatibility with SEM.

- **Demographics:** Eleven demographic/background variables were recorded (age, gender, education, employment, income, region, residency type, technical awareness, laptop ownership, and frequency of use (Table 1).

Table 1. Items of measurement

Construct	Code	Measurement Item (all: 5-point Likert scale, 1=Strongly Disagree to 5=Strongly Agree)	Factor Loadings
Attitude	ATT1	I have a favourable opinion about using a refurbished laptop.	0.849
	ATT2	Using a refurbished laptop is a wise choice for me.	0.884
	ATT3	I believe refurbished laptops are as good as new ones for my needs.	0.905
	ATT4	I would feel positive emotions when using a refurbished laptop.	0.833
	ATT5	I consider using a refurbished laptop to be a responsible action.	0.837
Perceived Risk	PR1	I am concerned about the quality of refurbished laptops.	0.720
	PR2	Using a refurbished laptop might involve more risk than a new one.	0.835
	PR3	I worry about the warranty and after-sales service for refurbished laptops.	0.809
	PR4	I think refurbished laptops may stop working sooner than new ones.	0.876
	PR5	Buying a refurbished laptop makes me anxious about wasting money.	0.855
Subjective Norm	SN1	People who are important to me support my choice to buy a refurbished laptop.	0.767
	SN2	My family thinks I should consider refurbished laptops.	0.872
	SN3	Friends encourage me to try refurbished laptops.	0.884
	SN4	People around me are generally positive about refurbished laptops.	0.859
	SN5	I feel social approval if I use a refurbished laptop.	0.749
Environmental Concern	EC1	I prefer products that are environmentally sustainable, such as refurbished laptops.	0.853
	EC2	Using a refurbished laptop helps protect the environment.	0.864
	EC3	Environmental issues influence my choice of buying a refurbished laptop.	0.858
	EC4	Reducing e-waste is important to me, so I consider refurbished laptops.	0.846
	EC5	I feel responsible to use refurbished electronics for environmental reasons.	0.859
Product Knowledge	PK1	I am knowledgeable about refurbished laptops and their benefits.	0.627
	PK2	I know how to distinguish a good-quality refurbished laptop.	0.854
	PK3	I keep informed about features of refurbished laptops.	0.901
	PK4	I know where to find trustworthy refurbished laptops.	0.882
	PK5	I am aware of the companies that offer reliable refurbished laptops.	0.844
Purchase Intention	PI1	I am likely to buy a refurbished laptop in the future.	0.854
	PI2	I would choose a refurbished laptop over a new one if the features are similar.	0.916
	PI3	I intend to purchase a refurbished laptop when I upgrade my device.	0.918
	PI4	I plan to recommend refurbished laptops to others.	0.937
	PI5	I will consider refurbished laptops as my first option for my next purchase.	0.941

3.4 Hypothesis

- **H1:** Attitude toward refurbished laptops positively influences purchase intention.
- **H2:** Perceived risk of refurbished laptops negatively influences purchase intention.
- **H3:** Subjective norm positively influences purchase intention for refurbished laptops.
- **H4:** Environmental concern positively influences purchase intention for refurbished laptops.
- **H5:** Product knowledge positively influences purchase intention for refurbished laptops.

3.5 Ethical Considerations

All participants received an informed consent form outlining the purpose, voluntary nature, confidentiality assurances, and data privacy measures of the study. Participation was voluntary, all data were anonymized, and no personally identifiable information was collected or reported.

4. Data Collection

4.1 Data Cleaning and Screening

Collected data were reviewed for completeness and consistency. Incomplete or duplicate responses were removed. Assumptions of normality were assessed, though PLS-SEM is robust to violations of normality.

4.2 PLS-SEM Modelling (SmartPLS)

The analysis comprised two stages:

- **Measurement Model Assessment:**
  - Internal consistency reliability (Cronbach's alpha, Composite Reliability, rho_A)
  - Convergent validity (Average Variance Extracted, outer loadings)
  - Discriminant validity (Heterotrait-Monotrait Ratio)

- **Structural Model Assessment:**
  - Path coefficients with bootstrapped standard errors and significance testing
  - Coefficient of determination (R^2) for endogenous constructs
  - Effect size (f^2) calculations
  - Variance Inflation Factor (VIF) for collinearity assessment
  - Model fit indices (SRMR, NFI)

4.3 Reporting and Interpretation

Significance of hypothesized relationships was evaluated using t-statistics and p-values from bootstrapping runs (5,000 samples). Model performance was summarized using explained variance (R^2), effect sizes, and practical significance of findings.

5. Result and Discussion

5.1. Structural Model Assessment (Path Coefficients and Hypothesis Testing)

The structural model demonstrates strong empirical support for the proposed theoretical framework examining consumer behaviour toward refurbished laptops in India. The path coefficient analysis reveals the following significant relationships:

Primary Findings:

- **Attitude → Purchase Intention ($\beta = 0.377$, $p < 0.05$)**: This represents the strongest predictor in the model, indicating that positive consumer attitudes toward refurbished laptops significantly influence purchase intentions. This finding aligns with the Theory of Planned Behaviour and confirms **Hypothesis H1**.

