

## **Discussing the Integration and Innovation of Product Design Thinking and Cultural Values from the Perspective of Sustainable Development**

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**Abstract:** The historical understanding of design has evolved from a focus on aesthetics and functionality towards a more comprehensive approach that considers its social, economic, and environmental impact. The product design lifecycle typically encompasses several distinct stages, including pre-production, manufacturing, distribution, consumer use, and disposal. Our mixed-methods study explored the integration of product design thinking and cultural values for sustainable development. We recruited 51 participants, consisting of sustainable product designers and consumers with diverse backgrounds. The survey revealed a strong interest in sustainability among participants, with a majority willing to pay a slight premium for eco-friendly products. Designers reported a higher awareness of Life Cycle Assessment (LCA) compared to consumers. Thematic analysis of interviews with designers and consumers highlighted five cultural aspects influencing design considerations: individualism vs. collectivism, masculinity vs. femininity, power distance, long-term vs. short-term orientation, and uncertainty avoidance. For instance, designers emphasized considering user needs based on cultural values, such as prioritizing personal preferences in individualistic cultures or family needs in collectivistic cultures. In conclusion, this study highlights the importance of considering cultural values when designing sustainable products.

**Keywords:** Design Thinking, Cultural Values, Sustainable, Designers and Mixed Methods

### **1. INTRODUCTION**

In recent decades, design thinking (DT) has emerged as a valuable approach beyond the traditional design field. This problem-solving methodology has gained increasing recognition in business, leadership, and management sectors (Lages et al., 2020; Rösch et al., 2023; Verganti et al., 2021). Its rise in popularity has sparked discussions about the democratization of design skills. Proponents argue that design thinking is not an innate talent, but rather a learnable and applicable approach to problem-solving across various professions (Cross, 2023). Design thinking (DT) has gained significant traction due to its emphasis on accessibility, fostering creativity and innovation, and offering a strategic approach to problem-solving across diverse disciplines. This versatility makes DT a

compelling candidate for addressing the multifaceted challenges of sustainable development, even for those without a design background. According to Zeltina the historical understanding of design has evolved from a focus on aesthetics and functionality towards a more comprehensive approach that considers its social, economic, and environmental impact (Zeltina, 2021). While interpretations of design's nature and purpose have varied throughout history, a constant element is its human-centered quality. Design is not merely a product of economic growth, but rather it reflects and shapes the socio-economic, ecological, and cultural tapestry of a given era. Design historians have documented a shift in design philosophy coinciding with industrialization. Prior to this period, societies valued objects for their longevity and utility. Industrialization ushered in an era of mass production, prioritizing short-term value and rapid product turnover. This linear economic model, characterized by a "take-make-use-dispose" mentality, has led to significant challenges, including increased resource depletion, environmental pollution, and social inequities (Zeltina, 2021). Historically, design thinking methods have proven effective in addressing complex, dynamic, and contested issues by integrating the perspectives of stakeholders. Similar challenges exist in achieving sustainable development goals, highlighting the significant potential of design thinking in this domain. Despite the well-established analytical, iterative, and imaginative nature of design thinking strategies, principles, and methods, there remains a gap in their integration with sustainability science and education for sustainable development (ESD). The current application of design thinking in sustainability appears to be somewhat superficial (Zeltina, 2021). This growing interest in DT has fuelled the development of professional training programs. For instance, Stanford University's Executive Education Initiative aims to equip business leaders with the skills necessary to integrate DT into their organizations (Royalty et al., 2015). Similarly, IDEO, a renowned design firm, offers a free Human-Centered Design (HCD) toolkit through an online platform (downloaded over 130,000 times). This initiative encourages individuals to leverage the DT process to tackle societal challenges and share their ideas. Design thinking has emerged as a powerful methodology for tackling complex problems, often referred to as "wicked problems" (Buchanan, 2010; Klingelfuss & Klingelfuss, 2021). This user-centered approach fosters innovation through collaboration within multidisciplinary teams. While design thinking's origins can be traced back to the design consultancy IDEO (Thoring & Müller, 2011), its popularity has transcended the design field. Business schools are increasingly incorporating design thinking into

their curriculums, and companies are utilizing it within their R&D departments to drive innovation. The growing demand for this approach has led to the establishment of educational institutions dedicated to design thinking, sometimes referred to as "D-Schools," around the world.

Geert Hofstede's influential framework (Hofstede, 1980, 1984) identified five key cultural dimensions: power distance (acceptance of unequal power distribution), individualism-collectivism (focus on individual vs. group goals), masculinity-femininity (assertiveness vs. cooperation), uncertainty avoidance (tolerance for ambiguity), and long-term orientation (future vs. present focus). This framework, based on a large-scale IBM employee study, has been widely adopted in cross-cultural research. Culture undeniably influences various aspects of human life, and product design is no exception (Hofstede, 2016). Understanding consumer needs and wants is a fundamental principle in product design, as these factors directly impact the product's specifications (Noble & Kumar, 2008). Product criteria, encompassing aspects like shape, colour, materials, quality, durability, and usability, are all determined based on the target market's requirements (Marti & Bannon, 2009). Ultimately, designers prioritize consumer perspectives throughout the design process, recognizing them as the end users of the product.

