wjert, 2024, Vol. 10 Issue 7, 97-114. *Original Article* ISSN 2454-695X

World Journal of Engineering Research and Technology

WJERT

www.wjert.org

SJIF Impact Factor: 7.029

INTERACTIVE DYNAMICS IN COMMON SPACES OF RESIDENTIAL PROJECTS: IMPROVING RESIDENTS' ENGAGEMENT

Fariel Khan*[1] and Anamika Jiwane[2]

[1]Department of Architecture and Interior Design University of Bahrain, Isa Town, Kingdom of Bahrain.

[2]Department of Architecture and Interior Design University of Bahrain, Isa Town, Kingdom of Bahrain.

Article Received on 01/05/2024 **Article Revised on 21/06/2024** **Article Accepted on 10/07/2024**

***Corresponding Author**
Fariel Khan
[1]Department of Architecture and Interior Design University of Bahrain, Isa Town, Kingdom of Bahrain.

ABSTRACT

The design of communal spaces in residential projects is evolving to create interactive environments that enhance resident engagement and well-being. This shift highlights the crucial role of communal areas in shaping social dynamics, fostering community, and improving quality of life. Researchers are adopting innovative approaches and technologies to foster meaningful interactions, emphasizing inclusivity, accessibility, and user-centeredness to meet diverse resident needs. Interaction dynamics within these spaces are vital for social engagement and community cohesion, especially in urban areas. Creating vibrant public spaces that encourage community engagement is essential. There is a strong push for user-friendly areas that promote connection and interaction. Smart technologies, like home automation systems and digital communication platforms, enhance connectivity and resident engagement. Additionally, inclusive practices are emphasized to bridge demographic gaps and foster harmony within communities. This research aims to provide insights and recommendations for architects, urban planners, and policymakers by examining current trends, challenges, and opportunities in common space design. The primary goal is to investigate the interactive dynamics within these spaces and identify strategies to improve resident engagement. Objectives include reviewing design and usage patterns, identifying factors influencing engagement, exploring technological integration, and developing design guidelines. Using qualitative methods and experimental

case studies with design students, the study seeks to enhance social interaction, community life, and overall living experiences in residential environments. This approach aims to contribute to residential projects that promote vibrant, connected, and cohesive communities.

KEYWORDS: Residents' Engagement, Community Cohesion, Interactive Dynamics, Smart Technologies, User-Centeredness.

1. INTRODUCTION

The design of common spaces in residential projects is experiencing a significant transformation, driven by the aim of creating interactive environments that enhance resident engagement and well-being. This shift reflects a growing acknowledgment of the crucial role that communal areas play in shaping social dynamics, fostering community, and elevating overall quality of life. Researchers are exploring innovative approaches and technologies to move beyond mere functionality and foster meaningful interactions and experiences. This rethinking of common space design is anchored in principles of inclusivity, accessibility, and user-centeredness, aiming to cater to the diverse needs and preferences of residents. Interaction dynamics within these spaces are pivotal in shaping social engagement and community cohesion, particularly in densely populated urban areas.

Gehl (2011) emphasizes the essential role of public spaces in urban environments and their profound impact on social interactions, community engagement, and well-being. He advocates for the creation of vibrant and user-friendly public spaces that encourage connection, engagement in activities, and a sense of belonging within communities. Orfanos et al. (2023) delve into how technologies are transforming residential spaces, enabling automation, energy efficiency, and enhanced connectivity for residents. Technological integration, such as smart home systems and digital communication platforms, further enhances resident engagement and fosters a sense of connectedness. Jacobs (1961) underscores the importance of inclusive practices and programming in bridging demographic gaps and promoting harmony and resilience in residential communities. She highlights the need to prioritize local neighborhoods and social interactions over large-scale development in housing projects. By examining current trends, challenges, and opportunities in common space design, this research aims to provide valuable insights and practical recommendations for architects, urban planners, and policymakers striving to create more interactive and vibrant residential communities.

AIMS AND OBJECTIVES

The primary aim of this research is to investigate the interactive dynamics in common spaces of residential projects and identify strategies to improve resident engagement. Objectives can be listed as

- To review the current design and usage patterns of common spaces in residential complexes.
- To identify the factors that influence resident engagement in these common areas.
- To explore the role of technological integration and space planning in enhancing interaction within common spaces.
- To develop design guidelines and recommendations for optimizing common spaces to foster better engagement among residents.

