OPTIMIZING SMALL SPACES: A COMPREHENSIVE STUDY ON INTERIOR DESIGN CHALLENGES, PERCEPTUAL EXPERIENCES, AND INNOVATIVE SOLUTIONS

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ABSTRACT

Creating aesthetically beautiful and functional interior spaces inside a constrained square framework has become increasingly difficult during a time of escalating environmental concerns and extensive housing challenges. A few of the challenges faced by residential users are adaptability and privacy, psychological problems such as claustrophobia, trouble relaxing, and negative effects on mood. These psychological aspects substantially affect an individual's general quality of life, emotional stability, and mental health. Such challenges force designers to come up with solutions that maintain a balance between functionality and appearance. The purpose of this study is to determine which design elements affect how space is perceived and explore the psychological and cultural influences on interior function. Using behavioral data, the challenges designers and users face in these constrained environments are investigated. A comprehensive analysis of studies relevant to compact space design is included in the literature evaluation section of the study. Both designers and users recognized the variety of challenges that small rooms pose. Users frequently express severe concerns about psychological effects. Hence, designers develop creative solutions to enhance the design of small spaces, such as innovative color patterns, lighting strategies, and optical illusions. The flexibility of user choices and designer recommendations to coexist shows that there are workable solutions in small-space design. Better living conditions and greater levels of well-being for those who occupy them are the ultimate results of this research's usefulness in resolving the many problems associated with constrained interior spaces.

Keywords*: *Spatial Perception, Design elements, Functionality, Small- Spaces, Psychological Impact

INTRODUCTION

Developing aesthetically pleasing and functional interior spaces within limited space has become increasingly significant in today's world [1]. The title of the study reflects the focus of an in-depth investigation of the various factors influencing interior design in small spaces. This research employs a multidisciplinary methodology, exploring into the aesthetic, practical, and psychological elements of interior design in small spaces. The global housing crisis and environmental concerns have made this problem even more critical. In an era marked by widespread housing crises and expanding ecological concerns, residential users face several challenges when living in compact areas. [2]. These barriers include the more obvious concerns of adaptability and privacy, together with the more subtle but significant psychological issues of claustrophobia, insomnia, and the presence of negative feelings. [3]. It is crucial to realize that the psychological factors included are not just theoretical ideas because they have a significant impact on a person's overall quality of life, emotional stability, and mental health. [3]. Comprehending and addressing these psychological concerns is essential to creating small living areas that are comfortable, practical, and emotionally stable.

Fig 1: Least affordable international housing markets [4]

To address the current scarcity of homes in metropolitan areas, Bangladesh will need to construct at least 8.5 million additional homes over the course of the next five years [4]. These complex issues present a challenge for designers, who must find a balance between aesthetics and functionality to create environments that enhance the lives of those who use them. [5]. This study aims to identify the core components of interior design that influence how we perceive space and thoroughly investigate the relationships between psychological and cultural factors that impact usable interior spaces. [6]. This study is predicated on the understanding that to get over these obstacles, actual data is required. Therefore, behavioral data is employed as a powerful tool to provide insight into the difficulties users and designers face in these limited situations. This study provides a thorough understanding of the complex constraints influencing interior design in small spaces. Using behavioral data to understand how people interact with and react to small living spaces offers crucial insights [7]. Thanks to this data-driven approach, better decisions can be made when constructing facilities that are physically and mentally advantageous. The study presents an intriguing comparison between the problems homeowners bring up and the innovative solutions that designers propose and implement. Although concerns regarding the psychological impact of tiny living spaces are often raised, designers have come up with innovative solutions. They have used cutting-edge techniques like imaginative schemes of color, creative lighting configurations, and visual illusions to transform constrained spaces into both aesthetically pleasing and functional spaces [5]. The compatibility of preferences of users and designer suggestions shows that practical solutions are possible in small-space design. When it comes to how designers artistically respond to consumers' worries about small living spaces, it is feasible to strike a balance between the needs of the user and their creativity. This combination is necessary to create small-space designs that are both practical and aesthetically beautiful.