### 1.1 Rationale and Objective

Our study investigates the synergy between product design thinking and cultural values, exploring their integration and potential for innovation in achieving sustainable development. As cultural preferences and contexts significantly influence product usage and life cycles, understanding these factors is crucial for designing products that are not only user-centered but also minimize environmental impact.

## 2. METHODS

### 2.1 Research Design and Participants

Our study adopted a mixed methods research design to explore the integration and innovation potential of product design thinking and cultural values for sustainable development. This approach allowed us to leverage the strengths of both qualitative and quantitative methods. We conducted surveys and interviews gather data from designers, consumers, or other stakeholders and gain insights into their perspectives on cultural influences and sustainable design. Our study recruited a total of 56

participants residing in Beijing, China. We employed purposive sampling to ensure a diverse range of cultural backgrounds. The participants consisted of two main groups (Sustainable Product Designers,  $N = 28$ ) and Consumers with Diverse Cultural Backgrounds,  $N = 28$ ). Sustainable product designers consisted of a mix of experienced designers and design professionals working in the field of sustainable product development. We recruited participants from design agencies, consultancies, and companies known for their focus on sustainable design. In contrast, consumers with Diverse Cultural Backgrounds comprised individuals from a variety of cultural backgrounds, including American, European, Latin American, Asian, African, and Middle Eastern. All participants were at least 18 years old. We recruited consumers through partnerships with cultural centres, community organizations, and online platforms catering to specific cultural groups. We ensured participants expressed an interest in sustainable products.

## 2.2 Conceptual Model of Cultural Aspects, Sustainable Concept and Product Design Issues

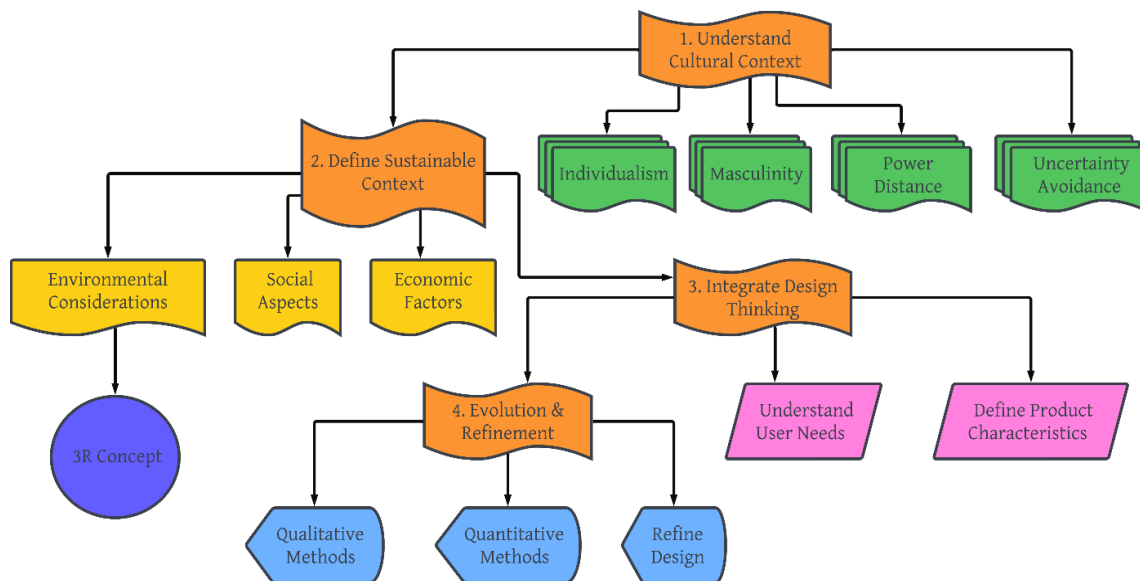
Our model proposes a systemic approach for sustainable product design that integrates cultural considerations with design thinking principles. The model consists of four key stages (see Figure 1):

- 1). The first stage involves understanding the cultural context and explores the influence of cultural dimensions on product design. It considers factors like individualism (preferences of individuals and groups), masculinity (gender roles and product targeting), power distance (decision-making power within the design process), and uncertainty avoidance (designers' need for predictability).

- 2). The second stage involves defining the sustainable context and focuses on the three pillars of sustainability. Social aspects encompass the behaviour, attitudes, and beliefs of designers, consumers, and companies ultimately shaping product characteristics. Economic factors include price, market analysis, and population growth, influencing production scale and product affordability. Environmental considerations involve the entire product lifecycle, from material sourcing to waste management. Designers should prioritize good waste management practices like reduce, reuse, and recycle (3R concept).