RESEARCH QUESTIONS

To achieve the aims and objectives, the following research questions will guide the study

How do design elements and spatial configurations of common areas influence resident engagement? What are the best practices and design strategies for enhancing interactivity and engagement in common spaces of residential complexes?

This research will employ qualitative approach to provide a comprehensive understanding of the interactive dynamics within common spaces of residential projects. The cases described and analyzed are done as experimental study with the design students who were given a brief to design residential projects with interactive common spaces. By addressing the above question, the study aims to contribute to the development of residential environments that promote social interaction, enhance community life, and improve the overall living experience for residents.

2. Literature Review

2.1. Interactive Interior Built Environment

Interactive interior-built environments refer to spaces designed with responsive elements that adapt to the occupants' needs and behaviors, leveraging technology, design, and architecture to create dynamic and engaging experiences. Recent research highlights the significant roles of both technology and design in shaping these environments. Current literature discusses the integration of smart technologies in creating interactive home environments, showing that such technologies can greatly improve the adaptability and functionality of residential spaces.

Similarly, Chalhoub and Fleury (2021) emphasize the importance of user-centered design in creating spaces that respond to occupants' needs, thereby enhancing overall well-being. Zhong et al. (2022) focus on biophilic design principles, incorporating natural elements into the built environment to promote physical and psychological well-being, thus demonstrating the value of designing with nature to create engaging and responsive spaces without relying solely on technology. Augmented reality (AR) can create immersive and interactive experiences in residential spaces and enhance user engagement. In the context of AR in residential spaces, the work of Vardouli and Buechley (2014) is particularly relevant. They examine interactive domestic environments, emphasizing how interactive technologies can transform everyday living spaces into engaging and adaptive environments. Interactive interior environments can be achieved through both technological and non-technological design approaches, emphasizing user-centered design to create adaptive, responsive, and engaging spaces that enhance the overall living experience.

2.2. Theories Associated with Interactive Environments

Interactive environments encompass spaces designed to respond dynamically to the needs and behaviors of their occupants. These environments are shaped by various theories that blend technology, design, and human-centered principles to enhance user experience and well-being. Key theories associated with interactive environments include Immersive Design Theory, Multisensory Design Theory, and User-Centered Design Theory etc. These theories collectively contribute to the development of interactive environments that are not only technologically advanced but also deeply attuned to the human experience.

Immersive Design Theory focuses on creating environments that fully engage users, making them feel as though they are part of the space. Slater and Sanchez-Vives (2016) extensively discuss this theory, examining how virtual reality (VR) can create immersive experiences that enhance user engagement and presence. They argue that immersive environments can significantly improve user interaction and satisfaction by providing a sense of being 'in' the environment rather than merely observing it. Recent research by Nilsson et al. (2020) builds on this theory, exploring how augmented reality (AR) can create immersive interactive environments in residential spaces. Their findings indicate that AR technologies can enhance the user's sense of presence and engagement, making their interactions with the environment more meaningful and enjoyable.

Multisensory Design Theory explores how engaging multiple senses—sight, sound, touch, smell, and taste—enhances user experience and interaction within built environments. This theory is supported by the work of Malnar and Vodvarka (2004), who discuss how incorporating elements that stimulate sight, sound, touch, smell, and taste can enhance the user experience. They highlight the importance of designing environments that provide a holistic sensory experience to improve user interaction and satisfaction. Research by Spence (2020) emphasizes the importance of integrating multisensory elements into design, arguing that it can create more engaging and memorable environments. By considering how different senses interact, designers can evoke stronger emotional responses and better meet user needs, leading to spaces that are functional and deeply satisfying on a sensory level. Pallasmaa (2021) expands on this theory, highlighting that traditional design often overlooks non-visual senses, resulting in sterile spaces. Incorporating elements like texture, acoustics, and scent can make environments feel more alive and responsive, enhancing well-being and comfort, and making spaces more conducive to relaxation, productivity, and social interaction.

User-Centered Design Theory emphasizes designing environments and products that prioritize the needs, preferences, and experiences of the users. This approach involves deeply understanding the users through research and involving them in the design process to create more intuitive and satisfying outcomes. Norman (2013) articulates the importance of human-centered design and argues that designs should accommodate human behaviors and cognitive processes to be effective and user-friendly.