In the end, this study offers an effective way to address the intricate issues regarding small interior places. It makes room for the emergence of improved living environments and higher degrees of well-being for those who occupy them [8]. This study investigated change, innovation, and research in this study to redefine interior design in the face of constraints. In the end, it is imperative that the study's objective of enhancing living conditions and well-being be accomplished. The research, by analyzing and resolving the challenges of building compact interior spaces, has the potential to completely

transform our understanding of interior design, especially in light of the increasing urbanization and environmental concerns. In conclusion, the study provides a complete analysis of the difficulties in designing small interior spaces. It tackles practical and psychological issues and offers chances for creative, fact-based solutions. The results of this study could significantly impact interior design, especially on how we address the growing problem of small spaces.

LITERATURE REVIEW

Careful consideration of design elements is essential in small areas to maximize efficiency and visual appearance. Some design strategies that improve space include multipurpose furniture, flexible layouts, and various design options designers employ to solve the issue of limited space while maintaining visual appeal [2]. The degree to which small spaces can be helpful and comfortable depends on the user's capacity to perceive space. Optical illusions, color schemes, and lighting may all be used to make tiny areas appear larger as part of their inquiry into spatial perception [2]. These design strategies impact how people perceive and use compact regions.

Functionality is crucial when it comes to limited areas. Functional design components are essential to ensure that small spaces meet consumers' needs [7]. Ergonomic furniture arrangements and efficient circulation patterns are two examples of these components. Solving functional difficulties is a prerequisite for improving the user experience [7]. For example, functionality was a core element of Le Corbusier's philosophy [9]. He believed that small interiors should prioritize practicality and functionality over excessive decoration. Also, he preferred open floor plans because he thought they might give the impression of more significant space and adaptability in tiny areas. He underlined the need to eliminate excessive barriers and divisions to create open, adaptable living spaces [9].

The psychological effects of limited spaces are essential to recognize the profound psychological impact of living in a limited space [6]. Stress, mental disorders, and claustrophobia are common problems. Recent studies show that residents of compact rooms are less happy overall and are under higher stress [3]. The layout and design of a room significantly influence the mental health of its residents. Especially after the COVID-19 pandemic, more people are working from home. So, indoor spaces have become places where residents spend much time living or working [10], which results in the indoor environmental quality impacting human well-being by affecting their mood and mental health. It can also lead to negative emotions like anxiety, stress, and sadness [11].

METHODOLOGY:

The study proposes a mixed-method approach as a comprehensive and balanced strategy to examine the interior design of small spaces. The study incorporates a Site Study and a Qualitative technique to ensure an in-depth understanding of the research problem.

Study Area

A neighborhood in Khulna called Nirala Residential has been chosen for a site survey on interior design in small spaces. At 67.31 acres, it is a tiny but densely inhabited area primarily used for residential purposes, with other infrastructure that is necessary to support such a function [12]. This study analyses the impact of design elements in residential interior spaces and their relationship with

people's perception of well-being. For this survey, a specific residential building in Nirala was selected as a study object. It is a three-story building with the same height on each floor. The floor measurements are 36'1" in length and 22'11" in width. The usable floor area was 828 sqft. Although the building was south-facing, it created much glare during the summertime. The daytime temperature conditions inside the building were unbearable during the summer. The data on temperature conditions was collected from the participants, and it was 36°C to 42°C even inside the building, especially between 2 pm and 4 pm.

The participants were asked to rate their satisfaction on a scale of 1 to 10, where one (1) indicates not happy, and ten (10) indicates extremely happy. Also, they were asked questions like (a) the size of the living arrangement—the size of the house, apartment type(one bedroom or studio apartment), etc., (b) ever feel uneasy or claustrophobic? If yes, could you please specify when and how often? (c) Have you ever experienced tension, worry, or mood swings? And (d) If they changed your small space's color scheme, lighting, or layout.