- 3). The third stage involves integration of design thinking and emphasizes understanding user needs and translating them into tangible design features. Designers must consider both consumer requirements and

their own technical capabilities to define product characteristics such as style, function, and ergonomics. Lastly, the fourth stage involves evolution and refinement (customer satisfaction) and focuses on assesses consumer satisfaction through qualitative and quantitative methods. Qualitative methods, such as interviews, can provide insights into user experiences. Quantitative methods, such as surveys, can measure satisfaction levels. Feedback from this stage can be used to refine the design and minimize product waste due to user dissatisfaction.



**Figure 1:** Conceptual Model of Cultural Aspects, Sustainable Concept and Product Design Issues

### 2.3 Data Collection Techniques

In the first phase, our study administered a self-administered online survey to the 56 participants recruited in Beijing. The survey consisted of 15 questions and took approximately 15 to 20 minutes to complete. Fifty-one (51) out of the 56 surveys were successfully retrieved, resulting in a high response rate of 91%. The survey instrument utilized a combination of Likert scale questions (allowing participants to express their level of agreement with statements) and multiple-choice questions. The survey was administered through a secure online platform to ensure data privacy. Prior to survey participation, all participants received an information sheet detailing the study's objectives, data collection procedures, and their rights as participants. Written informed consent was obtained from all participants before they began the survey. Participants were informed of their right to withdraw from the study at any point and assured of the anonymity and confidentiality of their responses.

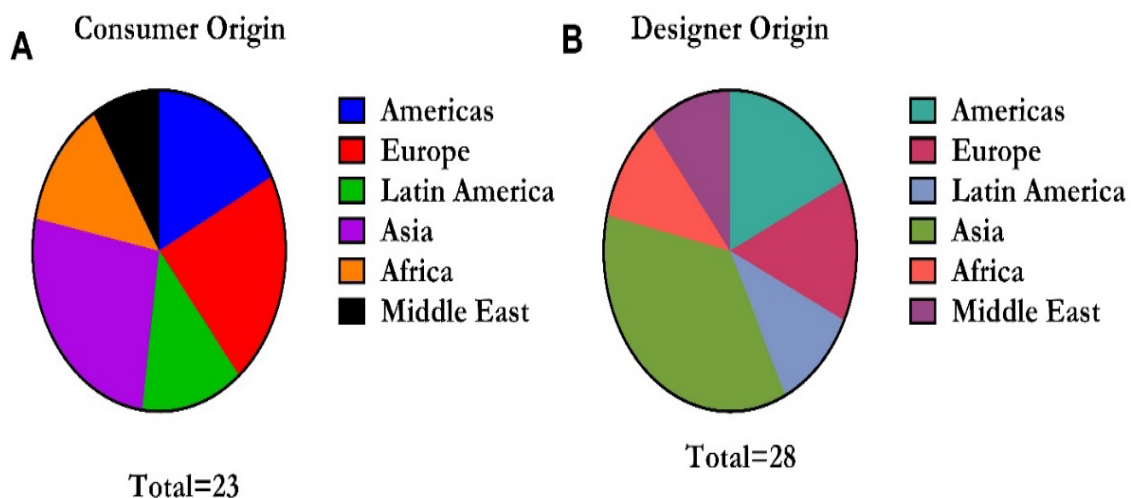
In the second phase of our study, we conducted semi-structured interviews with a subset of the participants. These interviews focused on understanding design considerations influenced by cultural values, consumer behaviour related to sustainable products, and challenges and opportunities in integrating cultural considerations into sustainable product design. We recruited a total of eight to ten participants for the interviews, representing a diverse range of backgrounds from the original sample (sustainable product designers and consumers with various cultural backgrounds). The interviews utilized a predetermined set of open-ended questions to guide the conversation while allowing flexibility to explore new topics arising from the participant's responses. Each interview lasted approximately 30 to 35 minutes.