Environment affects the Human behaviors theory: The Environment Affects Behavior Theory underscores the importance of thoughtfully designed environments in promoting desired behaviors and enhancing quality of life. By understanding and leveraging the principles of environmental psychology, architects, urban planners, and designers can create spaces that not only meet functional needs but also support the psychological and emotional well-being of their users.

2.3. Technology and Tools to Create Interactive Environments

Augmented Reality (AR) overlays digital information onto the physical world, creating interactive and immersive experiences. In interior design, AR can be used to visualize changes and customize environments in real-time. According to Azuma (1997), AR enhances user interaction by providing contextual information and interactive elements that respond to user inputs. Virtual Reality (VR) immerses users in a completely virtual environment,

offering a high level of interaction and engagement. VR can be utilized during the design phase to simulate and experience spaces before they are built. Whyte (2018) shows how VR can help users explore and interact with design concepts, leading to more informed and satisfactory design choices. Interactive surfaces, such as touchscreens and interactive tables, allow users to interact directly with digital content through touch. These surfaces can be integrated into various elements of the built environment to enhance interactivity. Research by Grønbæk et al. (2017) demonstrates how multi-touch surfaces can be used in residential settings to control home automation systems and provide interactive entertainment options. Smart materials including smart textiles in home environments which respond to environmental stimuli such as temperature, light, and pressure, can create dynamic and responsive environments that adapt to user interactions. Collectively, these technologies and tools contribute to the creation of interactive environments that enhance user experience and engagement. IoT enables seamless automation and control, AR and VR provide immersive and interactive experiences, interactive surfaces facilitate intuitive interactions, and smart materials create responsive and adaptive spaces.

3. Experimental Study - Analysis and Discussion

This experimental study examines four housing projects executed by third-year [300 level] students enrolled in the Interior Design Program at the University of Bahrain. These projects were assigned to provide the design students a hands-on experience in creating interactive environments within the multistoreyed residential projects . The primary aim the experimental study was to foster a design approach that focusses on smart, sustainable homes with well-designed communal spaces to promote user engagement and interaction.

Each of those projects was designed to meet the concept of creating interactive built environment. To achieve the same stduents integrated advanced interactive tools, interfaces, and technologies to enhance the user experience. Project emphasized on facilitating meaningful human-to-human interactions to optimize the functionality and appeal of communal areas.

Following key questions were kept as reference while organizing and analysing the gathered data from the experimental study

- How do residents interact in various spaces within the residential project and what factors initiate and sustain these interactions?

- How do specific components contribute to community engagement and which features or activities enhance the cohesion?
- How do the design of communal spaces influence social dynamics and relationships among residents?
- How do specific design features within communal areas impact interactions and engagement among residents?

  These questions will help analyse how residents interact within each component across the selected four residential projects, providing insights into their impact on community dynamics, resident satisfaction, and overall residents' experience.

3.1. Experimental study.

Project 01: ***Design Concept: Rejuvenate our relationship with nature.***

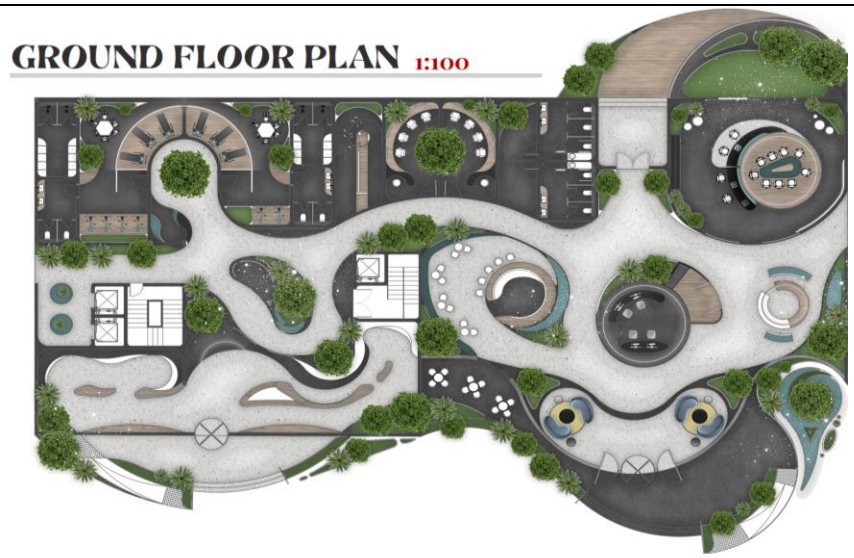

Fig. 01: Ground floor plan-Communal spaces of Project 01.