Fig 2: Bird-eye view of the study area (Khulna)

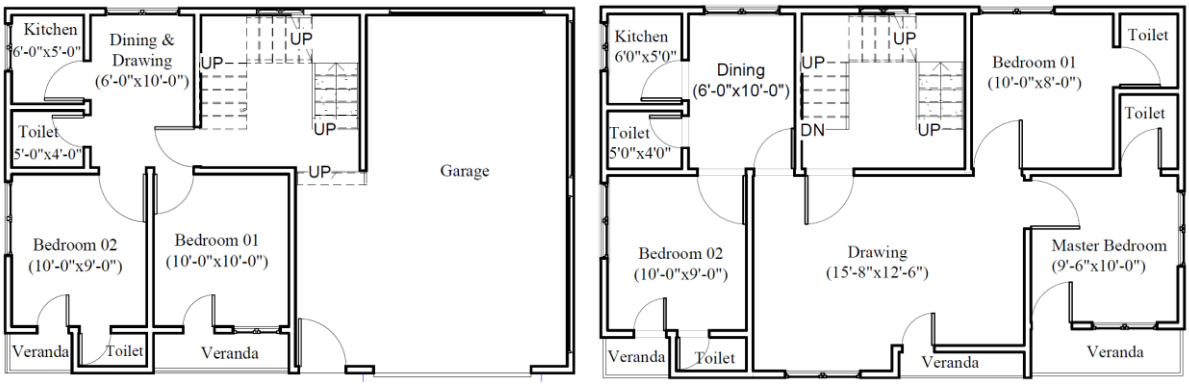


Fig 3: (a) Ground floor layout & (b) 1st & 2nd floor layout

Qualitative approach:

The selection of participants for the behavioral information collection will involve employing a purposive sample technique, which will include experienced interior designers as well as those residing in compact living spaces. Case studies will be used to identify recurring themes, problems, and innovative design solutions from qualitative data collected through open-ended survey questions and interviews. Information from many sources will be combined to gain a thorough understanding of the problems and solutions related to interior design for tiny spaces. Case studies that have undergone renovations due to issues with limited space will be chosen. To ensure consistency and reliability, the

results will be cross-checked and confirmed by establishing a relationship between the study area and case studies. In order to guarantee participant anonymity, informed permission, and confidentiality, surveys and interviews were conducted in accordance with ethical standards.

4. RESULTS AND DISCUSSIONS

4.1 Subjective Assessment

From the study object, the residents of the building were questioned about their comfort and discomfort while staying in the congested area. Of the total participants, there were 27.2% of males who spent their daytime in the office,18.2% were adults who go to college or university and spend most of the day there, another 18.2% were kids who spent half of the day in school, and finally, the majority of the percentage was 36.36% who were women mostly spending their whole day indoor. Over 85% of the participants were between 20 and 55 years old.

Table 1: Participants' rating of visual discomfort at various times of the day

Time	Comfortable	Bearable	Disturbing	Intolerable
8 am to 10 am	96.4%	2.1%	1.5%	0%
10 am to 12 pm	78.9%	6.2%	11.5%	3.4%
12 pm to 2 pm	43.7%	12.3%	25.6%	18.4%
2 pm to 4 pm	18.6%	19.4%	31.6%	30.4%

Table 1 shows the participants' visual discomfort ratings at different times of the day in the residential building that was the subject of the survey. The degrees of discomfort were divided into four categories: "Comfortable," "Bearable," "Disturbing," and "Intolerable." These sections provide the respondents' subjective evaluations of how comfortable or uncomfortable they felt due to visual elements at different times. The severity of the discomfort changed significantly during the day. The settings were considered suitable between 8 and 10 am by most of the participants (96.4%), suggesting adequate lighting and comfort for the eyes.