#### 2.4 Data Analysis

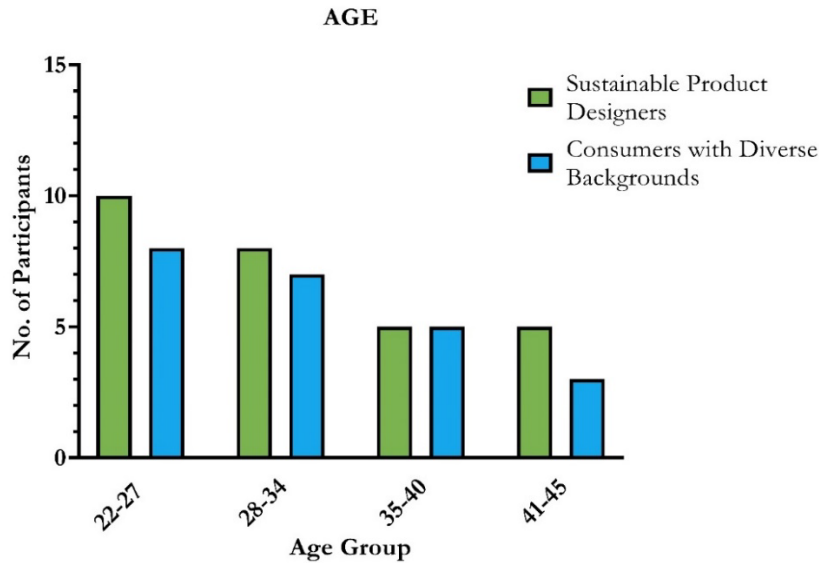
Quantitative data were analysed in GraphPad Prism version 9.5.1 at a two-tailed significance level of 5% using descriptive statistics (means, standard deviations, frequencies and percentages) and inferential statistics (Chi-square tests and correlation tests). Qualitative data were analysed using coding and thematic analyses to identify recurring themes.

### 3. RESULTS

The study included 51 participants (see Figure 2): 28 sustainable product designers and 23 consumers with diverse backgrounds. Among consumers, regional representation included: Americas (4 participants), Europe (5), Latin America (3), Asia (6), Africa (3), and the Middle East (2).

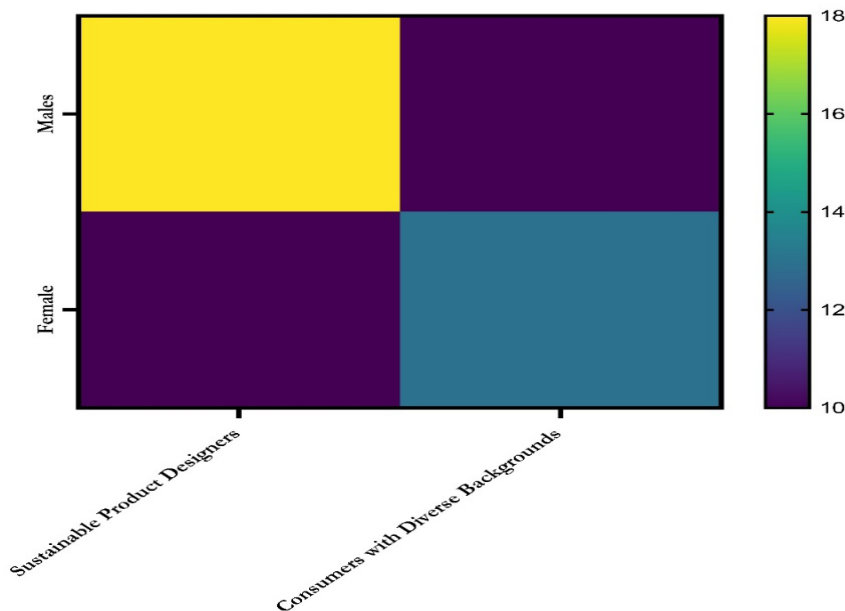


**Figure 2:** Pie Chart Distributions of Participants based on Consumer Origin and Designer Origin from Diverse Cultural Backgrounds.



**Figure 3:** Column Chart Showing Participant Demographics Classified into Various Age Categories

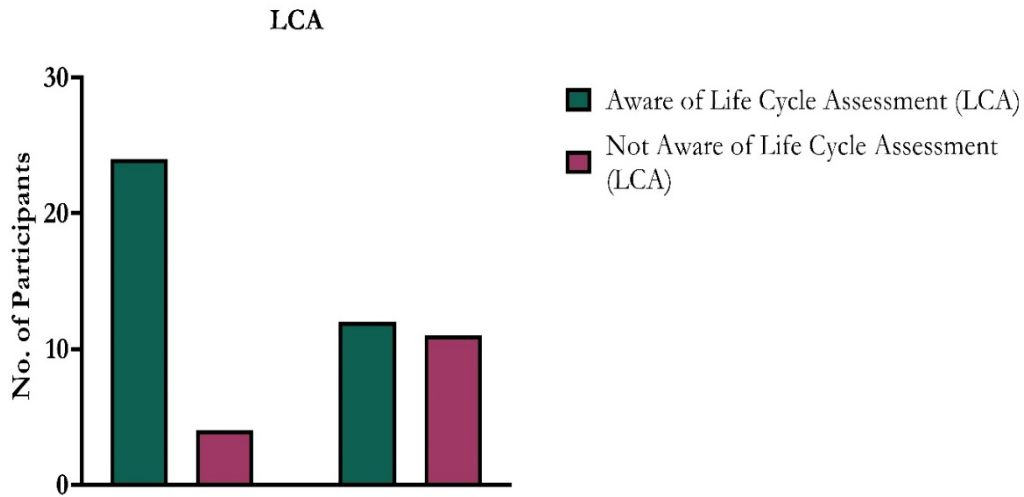
In Figure 3, a total of 51 participants were recruited for the study, consisting of two main groups: sustainable product designers (N=28) and consumers with diverse cultural backgrounds (N=23). The age distribution among designers was fairly even across the 22-27 (10), 28-34 (8), 35-40 (5), and 41-45 (5) age groups. Consumers with diverse backgrounds also had a balanced age range with 8 participants between 22-27, 7 between 28-34, 5 between 35-40, and 3 between 41-45.