Introduction : Project 01 is an innovative residential project designed to foster community interaction and enhance residents' quality of life through thoughtfully integrated communal spaces.

This project includes a variety of interactive areas such as a reception with waiting area, a café, a learning studio, a recycling counter, etc. Each of these components are meticulously designed to promote social engagement, support sustainable living practices, and encourage active participation among the residents.

Project 01 aims to build a cohesive and vibrant community where residents can connect, collaborate, and thrive together. This experimental study explores how these communal spaces function to enhance community dynamics and improve their overall living experience.

Project Components (Only selected components are discussed)

 Fig 02: Reception and waiting area.	 **Fig 03: View of different sitting arrangement of café area.**
The reception and waiting area acts as a focal point for appointments and social interactions. Comfortable seating and informative displays encourage spontaneous conversations, fostering a welcoming atmosphere and strengthening community connections.	**The café** serves as a social hub where residents form friendships, share ideas, and build community through regular gatherings and events. Activities like community coffee mornings, evening socials, poetry readings, and art displays foster social and cultural exchange. It also promotes local community projects and initiatives.
Design Elements Raised garden beds: To offer accessible planting Tool stations: To store gardening supplies Indoor and outdoor seating areas: To enhance communication Efficient watering systems: To empower sustainability practice Storage units: To store tools and materials Interactive boards: To track planting progress Native plant sections: To promote local biodiversity	**Design Elements** Comfortable seating options: to suit all types of residents Shelving: To hold a diverse selection of books for all Warm playful lighting: To achieve a lively atmosphere Open areas: To hold group discussions Green indoor plants: To create a calming effect

CONCLUSION: Project 01 demonstrates the power of well-designed communal spaces in fostering a vibrant and cohesive community. The project creates multiple opportunities for

residents to interact, learn, and engage in sustainable practices. The design layout enhancing social connections and promoting a high quality of life. The design incorporates User-Centered Design Theory, which focuses on meeting the needs and preferences of residents, biophilic design principles to integrate natural elements, and Environment Affects Behavior Theory to create spaces that positively influence social interactions and community well-being.

3.2. Experimental study

Project 02: ***Design Concept: Complementary in Diversity.***

<table>
<tr>
<td>

Fig 04: Ground floor plan -Communal spaces of project 02.</td>
<td>**Introduction:** Project 02 is a visionary residential community integrating nature for physical and mental wellness. It offers communal spaces in the form of planting workshop, reading café, activity workshops for all age groups , nursery for kids etc.</td>
</tr>
<tr>
<td colspan="2">These communal spaces foster community engagement, promote sustainable living, and enhance well-being by encouraging interaction and shared learning experiences. This project explores how these spaces facilitate resident interaction, support sustainability, and create a vibrant community environment.</td>
</tr>
</table>

Project Components (Only selected components are discussed)

 Fig 05: View of planting workshop.	 **Fig 06: View of reading area.**
Planting workshop: Residents participate in hands-on gardening workshops to learn planting methods, garden design, and sustainable practices. These collaborative sessions foster community bonding and enhance their environmental awareness.	**The reading area:** It encourages resident interaction and engagement through thoughtful design and amenities. Comfortable and cozy settings allow residents to relax, socialize, and enjoy activities such as reading, chatting, or community gatherings. These inviting spaces promote mental well-being, encourage social interaction, and strengthen community bonds.
Design Elements Flexible space arrangements: To facilitate the interaction Ample natural lighting: To connect with the nature Practical storage solutions: To aid the needs for residents Variety of interactive tools and equipment: To engage the residents Comfortable seating: To offer the comfort	**Design Elements** Comfortable seating: To manage the intended function Cozy atmosphere with community-focused décor: To create a welcoming ambience and a space of belonging for users Functional layouts: To prepare conducive environment for social gatherings Multi-functional spaces: To create opportunities for interactive meetings among the residents Biophilic features: To add to the comfort and relaxation of the users

CONCLUSION: Project 02 is a forward-thinking residential community designed to integrate nature, learning, and wellness into daily living. Guided by User-Centered Design Theory, it features communal spaces aimed at fostering interactive dynamics and community engagement. These spaces incorporate principles from interactivity design theory related to environment and greenery, emphasizing how Environment Affects Behavior Theory. The

project promotes sustainable practices and enhances well-being through resident interaction and shared learning experiences.