Between 10 am and 12 pm, there was a noticeable change in the proportion of individuals who found the settings comfortable (78.9%), while the percentage who found the conditions "disturbing" (11.5%) increased. This suggests that visual pain begins to worsen throughout this period. At midday (12 p.m. to 2 p.m.), a significant portion of participants (43.7%) deemed the visual conditions to be "Comfortable," but a significant portion (25.6%) believed them to be "Disturbing." Specifically, during that time, the residents' homemakers spend the day in the kitchen. From the layouts of the building, we can see that the orientation of the kitchen is on the west side. The sun starts to create glare afternoon, and it is impossible to bear that heat during summer. Only 18.6% of participants felt the afternoon conditions (2–4 pm) were "Comfortable," while a significant number (31.6%) and (30.4%) said they were "Disturbing" or "Intolerable." This appears to be the least comfortable time interval regarding optical conditions. These uncomfortable conditions are created because of the heat and glare of the sun.

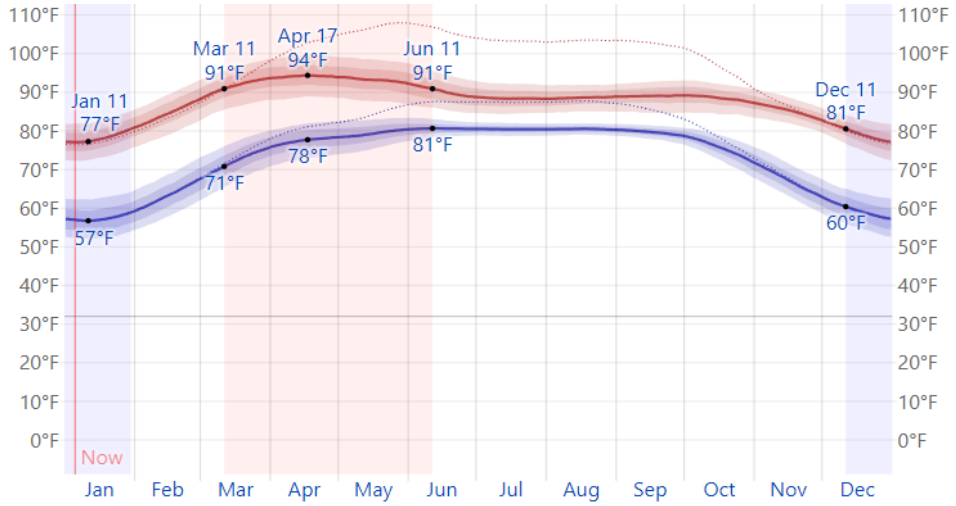


Fig 4: The average maximum(red line) and minimum(blue line) temperature in Khulna [13]

Based on the chart, we may infer that the hot (summer) season, which has an average daily high temperature above 91°F, lasts for 3.0 months, from March 11 to June 11. With an average high temperature of 93°F and low temperature of 79°F, May is the hottest month in Khulna. Additionally, the cold (winter) season spans 1.6 months, from December 11 to January 30, and has an average daily maximum temperature of less than 81°F. The lowest average temperature in January is 57°F, while the highest average temperature is 78°F. This makes January the coldest month in Khulna.

Also, from the figure below, the most uncomfortable time during the day is between 12 pm to 6 pm. The survey participants also indicated that the time of the day was the most uncomfortable.