**Figure 4:** A Heatmap of the Gender Distribution Across the two Study Groups of Sustainable Product Designers and Consumers with Diverse Cultural Backgrounds

In Figure 4, the study recruited 51 participants divided into two

categories: sustainable product designers (N=28, with 18 males and 10 females) and consumers with diverse backgrounds (N=23, with 10 males and 13 females).



**Figure 5:** Sustainability Awareness of Life Cycle Assessment (LCA) by Participant Group

In Figure 5, Life Cycle Assessment (LCA) awareness varied amongst participants. The majority (24 out of 28) of sustainable product designers were aware of LCA, while only half (12 out of 23) of consumers with diverse backgrounds possessed this knowledge. Overall, 36 participants demonstrated LCA awareness, compared to 15 who did not.

Table 1: Cultural Influence on Sustainability Preferences (Chi-Square)

| Region of Origin<br>(Consumers) | Prioritize Eco-Friendly Materials<br>(Yes) | Prioritize Eco-Friendly Materials (No) | Total |
|---------------------------------|--------------------------------------------|----------------------------------------|-------|
| Americas (N=4)                  | 3 (75%)                                    | 1 (25%)                                | 4     |
| Europe (N=5)                    | 3 (60%)                                    | 2 (40%)                                | 5     |
| Latin America (N=3)             | 2 (67%)                                    | 1 (33%)                                | 3     |
| Asia (N=6)                      | 5 (83%)                                    | 1 (17%)                                | 6     |
| Africa (N=3)                    | 2 (67%)                                    | 1 (33%)                                | 3     |
| Middle East (N=2)               | 1 (50%)                                    | 1 (50%)                                | 2     |
| Total                           | 16 (69%)                                   | 7 (31%)                                | 23    |

In Table 1, A Chi-Square test was conducted to assess whether there is a statistically significant association between cultural background and the prioritization of eco-friendly materials. The test yielded a Chi-Square value of 6.24 (df=5, p=0.28). As the p-value is greater than 0.05, we fail to reject the null hypothesis. This suggests there may not be a statistically significant difference in the prioritization of eco-friendly materials based on cultural background in this sample.



Table 2: Thematic Analysis of Design Considerations Influenced by Cultural Values

| Theme                                | Description                                                                                                                                                                                                   | Quotes                                                                                                                                                                                                                                                                     |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Individualism vs. Collectivism       | Designers emphasized considering user needs based on cultural values. Individualistic cultures might prioritize personal preferences, while collectivistic cultures might focus on family or community needs. | "For a kitchen appliance in North America, I might prioritize individual portion sizes. But in a collectivistic society, a larger capacity for family meals would be important." (Sustainable Product Designer)                                                            |
| Masculinity vs. Femininity           | Cultural gender roles can influence product design. In masculine cultures, a focus might be on functionality and durability, while feminine cultures might value aesthetics and user comfort.                 | "For tools in a traditionally masculine culture, a focus on ruggedness and raw materials might be important. In a more feminine culture, ergonomic design and ease of use might be prioritized." (Sustainable Product Designer)                                            |
| Power Distance                       | Designers consider how power structures within a culture might influence product interaction. In high power distance cultures, designs that emphasize clear hierarchy and control might be preferred.         | "For educational technology in a high-power distance culture, a design that clearly establishes the teacher's role might be important. In a lower power distance culture, a more collaborative design approach might be preferred." (Sustainable Product Designer)         |
| Long-Term vs. Short-Term Orientation | Cultural time horizons can influence product design considerations. In long-term oriented cultures, designs with a focus on durability and repairability might be valued.                                     | "For furniture in a long-term oriented culture, using high-quality materials and classic design elements that won't go out of style might be important." (Sustainable Product Designer)                                                                                    |
| Uncertainty Avoidance                | Cultural attitudes towards risk can influence product design. In high uncertainty avoidance cultures, designs that offer clear instructions and minimize user error might be preferred.                       | "For appliances in a high uncertainty avoidance culture, clear and intuitive controls with detailed user manuals might be important. In a culture with lower uncertainty avoidance, a more minimalist design approach might be acceptable." (Sustainable Product Designer) |

