A MULTI-STAGE VALIDATION OF AN INTERIOR DESIGN MODEL FOR PSYCHOLOGICAL WELL-BEING

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Abstract *— Traditional interior design often prioritizes aesthetics over users' psychological needs, while existing Human-Centered Design (HCD) approaches remain intuitive. This research proposes and validates a "human as an element" design paradigm focused on personalization, flexibility, and autonomy. A multi-stage mixed-methods methodology was used to test its impact on psychological well-being. The first stage, a Virtual Reality (VR) experiment (N=180), found that the "human as an element" design significantly increased psychological well-being compared to a minimalist (control) design, providing causal evidence. The second stage, a pre-test/post-test field case study (N=46), implemented these principles in a real-world setting. Results showed a dramatic increase in psychological comfort, validating the model's practical effectiveness. This study bridges the gap between internal (VR) and external (field) validity, culminating in an empirically tested "Integrative Psycho-Behavioral Interior Design Model" for evidence-based practice.*

Keywords: *Interior Design, Psychological Well-being, Virtual Reality (VR), Evidence-Based Design, Human-Centered Design*

I. INTRODUCTION

The modern era has transformed the function of a dwelling from a mere shelter into a vital space for identity formation, energy restoration, and productivity (Fan, 2017). Amidst the global architectural landscape, "interior design is a major part of human environmental design" (Zhang, Li, & Liu, 2019), playing a crucial role in bridging the physical structure of a building with the human experience within it. As an interdisciplinary practice, interior design deals with various fundamental elements such as "color, form, space, light, texture, materiality, mode, structure, sound, technology, environment, and context" (Sully, 2015). Interior space, particularly private spaces like bedrooms or personal work areas, has become the epicenter of daily life (Mahmoud, 2016), where "interior architecture has the potential to create social benefits by designing spaces that affect people's quality of life" (Kayaduran Mahir & Koca, 2024). Therefore, the approach to its design demands a profound understanding, as the profession encompasses a "multifaceted role in modern society, extending beyond mere aesthetic enhancement" (Pistolesi & Libin, 2024) to significantly influence functionality and comfort.

Historically, the discourse on interior design has often been dominated by conversations about style, trends, and visual aesthetics (Zhang & Ban, n.d.). Just as "fashion is implemented by paying attention to the social context through various studies" (Ratuannisa, Santosa, Kahdar, & Tresnadi, 2024), interiors are frequently viewed through the lens of ever-changing trends, where such changes are "evolutionary, not revolutionary" (Ratuannisa, Santosa, Kahdar, & Tresnadi, 2024). Design magazines and social media platforms often feature visually "perfect" spaces that are frequently sterile, lacking any trace of their inhabitants' lives (Pile, n.d.). An excessive focus on decorative aspects, where "decoration is an important aspect of any conversation about interior design" (Königk, 2010), risks creating environments that are beautiful yet fail to meet deeper psychological and functional needs (Mahmoud, 2016). This phenomenon aligns with profit-driven tendencies in design trends, which sometimes "ignore social consciousness in design" (Thamrin et al., 2018).

As a result of this aesthetics-oriented paradigm, a fundamental problem arises: the marginalization of the human as the primary subject in the design process. "Everyone receives, understands, and responds in a different way" to their environment (Mahmoud, 2016), thus a one-size-fits-all approach often fails. A space designed without deep consideration becomes "mute" and unresponsive, as "the most important element that must be considered in interior space is the 'user'" (Reddy, Chakrabarti, & Karmakar, 2012).

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This failure can manifest in various forms, from physical discomfort due to poor ergonomics (Dobreva & Bankova, 2019) to stress, because designers "must not only focus on the beauty and functionality of the space, but also on its impact on people's health and happiness" (Pistolesi & Libin, 2024). This is a neglect of the fact that "the achievement of physical and psychological comfort for users is usually the result of design efficiency" (Bettaieb & Alawad, 2018).

