Vol 3 No. 2 April 2026 P-ISSN : 3047-2113 E-ISSN : 3047-2121, Hal 43 – 48

JURNAL ILMIAH
MULTIDISIPLIN ILMU
Halaman Jurnal: https://journal.smartpublisher.id/index.php/jimi
Halaman UTAMA Jurnal : https://journal.smartpublisher.id/

DOI:https://doi.org/10.69714/9d98ga64

THE APPLICATION OF BEHAVIOURAL ARCHITECTURE PRINCIPLES TO SUPPORT THE EFFECTIVENESS OF DRUG REHABILITATION FACILITIES IN NORTH SUMATRA, INDONESIA

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ABSTRACT

Drug addiction in North Sumatra remains a critical public health and social issue, characterized by increasing numbers of users and limited rehabilitation facilities. Beyond physical and psychological challenges, social stigma significantly affects patients' willingness to undergo rehabilitation and influences recovery outcomes. The built environment plays an essential role in shaping human Behaviour, emotional responses, and social interaction during rehabilitation recovery. This study aims to examine how behavioural architecture principles can support the effectiveness of drug rehabilitation facilities. A qualitative descriptive method with a design-based approach is employed. Data were collected through literature review and semi-structured interviews with the National Narcotics Board (BNN/Badan Narkotika Nasional) of Medan. The analysis focuses on the relationship between spatial design and patient behaviour, including movement patterns, emotional regulation, territoriality, and social interaction. The findings indicate that the application of behavioural architecture through spatial zoning, environmental stimulus control, socio-spatial interaction settings, and territorial organization can positively influence patient behaviour, reduce stress, enhance emotional stability, and improve participation in therapeutic programs. The study concludes that behavioural architecture functions as a therapeutic design strategy that supports the effectiveness of drug rehabilitation environments.

Keywords: *Behavioural Architecture; Drug Rehabilitation; Therapeutic Environment; Spatial Behaviour*

1. INTRODUCTION

Regardless of socioeconomic standing, age, or educational attainment, drug misuse continues to be a serious public health and social issue in Indonesia. Drug addiction affects not just physical health but also social connections, mental health, economic productivity, and national security (BNN, 2025; H. Marlina, 2019). Compulsive substance use despite knowledge of its detrimental effects is the hallmark of drug addiction, a complicated and long-term illness that frequently involves cycles of recovery and relapse (R. s. Ulrich *et al.*, 2008). Rehabilitation is therefore a long-term intervention that necessitates complete treatment addressing the physical, psychological, and social aspects of healing rather than just a medical procedure (WHO, 2016).

Table 1. Cities with the Highest Crime Rates and Drug-Related Criminal Activity in 2025

No	Province	Cases	Suspect
1	DKI Jakarta	6,941	9,392
2	East Java	5,593	7,026
3	North Sumatera	5,540	6,987
4	West Java	3,144	3,996
5	South Sulawesi	2,585	3,641

Received April 16, 2026; Revised April 18, 2026; Accepted April 23, 2026; Published April 25, 2026

The situation in North Sumatera is getting worse, especially in Medan. The province often ranks among Indonesia's areas with the high number of criminal cases involving drugs (Badan Narkotika Nasional [BNN], 2025). North Sumatra is a major gateway for both domestic and international drug trafficking, contributing to the widespread availability and consumption of narcotics due to its strategic location along the Malacca Strait next to important international routes connecting Singapore, Malaysia, and Thailand (BNN, 2025). The region serves as both a transit corridor and a key consuming zone, according to statistical statistics showing high numbers of drug-related cases, suspects, and positive laboratory samples (BNN, 2025). Rehabilitation efforts in North Sumatra are still inadequate, despite the seriousness of the issue. There is a large disparity between the number of people in need of treatment and the number of rehabilitation facilities, recovery agents, and service capacity (BNN, 2025). Due to restricted access, inadequate facilities, and a lack of supporting surroundings, people are deterred from pursuing recovery, which contributes to the low rate of voluntary rehabilitation (BNN, 2025). Additionally, the majority of rehabilitation cases are started by family intervention or law enforcement participation rather than personal knowledge, according to national rehabilitation data, which reflects a lack of public awareness of rehabilitation as a health-based recovery process (BNN, 2025).

These difficulties are made worse by the social stigma associated with drug use. Drug addiction causes fear, prejudice, and social exclusion since it is frequently seen as a moral failing or criminal activity rather than a long-term medical disease (Corrigan et al., 2017). Such stigma deters people from enrolling in rehabilitation programs and has a detrimental impact on their mental health while they are receiving treatment (Livingston et al., 2012). Despite the National Narcotics Board's (BNN/Badan Narkotika Nasional) comprehensive communication, information, and education (KIE/Komunikasi, Informasi, Edukasi) programs, stigma persists, indicating that educational initiatives alone are insufficient in the absence of compassionate and supportive rehabilitative settings (BNN, 2025). Rehabilitation procedures must include psychological recovery, behavioural counseling, education, and vocational training in addition to physical detoxification in order to guarantee successful reintegration into society (WHO, 2016). Safety and security concerns must also be addressed in rehabilitation centers since patients receiving treatment may exhibit aggressive conduct or emotional instability (Z. Moula, J. Powell, and V. Karkou, 2018). According to earlier research, a sizable percentage of psychiatric inpatients behave violently or aggressively, underscoring the need of spatial design that promotes safety, supervision, and stress reduction (WHO, 2016). In this regard, therapeutic environments that affect patient behaviour, emotional stability, and recovery results are greatly influenced by architecture (H. Marlina, 2019).