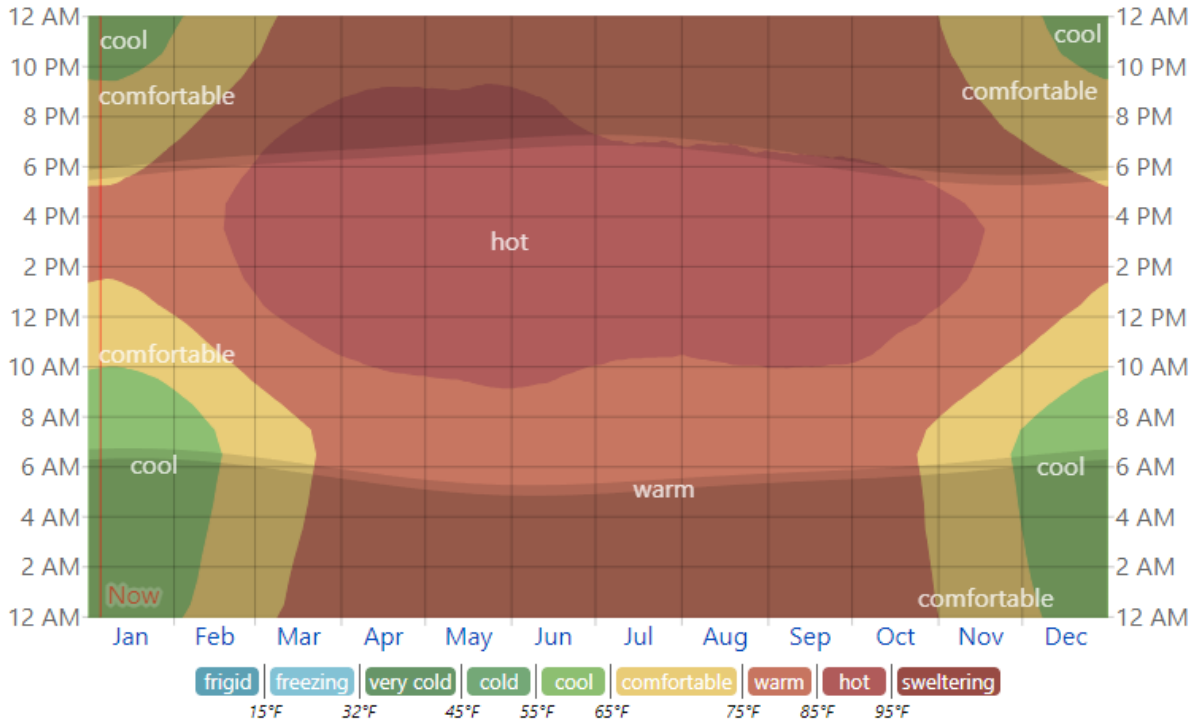


Fig 5: Average hourly temperature [13]

Table 2 shows the typical high and low temperatures in a residential environment for the summer, and the winter are shown in the table, along with the proportion of participants who felt comfortable and uncomfortable at each temperature.

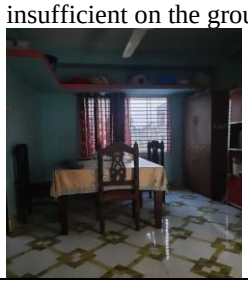
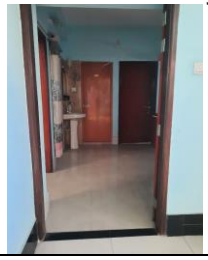
Table 2: Thermal comfort during summer and winter

	Indoor Average High Temperature	Indoor Average Low temperature	Participants' percentage of comfort	Participants' percentage of discomfort
Summer	**42°C**	**34°C**	**23.6%**	**76.4%**
Winter	**25°C**	**13°C**	**55.3%**	**44.7%**

This information helps to explain how temperature variations throughout the year affect residents' comfort and well-being. The participants' percentage of comfort is the proportion of individuals who were comfortable with the interior temperature throughout the summer. Only 23.6% of the participants said they felt comfortable in the summer, which is a relatively low number. However, a greater proportion—55.3%—felt that the inside temperature remained comfortable during the winter, indicating that most respondents thought the circumstances were adequate. The "participants' percentage of discomfort" is the proportion of participants

who said they were uncomfortable during the specified season. A sizable percentage (76.4%) of participants reported experiencing pain at some point during the summer, indicating that many were not appreciative of the warm indoor conditions. 44.7% of people said they were uncomfortable over the winter, meaning that while a significant number of people were still unpleasant, it was lower than in the summer.