In response, the Human-Centered Design (HCD) approach emerged, a paradigm that "prioritizes the needs, preferences, and behaviors of users" (Pistolesi & Libin, 2024). HCD emphasizes empathy as a starting point to "make systems usable and useful by focusing on the users" (Bagassi et al., 2018). In the context of interior design, this principle translates into designing that focuses on the design's impact on the user as they use the space (Perolini, 2020). "Humanized design is a unity of human and design," which regards the user as the sole criterion for judging a space (Fan, 2017). Thus, "the application of ergonomic methodologies to the design process" (Jung, Cho, Roh, & Lee, 2009) becomes increasingly important to ensure the space truly serves its occupants.

Although the HCD concept has been widely adopted, its application in interior design often remains intuitive. This is complicated by the status of the discipline itself, which is "difficult to define and even slippery" (Cys, 2009). Many designers find it "difficult to articulate design verbally as much of the design process is intuitive" (Haddad, 2014), which hinders the development of rigorous methodology. Furthermore, there is a historical perception that "interior design is inferior to architecture" (Königk, 2010), which may have slowed the development of its own theoretical base. The lack of a distinct category for interior architecture in academic databases like WOS (Kayaduran Mahir & Koca, 2024) also reflects the challenge in formalizing this field of knowledge.

This gap raises urgent research questions. A new approach is needed to test the validity of the HCD paradigm more objectively and to bring it from an abstract concept to practical application. Modern technologies like "3D virtual vision technology" (Zhang, Li, & Liu, 2019) and human-computer interaction (Pan & Wang, 2025) offer new tools to explore this relationship in a controlled manner. The primary research questions are: (1) Does a design paradigm that explicitly incorporates the "human as an element" (e.g., personalization, flexibility) significantly increase psychological well-being compared to a functional-minimalist design in a controlled experimental (VR) environment? (2) How can this paradigm be implemented and its effectiveness validated in the context of a real-world space (field case study)?

Based on this problem formulation, this study has three main objectives. First, to formulate a "human as an element" theoretical framework based on a critical literature review (Stage 1). Second, to quantitatively test the causal impact of this framework on user psychological well-being through a controlled Virtual Reality (VR) experiment (Stage 2). Third, to validate the practical application and impact of the framework in a real-world setting through an implementative case study with a *pre-test* and *post-test* design (Stage 3). These objectives align with the fundamental goals of design itself: to "meet people's physical and psychological needs" (Fan, 2017) and "create solutions that will improve human life" (Kayaduran Mahir & Koca, 2024).

The scope of this research is focused on private space (in the context of VR simulation) and communal space (for the field case study). This focus allows for an in-depth exploration of how "private spatial zones contribute to building the quality of communication between individuals" (Bettaieb & Alawad, 2018). The importance of private space is emphasized by Mahmoud (2016), who states that "privacy of space is considered one of the most important types of overall privacy." This study will not discuss the technical aspects of construction but will focus on elements that can be manipulated by the designer, in line with the definition of interior design as an "interdisciplinary practice" (Sully, 2015).

The significance of this research lies in its contribution to both academia and professional practice. Academically, it provides causal evidence (from VR) and external validity (from the case study) for the psycho-behavioral design paradigm. For practitioners, it offers a conceptual toolkit and validation methodology (VR and *pre/post-test*) to create spaces that enhance quality of life. Its relevance extends beyond the individual scale; these principles can inform larger frameworks like the "Sustainable Development Goals (SDGs)" (Kayaduran Mahir & Koca, 2024). These findings can even provide humanistic insights for macro-scale urban projects like the development of the Nusantara Capital City (IKN), ensuring that the technical vision of a "healthy city" (Carolina, 2022) is balanced with the creation of a deep "sense of community and place identity" (Hales, 2011).

The primary novelty of this research lies in three fundamental aspects. First, in its methodological aspect, this study formally integrates a controlled VR experiment (for internal validity) with an implementative *pre/post-test* case study (for external validity). This combination is rarely used in interior design studies, providing a higher level of proof than singular survey or qualitative studies. Second, in its conceptual aspect, this research formulates the "Integrative Psycho-Behavioral Interior Design Model," a

new framework that is not only theoretical but has been empirically tested through two validation stages. Third, in its practical aspect, this study transforms the abstract concept of "human-centered design" into measurable principles whose impact can be objectively tested using technology (VR) and field evaluation, addressing the need where "clients today are looking for designers who have knowledge... in research methodology" (Haddad, 2014).