3.3. Experimental study

Project 03: *Design Concept:* ***Infusion of tangible and intangible aspect of human living.***

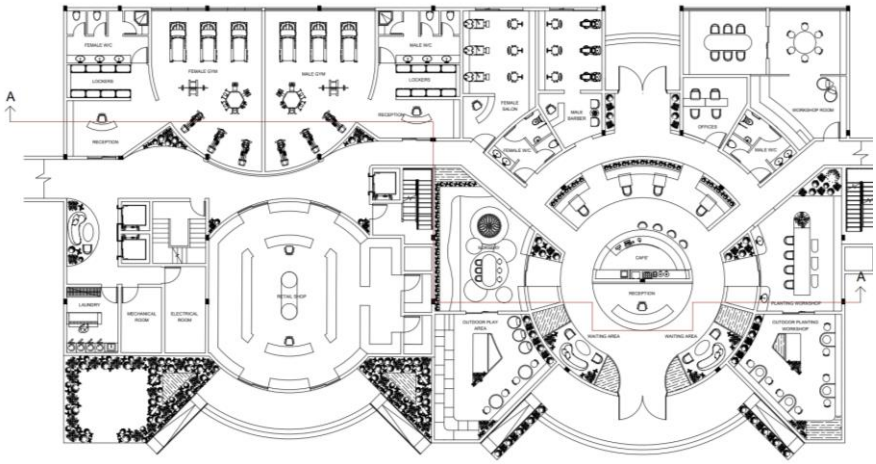

Fig 07: Ground floor plan-Communal spaces of project 03.

Introduction: Project 03 is a comprehensive residential project designed to create an enriching and interactive living environment.

Featuring diverse communal spaces like a reception area, nursery, indoor and outdoor planting areas, workshop space, salon, gym, retail shop, laundry, play area, and reading area, the designer aims to enhance social interactions and community cohesion.

Each space supports various forms of interaction, from casual socializing to learning and recreation. The project emphasizes meaningful activities, relationship-building, and a high quality of life for residents. This study investigates how these interactive spaces impact community dynamics, enhance resident engagement, and contribute to the overall success of the residential environment.

Project Components (Only selected ones are discussed here):

Fig 08: View of workshop.

Fig 09: View of mini library.

Workshop: The workshop area facilitates skill-building, promotes creativity and enhances education , fostering lifelong learning and community cohesion. Residents engage in hands-on activities, collaborate on projects, and share expertise, promoting personal growth under supportive environment.	**Mini Library:** It encourages resident interaction and engagement through thoughtful design and amenities. Comfortable and cozy settings allow residents to relax, socialize, and enjoy activities such as reading, chatting, or community gatherings. These inviting spaces promote mental well-being, encourage social interaction, and strengthen the community bonds.
Design Elements High-quality touchscreens: To create immersive experiences Comfortable seating: To avail easy viewing and interaction Digital art and eco-themed installations: To entertain and educate the residents Soundproofing and strategic audio use: To achieve required atmosphere	**Design Elements** Cozy chairs and communal tables: To achieve comfortable seating Adaptable décor for different themes: To create flexibility to suit all user needs Ambient adjustable lighting: To suit different activities Open Layout: To encourages easy movement and interaction Biophilic features: To integrate nature within the indoor spaces

CONCLUSION: Project 03 excels in creating a comprehensive and interactive living environment that caters to diverse resident needs. Through the inclusion of communal spaces, residents enjoy opportunities for social, educational, and recreational activities. The project's emphasis on creating interactive spaces aligns with design theories such as User-Centered Design and Environment Affects Behavior, enhancing social interactions and community cohesion. This approach sets a benchmark for residential developments seeking to cultivate vibrant and interconnected communities.

3.4. Experimental study

Project 04: ***Design Concept: Beauty of Nature.***

Fig 08: Ground floor -Communal spaces of project 04.

Introduction: Project 04 is an innovative residential project that integrates technology and sustainability with a community-focused design. Besides usual functional components the project added gallery with interactive screens on sustainability, café, gym with pool, children and family reading areas etc.

These spaces promote social interaction, lifelong learning, and wellness. By incorporating digital and sustainable elements, the project educates residents on eco-friendly practices and fosters a connected community. This study examines how these communal spaces enhance resident interactions, support education, and strengthen community engagement.

Project Components (Only selected ones are discussed here)

Fig 09: View of Gallery.

Fig 08: View of café.