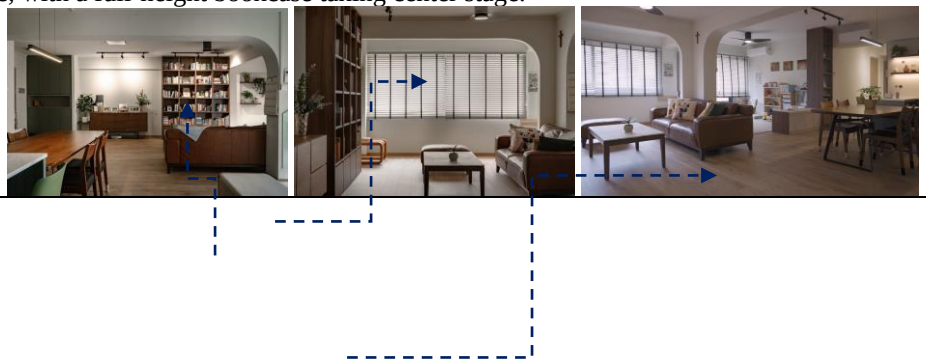
Table 3: Effect of interior elements on the participants

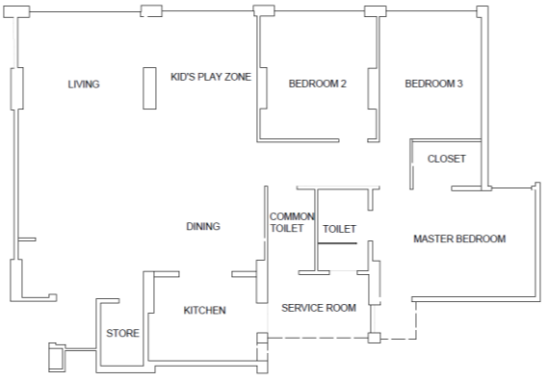
Elements	Description
Lighting	During the daytime, there was sufficient natural light, but after 1 pm, the sun created glare, which became intolerable for the participants to stay in the bedroom. In the afternoon, there was no sufficient lighting in the dining area. Also, the lighting was insufficient on the ground floor in the entry.  
Color patterns	The darker color on the wall made the ceiling lower than it really is and made the room shorter.
Furniture arrangements	As the dimensions of the room were small, the bulky size of the furniture made the bedrooms appear smaller.

An overview of the impact of key interior features on the respondents in the residential building under study is given in Table 3. These interior design components include furniture placement, lighting, and color schemes. The crucial interior design components that significantly contributed to the participants' comfort and well-being in the residential building under study are highlighted in Table 3. In addition to highlighting the particular problems and difficulties that the residents of the Nirala building confront in relation to these components, it emphasizes the significance of appropriate lighting, deliberate color schemes, and sensible furniture configurations to improve the overall living experience in small spaces.

4.2 Case Studies:

Table 4: The case studies from various renovations:

Cases	Description
CASE 01: Hougang, Singapore	The design concept embodies the client's objective of creating a vibrant and exciting environment for their family, particularly their three youngsters [14]. This flat is 1350 square feet. The dining area and living room were open-concept. The living area features a dark wood and green material palette, with a full-height bookcase taking center stage. 



CASE 02: Apartamento Ladrilho, Brazil

The transformation of an incomplete "skeleton" apartment into a tastefully customized and inviting living space [15]. The main objective of this project was to improve storage and overall efficiency while also adding flare and comfort to the interior. The kitchen was beautifully unified by a gorgeous double-sided handcrafted wooden cabinet, and the living/dining space was installed in its place. The second bedroom was designed to be versatile and is currently used as an office. It might be transformed into a functional second bedroom in the future.