II. METHODS

This study adopts a sequential multi-stage mixed-methods design (QUAL $\rightarrow$ QUAN $\rightarrow$ MIXED) to comprehensively test its hypotheses. The initial qualitative stage (Stage 1) focused on theoretical formulation. This involved a Critical Literature Review to identify object-centered biases in traditional design theory and a Conceptual Analysis drawing from environmental psychology and phenomenology. This phase served to construct the "human as an element" concept and formulate a robust theoretical foundation and relevant hypotheses before proceeding to empirical validation.

$$\boldsymbol{a = \frac{k}{k-1}(1 - \frac{\sum_{i=1}^{k} \mathrm{a}\frac{2}{y^1}}{a^{\frac{2}{x}}}}$$

The second stage (Stage 2) was a controlled quantitative experiment for empirical validation, using a Virtual Reality (VR) simulation with a *between-subjects* design. Participants (N=180), recruited via purposive sampling (non-design students), were randomly assigned to either a Control Group (n=90) viewing a functional-minimalist VR space, or an Experimental Group (n=90) viewing a VR space designed with the "human as an element" paradigm (e.g., personalization, flexibility). To minimize confounding variables, dependent variable data (comfort, sense of belonging, emotional satisfaction) were collected via a 7-point Likert scale. The internal consistency and reliability of this instrument were first confirmed using Cronbach's Alpha (formula above), with a value $\ge$ 0.70 considered reliable.

$$\boldsymbol{t = \frac{m1 - m2}{\sqrt{\frac{s^2 1}{n^1} + \frac{s^2 2}{n^2}}}}$$

Following the reliability check, the primary hypothesis of Stage 2 was tested using an Independent Samples t-test (formula above). This statistical test was used to objectively determine if a significant mean difference existed between the well-being scores reported by the Control and Experimental groups, thereby testing the causal impact of the design intervention. The third stage (Stage 3) then moved to field validation to test the external validity and practical application of the concept. This stage employed an implementative case study with a *pre-test* and *post-test* design. A real-world location (a student lounge, N=46 regular users) was selected, where *pre-test* data was collected before the space was physically redesigned according to the "human as an element" principles. After an adequate adaptation period (e.g., 1 month), *post-test* data was collected from the same users.

$$\boldsymbol{t = \frac{d}{s_{d/\sqrt{n}}}}$$

In this final stage (Stage 3), data were analyzed using a mixed-methods approach for a holistic understanding. The quantitative data from the case study was analyzed using a Paired Samples t-test (formula above) to measure any statistically significant changes between the *pre-test* and *post-test* conditions for the same participants, quantifying the real-world impact. This numerical data was then deliberately enriched and explained by qualitative data gathered from post-intervention semi-structured interviews. These interviews were analyzed using thematic analysis, ensuring that the research findings were not only statistically valid but also deeply supported by rich narratives from real user experiences.

III. RESULTS AND DISCUSSION

A. Stage VR Experimental Validation

Analysis of the VR experiment data (N = 180) provided strong initial quantitative evidence. First, the reliability test of the 7-point Likert scale instrument yielded a Cronbach's $\alpha = .88$, indicating excellent internal consistency for measuring the *Psychological Well-being* construct (comprising sub-scales of comfort, sense of belonging, and emotional satisfaction).

The main hypothesis test using an independent samples *t*-test (see Table 1) revealed a highly significant difference between the two conditions. Participants in the Experimental Group ("human element" space) reported a statistically significant higher composite *Psychological Well-being* score (M = 6.15, SD = 0.80) compared to the Control Group (minimalist space) (M = 4.20, SD = 0.91). This mean difference of 1.95 points was highly significant, $t(178) = 15.22$, $p < .001$ (two-tailed), with a large effect size (Cohen's $d = 2.27$).

This finding provides strong causal evidence in a controlled environment that a design actively integrating personalization, flexibility, and biophilia has a direct and positive impact on users' psychological perceptions. The functional-minimalist space, while aesthetically "clean," demonstrably failed to meet the deeper psychological needs for "sense of belonging" and "emotional control" provided by the experimental design.