Gallery: Residents in the digital gallery explore environmental initiatives,

Cafe: The café serves as a vibrant social hub where residents gather for coffee, meals, and

participate in interactive virtual tours of sustainable architecture, and learn about eco-friendly living. The space fosters a dialogue on adopting sustainable practices and serves as a cultural hub, showcasing digital art and technology-driven environmental stewardship.	community events. This interactive space fosters a sense of belonging, cultural exchange, creating opportunities for residents to connect over shared interests and experiences.
Design Elements: High-quality touchscreens: To create immersive experiences Comfortable seating: To avail easy viewing and interaction Digital art and eco-themed installations: To entertain and educate the residents Soundproofing and strategic audio use: To achieve required atmosphere	**Design Elements:** Cozy chairs and communal tables: To achieve comfortable seating Adaptable décor for different themes: To create flexibility to suit all user needs Ambient adjustable lighting: To suit different activities Open Layout: To encourages easy movement and interaction Biophilic features: To integrate nature within the indoor spaces
Gallery: Residents in the digital gallery explore environmental initiatives, participate in interactive virtual tours of sustainable architecture, and learn about eco-friendly living. The space fosters a dialogue on adopting sustainable practices and serves as a cultural hub, showcasing digital art and technology-driven environmental stewardship.	**Cafe:** The café serves as a vibrant social hub where residents gather for coffee, meals, and community events. This interactive space fosters a sense of belonging, cultural exchange, creating opportunities for residents to connect over shared interests and experiences.

CONCLUSION: Project 04 effectively combines User-Centered Design Theory by prioritizing residents' needs and preferences in communal spaces. It integrates Environment Affects Behavior Theory through biophilic design, incorporating greenery to enhance well-being and community interaction. These strategies ensure that the project fosters a dynamic, sustainable, and engaging residential environment.

3.5. DISCUSSION ON THE EXPERIMENTAL STUDY

The findings of the experimental study for selected four projects can be summarized as follows

All projects prioritize the needs and preferences of residents through User-Centered Design Theory, ensuring that communal spaces are tailored to enhance user experience and engagement. They incorporate Environment Affects Behavior Theory, focusing on how the physical environment can positively influence social interactions, community well-being, and resident behavior. Projects 01, 02, and 04 explicitly mention the integration of natural elements into their design, employing Biophilic Design Principles to improve well-being and foster a connection with nature. All projects emphasize creating spaces that enhance social connections and community cohesion, providing opportunities for residents to interact, learn, and engage in activities together. Additionally, Projects 01 and 02 specifically promote sustainable practices within their design, integrating eco-friendly elements and encouraging sustainable living. Projects 02, 03, and 04 focus on creating interactive spaces that cater to various needs, including social, educational, and recreational activities, fostering a dynamic and engaging residential environment.

4. CONCLUSION AND RECOMMENDATION

One of the issues created by new residential architecture is the fragmentation of neighborhoods and communal spaces in residential complexes. While modern architects designed spaces within these complexes to provide areas for residents and families to spend time together, the lack of variation and unforeseen vulnerabilities have led to significant inefficiencies. These inefficiencies highlight the need for designers to seriously reconsider and revise the design of these communal spaces.

This research on interaction dynamics within common spaces of residential projects has illuminated the critical role these areas play in fostering social engagement and enhancing the overall well-being of residents. Through a comprehensive analysis of current design and usage patterns, it is evident that the physical layout and spatial configuration of common spaces significantly influence how residents interact. Key factors such as accessibility, visibility, and the availability of communal amenities are crucial in promoting frequent and meaningful interactions. The study has identified several factors that enhance resident engagement in common areas, including the integration of technology and the organization of community activities. Technological advancements, such as interactive digital platforms,

facilitate communication and coordination among residents, making it easier to organize events and share information. Furthermore, communal spaces to organize community activities and events are essential for building social cohesion, as they provide structured opportunities for residents to meet, interact, and form relationships.

From the literature reviews on interactive and social dynamics and the experimental study for designing communal spaces in residential projects, a need arises to rethink the design of common spaces in residential projects. The direction of rethinking has to be aligned to create interactive environments for enhancing residents' engagement and well-being. By prioritizing User-Centered Design Theory, developers can ensure that communal spaces meet the diverse needs and preferences of residents, fostering meaningful interactions and a sense of community. Incorporating Environment Affects Behavior Theory helps to create physical environments that positively influence social dynamics and community cohesion. The integration of natural elements through Biophilic Design Principles can improve well-being and strengthen residents' connection to nature. Emphasizing sustainability within these designs promotes eco-friendly living and supports long-term environmental health. Finally, the creation of interactive and multi-functional spaces caters to various social, educational, and recreational needs, establishing vibrant and engaging residential communities. These approaches collectively contribute to the development of cohesive, resilient, and thriving communities in urban settings.