CASE 03: Manila, Philippines

The Alba Home 2 is a remarkable micro dwelling that features versatile design components and can accommodate a family of five [16]. Functional storage solutions and flexible furnishings complement the room's open-plan layout. The bedroom has a gorgeous, elevated platform bed with built-in storage surrounding it, concealing a child's fold-out mattress to maximize space economy. The apartment features mustard yellow, forest green, and terracotta accents in a bright color scheme. Mirrors create the illusion of more space, and vertical lines are used to maximize the amount of accessible vertical space.

Interior designers can learn valuable information about the relationship between the study area in Khulna's Nirala Residential neighborhood and case studies from various locations. This relationship may also help address some of the issues brought up in the survey. The following are some ways that the designers can benefit from the relationship between the case studies and Nirala's conclusions:

Table 5: The interrelationship between the findings:

Name	Description
Temperature and comfort	Summertime highs in Nirala caused suffering for the locals, especially in the afternoon when the heat and glare were unbearable. Case 01 from Hougang, Singapore, highlights how crucial it is to give families comfortable living spaces. Designers might take a cue from this example, which effectively controls lighting and temperature to create a comfortable environment while resolving the discomfort caused by heat and glare in Nirala.
Lighting	Participants in Nirala mentioned that several rooms, like the afternoon bedroom and the bottom floor entry, lacked enough lighting. Case 02, Apartamento Ladrilho, Brazil, demonstrates how overall efficiency and lighting were enhanced through renovations. To improve illumination in the assessed building and solve the concerns raised by the occupants, designers might take a lesson from this example.
Color patterns	Darker wall colors, according to Nirala residents, give the impression that rooms are smaller. Inspiration can be found in Case 03, Manila, Philippines, in the use of color and pattern. Strategic use of color schemes and patterns can help designers solve the apparent problems with smaller spaces in Nirala and give the impression of space.
Furniture arrangements	Small rooms in Nirala seemed much smaller because of the heavy furniture. Case 02, Apartamento Ladrilho, Brazil, shows how to make the most of available space by arranging furniture in a flexible way. Designers can utilize comparable tactics to optimize the restricted area within the Nirala structure.
Multifunctional design	Case 03, Manila, Philippines, shows how to make the most of small areas by utilizing multifunctional design features. This strategy can be used to create adaptable living spaces and solve the study object’s space constraints.

By integrating the case studies with the Nirala survey data, interior designers can gain valuable insights on doable design concepts that can improve the comfort and well-being of the inhabitants. Some tips for making the most of small spaces include maximizing lighting, using color and furniture strategically, and adding multifunctional design elements. Designers may draw inspiration from these situations to make the interior areas of the Nirala residential complex more comfortable and useful, thereby addressing the specific difficulties brought up in the survey.

5. CONCLUSIONS

Case studies of renovated residential buildings offer helpful insights into the ideas and strategies for large, functional living arrangements. These guidelines maximize available space by prioritizing flexibility, functionality, and beauty [17]. The study's findings in Khulna's Nirala Residential Area provide insight into the difficulties experienced by people living in small spaces and the effects that interior design aspects have on people's well-being. According to the poll, inhabitants were uncomfortable because of high interior temperatures, glare problems, inadequate lighting, furniture

placement, and color schemes. These results highlight the necessity for well-considered interior design solutions to improve living circumstances in these kinds of crowded neighborhoods. Interior designers can learn a lot from the interplay between the case studies from different regions and the study area. Through the utilization of practical design approaches presented in the case studies, designers can effectively tackle the problems noted in Nirala. These tactics include multipurpose design components, furniture placement, color coordination, and lighting optimization to maximize space efficiency.