Tabel 1. Hasil Uji t Sampel Independen untuk Skor Psychological Well-being

Group	n	M	SD
Control (Minimalist)	90	4.20	0.91
Experiment (Human Element)	90	6.15	0.80

Catatan. N = 180. Skor *well-being* diukur pada skala 1-7. Hasil uji *t* menunjukkan perbedaan yang signifikan antar grup, $t(178) = 15.22$, $p < .001$.

B. Stage Field Case Study Validation

The real-world validation (student lounge case study, N = 46 regular users) confirmed and expanded upon the VR experiment findings using a paired-samples *t*-test (see Table 2) to compare satisfaction scores before (pre-test) and after (post-test) the physical design intervention. There was a statistically significant increase in all measured variables. The *Functional Satisfaction* score (ease of use, flexibility) rose from M = 3.85 to M = 6.02, while the *Psychological Comfort* score (including sense of belonging and safety) showed the most dramatic increase, from M = 3.11 (SD = 1.15) to M = 5.98 (SD = 0.90), $t(45) = -14.7$, $p < .001$. These quantitative results demonstrate that the "human as an element" principle is highly effective when applied to a real physical space, yielding drastic improvements in users' daily perceptions and well-being.

Thematic analysis of post-test semi-structured interviews provided an in-depth explanation for *why* these quantitative scores increased so sharply, revealing the underlying psychological mechanisms (see Table 3). User narratives enriched the statistical data, with three main themes emerging: 1) *Spatial Autonomy*, where modular furniture (lightweight, wheeled chairs) allowed participants to "claim" and "arrange" the room, making it feel like "our space, not just a waiting room"; 2) *Human Traces*, where bulletin boards and display shelves transformed the space from a "sterile hallway" into a "community home" by showing visible signs of life and identity; and 3) *Sensory Oasis*, where biophilic elements and warmer lighting created a "place to 'breathe' between stressful classes," indicating the space's function as an active emotional regulator.

Table 2. Paired Samples t-test Results for Satisfaction Scores (Field Case Study)

Variable	Pre-Test M (SD)	Post-Test M (SD)	t	df	p
Functional Satisfaction	3.85 (1.02)	6.02 (0.95)	-11.40	45	< .001
Psychological Comfort	3.11 (1.15)	5.98 (0.90)	-14.70	45	< .001

Note. N = 46 same participants. Scores were measured on a 1–7 Likert scale.

Table 3 Synthesis of Qualitative Thematic Analysis (Field Case Study)

Main Qualitative Theme	Conceptual Definition	Key Illustrative Quote from Participant	Connection to Quantitative Variable (Table 2)
Spatial Autonomy	The ability to manipulate the space (flexibility) provides a sense of control and agency.	"I love that I can move the sofa to create my own study 'fort'." (*P-07*)	Explains the significant increase in the *Functional Satisfaction* score.
Human Traces	A space that allows for collective expression and personalization builds identity and a sense of belonging.	"That bulletin board is alive. It shows people are here, not just a building." (*P-11*)	Explains the dramatic increase in the *Psychological Comfort* score (sense of belonging).
Sensory Oasis	Sensory elements (biophilia, light) are actively used to manage stress and for cognitive restoration.	"These plants make the room feel fresh, not 'dead' like before." (*P-02*)	Contributes to the general increase in *Psychological Comfort* (sense of safety, relaxation).

C. Convergence and Conceptual Model

The integration of data from all three research stages yields a rich and validated understanding. Stage 1 provided the theoretical foundation for the inquiry. Stage 2 (VR) provided strong causal evidence, in a controlled environment, that the "human as an element" principle significantly *causes* an increase in psychological well-being. Stage 3 (Case Study) provided external validity, demonstrating that these principles are highly effective in a real-world context, while its qualitative data provided a narrative explanation for *why* they are effective. This convergence is summarized in Table 4.

Table 4. Convergence of Findings Across Research Stages

Research Stage	Methodology	Key Finding	Contribution to Model
Stage 1	Theoretical Formulation	Identified core psycho-behavioral needs (rituals, identity, stress, sensory).	Forms the basis for Pillar 1: Diagnostics.
Stage 2	VR Experiment (QUAN)	Causal Evidence: "Human element" design *causes* a significant increase in well-being.	Provides internal validation for Pillar 2: Principles.
Stage 3	Field Case Study (MIXED)	External Validity: Principles are highly effective in a real-world context. Qualitative data explains *why*.	Provides external validation for Pillar 3: Process & enriches Pillar 2.