In Table 2, five cultural aspects influenced design considerations according to interviews. Individualistic cultures prioritize personal needs, while collectivistic cultures focus on families (e.g., appliance size). Masculine cultures value functionality (e.g., rugged tools), while feminine cultures value aesthetics (e.g., ergonomic design). Power distance dictates design hierarchy (e.g., educational technology). Long-term cultures prioritize durability (e.g., furniture), and uncertainty avoidance cultures prefer clear instructions (e.g., appliances)

Table 3: Consumer Behaviour Related to Sustainable Products

| Theme                                    | Description                                                                                       | Example Quote                                                                                                                                             |
|------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environmental Awareness as a Motivator   | Consumers expressing concern about environmental issues and a desire to make sustainable choices. | "I'm willing to pay a bit more for products made from recycled materials because I want to do my part for the environment." (Consumer, Europe)            |
| Cultural Influence on Product Perception | Cultural background shaping consumer preferences and expectations regarding sustainable features. | "In my culture, durability and repairability are highly valued. Sustainable products for me should be built to last and easy to fix." (Consumer, Africa)  |
| Price Sensitivity and Affordability      | Consumers highlighting the importance of affordability alongside sustainability considerations.   | "I'm interested in sustainable products, but they can be expensive. More needs to be done to make them accessible to everyone." (Consumer, Latin America) |

In Table 3, interviews revealed three themes regarding consumer behaviour and sustainable products. Environmental awareness motivated some consumers (e.g., "willing to pay more for recycled materials"). Cultural background influenced product perception (e.g., "durability and repairability valued"). Affordability remained a concern alongside sustainability (e.g., "sustainable products can be expensive").

Table 4(a): Challenges in Integrating Cultural Considerations

| Theme                                         | Description                                                                                                     | Example Quote                                                                                                                                        |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Limited Market Research and Data Availability | Difficulty in obtaining detailed cultural insights for specific markets, particularly less represented regions. | "It's challenging to design for diverse cultural contexts when reliable consumer data from those regions is limited." (Sustainable Product Designer) |

Table 4(b): Challenges in Integrating Cultural Considerations

| Theme                                             | Description                                                                                                            | Example Quote                                                                                                                                                                          |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Balancing Global Appeal with Cultural Specificity | Striking a balance between creating products with universal appeal and catering to unique cultural needs.              | "We want our sustainable clothing line to be attractive to a global audience, but also want to offer culturally-relevant styles for different markets." (Sustainable Product Designer) |
| Standardization vs. Customization                 | Balancing the cost-efficiency of standardized production with the need for customization to meet cultural preferences. | "Offering too many culturally-specific variations can increase production costs, but a one-size-fits-all approach might not resonate with consumers." (Sustainable Product Designer)   |

In Table 4, three challenges emerged regarding integrating cultural considerations: limited market research for under-represented regions ("reliable consumer data...limited"), balancing global appeal with cultural needs ("attractive to a global audience...culturally-relevant styles"), and cost-efficiency of standardized production versus customization ("production costs...one-size-fits-all").

Table 5: Opportunities in Integrating Cultural Considerations

| Theme                                         | Description                                                                                                                         | Example Quote                                                                                                                                                                             |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enhanced Market Differentiation               | Catering to cultural preferences can create unique selling propositions and attract new customer segments.                          | "By incorporating traditional weaving techniques into our sustainable bags, we've been able to tap into a new market of culturally conscious consumers." (Sustainable Product Designer)   |
| Promoting Cultural Exchange and Understanding | Sustainable products can act as bridges between cultures, fostering appreciation for diverse design aesthetics and functionalities. | "Our culturally-inspired sustainable toys allow children from different backgrounds to learn about each other's cultures through play." (Sustainable Product Designer)                    |
| Innovation and Co-Creation                    | Integrating cultural considerations can spark innovation and lead to more inclusive and user-centered sustainable design practices. | "Working with local artisans and designers allows us to learn from their traditional practices and incorporate them into sustainable product development." (Sustainable Product Designer) |

In Table 5, three themes highlighted the opportunities of integrating cultural considerations. Firstly, catering to cultural preferences led to enhanced market differentiation ("tap into a new market"). Secondly, sustainable products promoted cultural exchange (e.g., "children...learn about each other's cultures"). Finally, cultural integration fostered innovation and co-creation ("learn from their traditional practices")