This research highlights the importance of thoughtful and inclusive design in creating engaging common spaces. Design elements that encourage interaction, such as flexible seating arrangements, multipurpose areas, and aesthetically pleasing environments, contribute to a vibrant community life. Authors recommend the following best practices and design strategies to optimize the common spaces to lead social life in residential complexes, ensuring they can cater to diverse resident needs and preferences.

Guidelines for Designing Communal Spaces in Residential Projects

- **Ensure Inclusivity and Accessibility:** Design communal spaces to be inclusive and accessible to all residents, bridging demographic gaps and promoting harmony within the community.

- **Utilize Technology for Enhanced Engagement:** Incorporate smart home systems and digital communication platforms to facilitate coordination, information sharing, and resident interaction, fostering a sense of connectedness.
- **Promote Social Interactions and Community Cohesion:** Create communal areas that encourage social connections, interaction, and community building, fostering a vibrant and cohesive community.
- **Incorporate Natural Elements:** Use biophilic design principles to integrate greenery and natural features, enhancing well-being and creating a pleasant living environment.
- **Design Interactive and Multi-Functional Spaces:** Develop spaces that support various activities, including social, educational, and recreational pursuits, to cater to the diverse needs of residents and enhance community engagement.
- **Enhance Sustainability:** Integrate sustainable practices into the design of communal spaces, promoting eco-friendly living and encouraging residents to engage in sustainable activities.
- **Apply Environment Affects Behavior Theory:** Design spaces that positively influence social interactions and community well-being, recognizing the impact of the physical environment on behavior.
- **Prioritize User Needs and Preferences:** Apply User-Centered Design Theory to ensure communal spaces address the diverse needs and preferences of residents.
- **Incorporate multisensory theory:** It can significantly enhance resident engagement and well-being by creating immersive and interactive environments that appeal to all the senses.

REFERENCES

1. Azuma R T A Survey of Augmented Reality, Presence: Teleoperators and Virtual Environments, 1997.
2. Chalhoub J and Fleury P “Interactive Environments in Healthcare: Enhancing Patient Experience through Responsive Design” Journal of Healthcare Engineering, 2021; 2021: 1-15.
3. Gehl J Life Between Buildings: Using Public Space, Island Press, 2011.
4. Grønbæk K, Petersen M G and Harder H Interactive Tables in Interior Design, Journal of Ambient Intelligence and Smart Environments, 2017.
5. Jacobs J The Death and Life of Great American Cities, Random House, 1961.
6. Malnar J M and Vodvarka F Sensory Design, University of Minnesota Press, 2004

7. Nilsson N C, Nordahl R and Serafin S "Immersion Revisited: A Review of Existing Definitions of Immersion and Their Relation to Different Theories of Presence", Human Technology, 2020; 16(3): 309-341.
8. Norman D A The Design of Everyday Things. Basic Books, 2013.
9. Orfanos V A, Kaminaris S D, Papageorgas P , Piromalis D and Kandris D "A Comprehensive Review of IoT Networking Technologies for Smart Home Automation Applications", Journal of Sensors and Actuator Networks, 2023; 12(2): 1-31.
10. Pallasmaa J The Eyes of the Skin: Architecture and the Senses, John Wiley & Sons, 2021.
11. Slater M and Sanchez-Vives M V "Enhancing Our Lives with Immersive Virtual Reality", Frontiers in Robotics and AI, 2016; 3: DOI=10.3389/frobt.2016.00074
12. Spence C and Gallace A Multisensory design: Reaching out to touch the consumer, Psychology & Marketing, 2011; 28(3): 267-308
13. Vardouli T and Buechley L "Interactive Domestic Environments: An Ethnographic Study of Home Automation", Personal and Ubiquitous Computing, 2014; 18(1): 117-129.
14. Whyte J Virtual Reality and the Built Environment, Building Research & Information, 2018.
15. Zhong W, Schröder T and Bekkering J Biophilic design in architecture and its contributions to health, well-being, and sustainability: A critical review", Frontiers of Architectural Research, 2022; 11(1): 114-141.