Based on this convergence of empirical findings, this research proposes a new conceptual framework: *The Integrative Psycho-Behavioral Interior Design Model* (see Table 5). This model is designed as a practical tool for designers to shift from an intuition-based to an evidence-based approach. The model stands on three fundamental pillars tested in this research: Pillar 1: Human Dimension Diagnostics, which mandates an initial assessment beyond aesthetics (mapping behavior, identity, psychology, and sensory needs); Pillar 2: Validated Design Principles, which translates diagnostics into a design priority hierarchy (confirming *Autonomy & Control* as the top priority); and Pillar 3: Multi-Layered Validation Process, which advocates for an iterative design process using simulation (like VR) for internal validation and post-occupancy evaluation (like pre/post-test) for external validation.

Table 5 Conceptual Diagram of the Integrative Psycho-Behavioral Interior Design Model

phase / pillar	key components	key designer activities	output	tools
Pillar 1: HUMAN DIMENSION DIAGNOSTICS	1. *Behavioral:* Rituals & Activity Flow 2. *Identity:* Values & Self-Narrative 3. *Psychological:* Stressors & Restoration 4. *Physical:* Sensory & Ergonomics	Conduct in-depth interviews, observations (if possible), and use structured questionnaires to map holistic user needs.	Psycho-Behavioral User Profile: A comprehensive document summarizing findings from the four dimensions.	Diagnostic Questionnaires, Daily User Journey Maps, Collaborative Vision Boards.
▼	*(Input for Next Phase)*	▼	▼	▼
Pillar 2: MEASURABLE DESIGN PRINCIPLES	*Priority 1:* Autonomy & Control (Personalization, Flexibility) *Priority 2:* Sensory Quality (Light, Biophilia, Acoustics, Tactility) *Priority 3:* Functional Support (Ergonomics, Flow, Storage)	Translate the User Profile into concrete design strategies. Determine the priority hierarchy of design elements based on user context.	Evidence-Based Design Brief: A document articulating design goals within the framework of measurable principles.	Design Priority Matrix, Sensory Element Checklist, Functional Zoning Analysis.
▼	*(Input for Next Phase)*	▼	▼	▼
Pillar 3: ITERATIVE & EMPATHETIC DESIGN PROCESS	1. Ideation & Conceptualization 2. Prototyping & Simulation 3. User Feedback & Validation 4. Implementation & Post-Occupancy Evaluation	Develop design concepts, create prototypes (digital/physical), actively solicit and integrate user feedback, and conduct evaluation after the space is inhabited.	Validated Final Design & Post-Occupancy Evaluation Report (optional): The final product refined through cycles and data on its real-world performance.	Sketches, Mood Boards, 3D Models, Virtual Reality (VR) Simulation, Post-Occupancy Satisfaction Survey.
↻	*(Feedback Loop → Phases 1 & 2)*	↻	↻	↻

D. Discussion of Research

The research is multidimensional, primarily stemming from its integrated multi-stage methodology. Unlike polarized studies that either remain in the lab (VR-only) or are purely descriptive (qualitative case

studies), this work bridges the critical gap between internal and external validity. It systematically combines the strengths of a controlled VR experiment (proving causation) with a field-based pre/post-test case study (proving real-world application). This methodological innovation allows for the development and empirical validation of a new conceptual model that is both theoretically sound and practically This integrated approach provides a significant contribution by equipping designers with a data-driven language and a validated process. Instead of relying on intuition ("I feel flexibility is important"), a designer using this model can state that "VR data shows this principle significantly increases 'sense of belonging' ($p < .001$), and our field study confirmed a 56% increase in functional satisfaction post-implementation." This shift from a taste-based to an evidence-based argument is a key practical outcome. Table 6 further delineates how this specific research contribution fills existing gaps in previous literature.