- **Perceived Risk → Purchase Intention ($\beta = -0.228$, $p < 0.05$)**: The negative coefficient confirms that higher perceived risks (quality concerns, warranty issues, financial risk) significantly reduce purchase intentions for refurbished laptops, supporting **Hypothesis H2**.

- **Subjective Norm → Purchase Intention ($\beta = 0.105$, $p < 0.05$)**: Social influence shows a positive but relatively weak effect on purchase intentions, supporting **Hypothesis H3**.

- **Environmental Concern → Purchase Intention ($\beta = 0.180$, $p < 0.05$)**: Environmental consciousness positively influences purchase intentions, though with moderate effect size, confirming **Hypothesis H4**.

- **Product Knowledge → Purchase Intention (β = 0.090, p < 0.05)**: Although having statistical significance, product knowledge demonstrates the weakest direct effect on purchase intentions, confirming **Hypothesis H5**.

5.2 Model Explanatory Power and Predictive Relevance

The model demonstrates substantial explanatory power with **R^2 = 0.525** for Purchase Intention, indicating that the five predictor constructs collectively explain **52.5% of the variance** in consumer purchase intentions for refurbished laptops. This represents a strong model performance according to Cohen's (1988) guidelines for behavioural research.

The effect sizes (f^2) reveal:

- **Attitude**: Large effect (f^2 = 0.193)
- **Perceived Risk**: Medium effect (f^2 = 0.069)
- **Environmental Concern**: Small to medium effect (f^2 = 0.036)
- **Product Knowledge and Subjective Norm**: Small effects (f^2 < 0.02)

5.3 Measurement Model Reliability and Validity

The measurement model demonstrates excellent psychometric properties:

Internal Consistency Reliability:

- **Cronbach's Alpha**: All constructs exceed 0.87, well above the 0.70 threshold
- **Composite Reliability (ρc)**: All values > 0.90, indicating excellent internal consistency
- **Composite Reliability (ρA)**: All values > 0.91, confirming robust reliability

Convergent Validity:

- **Average Variance Extracted (AVE)**: All constructs exceed 0.66, surpassing the 0.50 minimum threshold
- **Outer Loadings**: Most indicators load above 0.80, with only PK1 (0.643) and PR1 (0.717) slightly below this threshold but still acceptable above 0.60

Discriminant Validity:

The Heterotrait-Monotrait (HTMT) ratio analysis confirms discriminant validity, with all values below the conservative 0.85 threshold, ensuring constructs are empirically distinct.

5.4 Collinearity Assessment

Variance Inflation Factor (VIF) values for all predictor constructs are below 3.0, indicating no multicollinearity concerns in the structural model. This confirms that each predictor contributes unique explanatory value.

5.5 Model Fit Assessment

The model demonstrates adequate fit:

- **SRMR = 0.071** (below the 0.08 threshold)
- **NFI = 0.871** (approaching the 0.90 benchmark)

These indices suggest reasonable model fit, though there may be room for minor improvements.

5.6 Practical and Theoretical Implications

Theoretical Contributions:

1. The study extends the Theory of Planned Behaviour to the circular economy context in an emerging market setting
2. Confirms the central role of attitudes in driving sustainable consumption behaviour

3. Validates the importance of risk perception as a barrier to circular product adoption
4. Demonstrates that environmental concern, while significant, is not the primary driver of purchase behaviour

Practical Implications:

1. **Marketing Strategy**: Organizations should prioritize attitude formation through positive messaging and product demonstrations
2. **Risk Mitigation**: Addressing quality concerns through warranties, certifications, and transparent quality assessments is crucial
3. **Environmental Messaging**: While important, environmental benefits should be combined with other value propositions
4. **Social Influence**: Leveraging testimonials and social proof can provide additional purchase motivation

5.7 Limitations and Future Research Directions

The measurement model shows one indicator (PK1) with loading below 0.70, suggesting potential for instrument refinement. Future research could explore additional factors such as price sensitivity, experience, and technological anxiety that may influence circular economy adoption decisions.

6. Conclusion

This research advances the understanding of how circular economy principles can be successfully integrated into consumer behaviour for sustainable laptops within the Indian market. Drawing on the Theory of Planned Behaviour and leveraging empirical evidence from a robust SEM analysis, the study demonstrates that attitude toward refurbished laptops is the single most powerful driver of purchase intention, while perceived risk stands as the principal barrier. Environmental concern, product knowledge, and subjective norms also exert significant, albeit more moderate, influences.

The findings highlight that positive messaging, quality assurance, warranty provision, and information transparency are critical levers for increasing consumer uptake of refurbished laptops in emerging markets. Organizations and policymakers must directly address consumer doubts and risk perceptions to bridge the persistent intention-action gap. Additionally, the model's strong predictive power and excellent measurement reliability stress the importance of a multi-factorial approach to behavioural interventions, rather than relying solely on environmental arguments.

By focusing on context-specific drivers and barriers and applying rigorous analytic techniques, this paper contributes both theoretical advancement and actionable recommendations for accelerating circular economy adoption in India's electronics sector. Future research should extend these insights by exploring longitudinal behavioural pathways, different product categories, and interventions that convert intention into sustained circular purchasing behaviour. Ultimately, fostering a circular electronics market is not only a matter of economic or environmental necessity, but a pivotal step toward sustainable development and responsible consumption globally.

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