Although this study provided insightful information, there were few investigations on the spaciousness of small areas. Architects must possess a thorough understanding of the dynamic properties of design elements. From the site plan to the building form and orientation, from window design to furniture placement, these components blend at different scales. While a large body of research has examined the effects of architectural factors, little of it examines the performance of design elements from the standpoint of interior design and layout. When it comes to design techniques, architects frequently concentrate on how different construction factors affect interior design and layout. An overview of the experiences of the residents is given in this study. It would be advantageous to look at how interventions and design modifications affect well-being over the long run. The study concludes by emphasizing how crucial it is to address interior design components in small spaces to enhance occupants' comfort and well-being. Further study can help the development of effective design solutions for densely populated residential areas like Nirala by addressing the limits and learning from successful case studies.

REFERENCES

[1] Al-Ramahi, A., Iranmanesh, A., & Denerel, S. B. (2023). Well-Being as an Effective Aspect in the Perception of Vital In-between Spaces within Art and Architecture Faculties. *Buildings*, *13*(6), 1467.

[2] Al-Zamil, F. A. (2017). The Impact of Design Elements on the perception of spaciousness in Interior Design. International Design Journal, 7(2), 177-187.

[3] Cleveland Clinic medical professional. (2023, December 11). *Claustrophobia: What Is It, Symptoms, Causes & Treatment*. Cleveland Clinic. https://my.clevelandclinic.org/health/diseases/21746-claustrophobia

[4] Cox, W. (2023). DEMOGRAPHIA INTERNATIONAL HOUSING AFFORDABILITY-2023 EDITION.

[5] Spence, C. (2020). Senses of place: architectural design for the multisensory mind. *Cognitive Research: Principles and Implications*, *5*(1), 46.

[6] Hamdy Mahmoud, H. T. (2017). Interior architectural elements that affect human psychology and behavior.

[7] Li, Z., & Wu, J. (2021). Research on the design of small interior space. In *E3S Web of Conferences* (Vol. 308, p. 01002). EDP Sciences.

[8] Krieger, J., & Higgins, D. L. (2002). Housing and health: time again for public health action. *American journal of public health*, *92*(5), 758-768.

[9] Samuel, F. (2007). Le Corbusier in detail. routledge.

[10] Morales-Bravo, J., & Navarrete-Hernandez, P. (2022). Enlightening wellbeing in the home: The impact of natural light design on perceived happiness and sadness in residential spaces. Building and Environment, 223, 109317.

[11] Rasskazova, E. I., Leontiev, D. A., & Lebedeva, A. A. (2020). Pandemic as a challenge to subjective well-being: anxiety and coping. Counsel. Psychol. Psychother., 90-108.

[12] Hasan, M, Khan, MSA, Sutradhar, I, Hossain, MM, Hossaine, M, Yoshimura, Y, et al. Prevalence and associated factors of hypertension in selected urban and rural areas of Dhaka, Bangladesh: findings from SHASTO baseline survey. BMJ Open. (2021) 11:e038975.

[13] The weather year round anywhere on earth—Weather spark. (n.d.). Retrieved January 8, 2024, from https://weatherspark.com/

[14] BuildBuilt TV. (2023, November 18), *Family-Friendly Home With A Built-In Bookshelf | BuildBuilt Portfolio* [https://youtu.be/Ohp0QXfYjYQ?si=cDbx5nTHt6x1GgE-]. YouTube.

[15] Never Too Small. (2023, November 16), *NEVER TOO SMALL: Brazilian Architect's Storage Efficient Apartment, Curitiba 55sqm/592sqft* [https://youtu.be/d8mQ54xU01o?si=b8QaD5bnXuqaNyG_]. YouTube.

[16] Never Too Small. (2023, October 19), *NEVER TOO SMALL: Family of 5's Multifunctional Micro Apartment, Manila 28 sqm/301sqft* [https://youtu.be/B8h1eMrT1pA?si=kMSi3flqy7DDPudi]. YouTube.

[17] Design21. (2023, October 19). *Balancing Aesthetics and Functionality in Home Architecture*. LinkedIn: Log In or Sign Up. https://www.linkedin.com/pulse/balancing-aesthetics-functionality-home-architecture-design21