Table 6 Comparison of Research Novelty Contribution with Previous Studies

Novelty Aspect	Previous Studies (General)	Limitation / Gap Filled	Specific Contribution of This Research
Methodological	Type 1: Correlational Surveys. Type 2: Qualitative Case Studies. Type 3: Isolated Lab/VR Experiments.	Type 1: Cannot prove causation. Type 2: Hard to generalize, often lacks quantitative baseline. Type 3: Low external (real-world) validity.	Multi-Stage Design (VR + Field): Combines internal validity (VR) with external validity (Pre/Post Case Study), proving both causation and real-world application.
Conceptual	General HCD Principles (e.g., IDEO). Environmental Psych. Theories (descriptive).	Too general, lacks priority hierarchy. Often theoretical, not prescriptive for design practice.	Validated Psycho-Behavioral Model: Formulates a model with a hierarchy of principles (Pillar 2) whose impact has been empirically validated via Stage 2 and 3.
Practical	Style Guides (intuition-based). Project Reports (anecdotal).	Taste-based, not data-based. Hard to articulate value (beyond aesthetics) objectively.	Evidence-Based Design Toolkit: Provides a process (Pillar 3) and proof (Tables 1 & 2) for practitioners to test, implement, and validate well-being-focused designs.

IV. CONCLUSION

This research successfully provides strong, multi-layered empirical evidence to address the fundamental gap between interior design focused on aesthetics and the deep psychological human need for space. Through a sequential, multi-stage methodology, this study definitively demonstrates that a design paradigm explicitly treating the "human as an element"—which prioritizes personalization, flexibility, and user autonomy—is significantly superior to a sterile, functional-minimalist approach. Initial quantitative validation in a Virtual Reality (VR) experiment provided clear causal evidence; participants in the experimental condition reported significantly higher psychological well-being compared to the control group, a highly statistically significant difference with a large effect size. This finding was not limited to the controlled laboratory environment. Real-world case study validation reinforced and expanded these findings, demonstrating high external validity. A paired-samples t-test analysis of the *pre-test* and *post-test* physical intervention showed a dramatic increase, especially in Psychological Comfort, which surged to a much higher level. The accompanying qualitative data provided a rich narrative explanation for *why* this increase occurred, identifying several main psychological mechanisms: "Spatial Autonomy" (a feeling of control through modular furniture), "Human Traces" (a sense of belonging through visible personalization), and "Sensory Oasis" (emotional regulation through biophilic elements and lighting).

The main contribution of this research extends beyond mere hypothesis validation; it leads to the formulation of the Integrative Psycho-Behavioral Interior Design Model—a new conceptual framework based on and validated by empirical data from this study. This model presents significant conceptual and practical novelty for the discipline. Conceptually, the model transforms the often-abstract principles of Human-Centered Design (HCD) into actionable and tested pillars: Human Dimension Diagnostics (a mandate to map behavior, identity, and sensory needs before designing), Validated Design Principles (establishing a priority hierarchy, with data from this study confirming Autonomy & Control as the top priority), and a Multi-Layered Validation Process (advocating the use of simulation like VR for internal validity and post-occupancy evaluation for external validity). Practically, the novelty of this research lies in empowering designers with an evidence-based language. Instead of relying on subjective intuition,

practitioners can now use methodology and data (citing high statistical significance and substantial increases in functional satisfaction) to advocate for design choices that objectively enhance well-being, bridging the gap between design intent and measurable human impact.

Although these findings are robust, the research has limitations that pave the way for future investigations. The generalization of findings is limited by the specific context of the research samples (students for VR and the case study). Replication of this model in different environments—such as corporate workplaces, healthcare facilities, or elderly housing—is essential to establish its universal applicability. Furthermore, while the VR experiment provided excellent variable control and the field study offered real-world validity, future research could integrate more objective measures. For example, incorporating biometric data (such as heart rate variability or eye-tracking) within VR simulations (as part of the validation process) could capture non-conscious physiological stress responses to space, supplementing self-reported data. Finally, the field case study used a short-term post-occupancy evaluation (spanning only a brief period); longitudinal studies that track the design's impact over extended periods are needed to understand the sustainability of the well-being effects and distinguish between true design impact and the novelty effect. Future research must continue to refine and expand this Integrative Psycho-Behavioral Model, building upon the evidence-based foundation established by this study.

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