#### 4. DISCUSSION

Our findings revealed a strong interest in sustainability among participants, with a majority willing to pay a slight premium for eco-friendly products. Designers reported a higher awareness of Life Cycle Assessment (LCA) compared to consumers. The product design lifecycle typically encompasses several distinct stages, including pre-production, manufacturing, distribution, consumer use, and disposal (Alting, 1995; Ghazali et al., 2012). The design phase, which precedes manufacturing, is often considered the most critical and complex stage. During this phase, designers engage in a series of iterative processes to refine a product concept. These processes may involve activities such as defining customer needs, evaluating technical feasibility, and optimizing production time. Through careful consideration of these factors, designers aim to create a product that meets user requirements while ensuring efficient and successful manufacturing (Jamwal et al., 2021). Product design plays a critical role in attracting customers (Sabir, 2020). Striking a balance between customer needs and technical feasibility is paramount for successful product development. Understanding customer preferences through market research is crucial in informing the design process (Melovic et al., 2020). Designers utilize this understanding to translate customer wants into tangible product features. Ultimately, a strong focus on customer requirements strengthens the design and ensures it aligns with market needs. While manufacturing aims to maximize profit margins through cost-efficiency (Alting, 1995), the initial design phase should prioritize user needs as identified through market analysis. This analysis can then be used by designers to evaluate a product's potential for success in the marketplace. Several scholars have highlighted the significant role of human-designed environments, including buildings, products, and systems, in contributing to pressing socio-ecological challenges (Asha'ari et al., 2023; Parikh, 2010; Shapira et al., 2017). In response, design fields are increasingly exploring concepts and processes to address both environmental and social

sustainability concerns. Examples include Cradle to Cradle, which emphasizes safe and continuous material lifecycles, and the Method for Sustainable Product Development, which provides a framework for environmentally conscious product creation. Additionally, frameworks like Product Service Systems and Design for Sustainability offer strategies to minimize environmental impact.

Furthermore, design approaches are placing greater emphasis on understanding human dynamics, interactions, desires, and needs. This is evident in methodologies like Human-Centered Design, Service Design (Stickdorn et al., 2018), and Base of the Pyramid Protocol. While design alone cannot solve all sustainability challenges, it offers a valuable, and often overlooked, critical thinking approach. By integrating design thinking into sustainability efforts, we can develop more effective solutions. Our thematic analysis of interviews identified five cultural aspects influencing design considerations. Cultures with high LTO scores, characterized by openness to alternative truths and a focus on the future, may be well-suited to most design thinking criteria. Their adaptability allows them to embrace new insights from various user research methods, including ethnographic approaches. However, desk research, which traditionally seeks to establish "objective" or "absolute" truths, might be less favoured by these cultures. Similarly, analytical methods that aim to arrive at a single, agreed-upon truth, such as frameworks or synthesis exercises, may present challenges. In these cultures, low-fidelity prototypes that allow for ongoing exploration and iteration are likely to be preferred over highly polished, near-finished prototypes. Conversely, cultures with low LTO may find the analytical aspects of design thinking, such as synthesis and decision-making processes (voting on ideas, establishing clarity, incorporating feedback), to be more straightforward. Their emphasis on established truths and a more normative approach can facilitate reaching agreement during these stages. However, the concept of space layout within design thinking is likely less influenced by the LTO dimension. We suggest that teamwork dynamics may also be affected by masculinity. Cultures with high masculinity scores may prioritize individual achievement over group harmony. This could lead to a reluctance to share ideas openly, for example on whiteboards or brainstorming walls. Additionally, a focus on individual work might result in a disregard for noise levels in open office environments. However, these cultures may find aspects of design thinking quite appealing. Plenum spaces for focused work and workshop environments where tangible creations are produced may resonate well with their preferences. Moreover, design thinking mindsets that emphasize experimentation and a bias towards

action may suit their tendency to prioritize doing over excessive planning or discussion. Conversely, cultures with low masculinity scores, often characterized by greater empathy, may find user research activities more natural due to their ability to connect with users' needs. We propose that cultures with high PDI may struggle with aspects of design thinking that encourage playfulness and free expression, particularly in the presence of superiors. The fear of appearing foolish in front of authority figures can hinder creative brainstorming sessions or role-playing exercises, where wild ideas and experimentation are valued. Furthermore, a strong deference to hierarchy can influence feedback mechanisms, potentially giving undue weight to the opinions of higher-ranking individuals, regardless of the content of the feedback itself. Conversely, cultures with low PDI are generally more comfortable with teamwork and democratic processes. Individuals in these cultures readily accept that team members have equal standing and may be more inclined to participate in collaborative decision-making, such as voting. The impact of PDI is less pronounced in specific design thinking activities. Analytical methods and tools (synthesis, frameworks, personas, etc.) are typically less susceptible to its influence. Similarly, most prototyping techniques, with the exception of role-playing, are not significantly affected by a society's power distance orientation. Individualism-collectivism (IDV) can influence the effectiveness of design thinking practices (Hofstede, 2016). Cultures with high IDV prioritize individual goals and have looser group ties. This emphasis on individual achievement can be advantageous during brainstorming sessions, where a variety of perspectives and even "wild ideas" are encouraged. However, high IDV cultures may encounter challenges in other aspects of the design thinking process. The analytical phases, such as synthesis, framework development, and persona creation, often rely heavily on collaboration and reaching consensus among team members. A strong focus on individual viewpoints in high IDV cultures might make achieving agreement more difficult.

Conversely, cultures with high IDV may be more comfortable with diverse teams due to their appreciation of individuality and tolerance for eccentricity. These same characteristics can lead to an openness to diverse perspectives within the team, even if they are idiosyncratic. However, the concept of a "T-shaped profile," which emphasizes both depth of expertise and broad knowledge across disciplines, might be less prevalent in high IDV cultures due to potentially weaker connections between individuals. Furthermore, the open office environments often associated with design thinking might pose challenges in high IDV cultures. Respect for personal

space and a desire to avoid disrupting others, which are not necessarily strong characteristics in such cultures, can be essential in open-plan settings. On the other hand, these cultures may be more comfortable with plenum spaces, which offer opportunities for focused work and individual withdrawal. Cultures with high UAI may find aspects of design thinking, such as experimentation and playfulness, to be challenging. Their preference for clear rules and structure may initially seem at odds with the iterative and open-ended nature of design thinking. However, the emphasis on structure in high UAI cultures can also be beneficial. The defined stages and processes within design thinking may resonate with their desire for a well-organized approach. Similarly, designated workspaces with specific purposes may be more comfortable for these cultures than highly flexible furniture arrangements. The impact of UAI on playfulness may also be nuanced. Games with clear rules and objectives may be more readily embraced than activities requiring a high degree of improvisation. In contrast, cultures with low UAI tend to be more comfortable with the inherent uncertainty of design thinking. They are more likely to accept that solutions are not always immediately apparent at the outset of a project. These cultures may readily embrace experimentation and view failure as a learning opportunity that can ultimately lead to better solutions. Consumer interviews highlighted three themes related to sustainable products. Environmental awareness motivated some consumers, while cultural background shaped product perception. Affordability remained a key concern alongside sustainability. Successful product design necessitates a multifaceted approach that considers not only consumer needs but also cultural influences (Chatterjee et al., 2021; Guiné et al., 2020). While understanding user requirements is crucial, designers must delve deeper to incorporate cultural aspects into their designs. This requires a strong understanding of the target audience's cultural background. The concept of a singular, clearly defined culture is increasingly challenged by globalization and intense competition in the product market (Razzaghi et al., 2009). Research by Razzaghi et al. explored the influence of designers' cultural backgrounds on industrial product design (Razzaghi et al., 2009). Their findings suggest a link between cultural archetypes and the designers' own cultural heritage, which can be reflected in the final product's form and aesthetics. Our study the study also identified challenges and opportunities associated with integrating cultural considerations. Challenges included limited market research data for under-represented regions, balancing global appeal with cultural specificity, and cost-efficiency of standardized production versus customization. However, our

findings also revealed significant opportunities. Catering to cultural preferences can lead to enhanced market differentiation and attract new customer segments. Sustainable products can act as bridges between cultures, fostering appreciation for diverse design and functionality. Finally, integrating cultural considerations can spark innovation and co-creation, leading to more inclusive and user-centered sustainable design practices. The pursuit of global sustainability necessitates a significant reduction in resource consumption and waste generation (Branca et al., 2021). Industrial production remains a major contributor to pollution and waste, and the current production model cannot be sustained indefinitely. Environmental concerns have become a pressing issue, driven by the depletion of natural resources due to ever-growing human demands. The impact of environmental degradation is far-reaching, affecting all aspects of human life, and product design is no exception. To achieve sustainable product design, several key considerations must be integrated into the design process. These considerations can be broadly categorized into three main pillars: social, economic, and environmental factors. Sustainable product design requires integrating social, economic, and environmental considerations (Abubakr et al., 2020; Alting, 1995; Veale & Quester, 2009). Socially, designers must consider a growing population and the evolving needs and behaviours of customers. Qualitative research methods can help understand these evolving behaviours. Economically, price is a key factor, and designers must balance customer needs with manufacturing efficiency to achieve market success (Veale & Quester, 2009). Finally, environmental considerations include the entire product lifecycle, from pre-production to disposal, to minimize environmental impact. Several studies highlight the limitations of imposing Western cultural values on product design for international markets (Garrett et al., 2006). Cultural differences necessitate a nuanced approach. Garrett et al employed a mixed-methods approach, utilizing both qualitative and quantitative data collection, to examine the concept of domain culture (Garrett et al., 2006). Their findings revealed significant discrepancies in the results obtained through the two methods. These discrepancies suggest a potential link between formalization, centralization, role flexibility, inter-functional climate mechanisms, and Hofstede's power distance dimension.

## 5. CONCLUSION

Our study revealed cultural considerations are important for sustainable



product design, with consumers valuing sustainability and some willing to pay a premium. However, limited data in certain regions and balancing global appeal with cultural needs pose challenges. Future research with a larger, more geographically diverse sample could explore how to leverage cultural insights for impactful and commercially viable sustainable products.

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