Behavioural architecture emphasizes the relationship between space and human behaviour. Spatial elements such as layout, circulation, boundaries, lighting, and environmental stimuli can guide, restrict, or encourage certain behaviours. This approach is particularly relevant in rehabilitation settings where patients often experience anxiety, emotional instability, and Behavioural fluctuations.

The role of architecture as a Behavioural modifier remains underexplored. Therefore, this study aims to analyze how Behavioural architecture principles can be applied in drug rehabilitation facilities and how these principles contribute to improving rehabilitation effectiveness.

2. METHOD

This study employs a qualitative descriptive research method with a design-based research approach to examine the suitability and implementation of Behavioural architecture principles in drug rehabilitation facilities and their contribution to the effectiveness of the rehabilitation process. A qualitative approach is considered appropriate as the research focuses on understanding relationships between spatial design, patient needs, and recovery processes rather than measuring outcomes quantitatively. The design-based research approach allows architectural design to be positioned as an analytical medium through which theoretical principles, empirical findings, and contextual conditions are interpreted and synthesized. In this study, architectural design is treated not only as a physical outcome but also as a research instrument to explore how Behavioural architecture spatial strategies respond to rehabilitation needs.

Data were collected through primary and secondary sources. Secondary data were obtained through an extensive literature study of books, academic journals, national reports, and international guidelines related to drug rehabilitation, therapeutic environments, healthcare architecture, and Behavioural architecture principles. These sources provide theoretical foundations and empirical insights into rehabilitation models, patient spatial needs, safety considerations, stigma reduction, and the role of the built environment in recovery. Primary data were collected through semi-structured interviews with representatives of the National

Narcotics Board (BNN/*Badan Narkotika Nasional*) of Medan. The interview was conducted with Dr. Suku Ginting, one of the doctors working at the National Narcotics Agency (BNN) in Medan, and lasted 40 minutes. The interview was recorded with the informant's permission and subsequently transcribed for thematic analysis. The interviews were conducted to obtain contextual information regarding rehabilitation practices, challenges in facility provision, patient behaviour, rehabilitation capacity, and perceptions of spatial and environmental factors influencing recovery processes. The combination of literature study and interviews enables triangulation between theoretical perspectives and real-world institutional practices.

The data analysis method was carried out through qualitative interpretation and design analysis. Behavioural architecture principles were systematically mapped against key spatial and architectural elements relevant to rehabilitation facilities, including circulation, zoning, accessibility, safety, sensory comfort, and flexibility of space. This mapping process was used to evaluate how each principle responds to the physical, psychological, and social needs of rehabilitation patients. Furthermore, the potential impact of design strategies on rehabilitation effectiveness was analysed by examining their contribution to patient comfort, safety, emotional stability, and participation in rehabilitation programs. The analysis emphasizes the relationship between Behavioural architectural design and the quality of the rehabilitation environment, allowing conclusions to be drawn regarding the role of Behavioural architecture as a supportive framework for drug rehabilitation processes.

3. RESULTS AND DISCUSSION

Drug rehabilitation is a comprehensive and structured process aimed at addressing substance dependency through medical, psychological, and social interventions. Within rehabilitation centres, patients typically undergo medical examinations to manage withdrawal symptoms and physical health conditions, alongside psychological assessments to address behavioural patterns, emotional instability, and mental health issues associated with addiction (H. Marlina,2019). In addition to clinical treatment, rehabilitation programs commonly incorporate psychosocial therapies, counselling sessions, and educational activities that prepare patients for reintegration into society. Vocational training and skill-based activities, such as craft workshops, painting, and creative expression classes, are widely implemented in rehabilitation facilities as part of therapeutic programs that enhance self-esteem, emotional regulation, and social interaction skills (NIDA, 2020; WHO, 2016). These activities not only support recovery but also contribute to restoring patients' sense of identity and purpose beyond substance use.

The results indicate that drug rehabilitation patients present multidimensional needs that directly shape spatial criteria within rehabilitation facilities. Physically, patients may experience withdrawal symptoms, reduced stamina, and fluctuating mobility across different stages of rehabilitation. These conditions require environments that minimize physical effort, provide efficient and legible circulation, and ensure easy access to medical and therapeutic spaces. Environmental comfort such as appropriate lighting, ventilation, acoustic control, and ergonomic layouts supports daily rehabilitation routines and helps prevent fatigue that could hinder recovery.

Psychological and emotional needs are equally critical in determining rehabilitation effectiveness. Patients often face anxiety, emotional instability, and reduced concentration, particularly during early rehabilitation stages. Accordingly, spatial environments must provide a balanced provision of private, semi-private, and communal spaces. Private and semi-private areas support counselling, reflection, and emotional regulation, while communal spaces facilitate group therapy, social interaction, and skill-based activities such as crafts and creative workshops. Spatial clarity and consistency reduce confusion and stress, enabling patients to engage more confidently in rehabilitation programs.

Safety and privacy are essential spatial criteria derived from building layout and environmental context. Rehabilitation facilities must support controlled access, supervision, and gradual transitions between public, semi-public, and private zones. This spatial hierarchy minimizes the risk of aggressive behaviour, protects patient privacy, and supports emotional security without creating an overly institutional atmosphere. The relationship between space and rehabilitation processes becomes evident as spatial sequencing aligns with rehabilitation stages, allowing patients to progress physically through spaces in parallel with their recovery journey.

3.1. Behavioural Characteristics of Rehabilitation Patients

Drug rehabilitation patients exhibit complex and multidimensional behavioural patterns that significantly influence spatial requirements within rehabilitation facilities. These patients often experience emotional instability, anxiety, withdrawal symptoms, and fluctuating motivation levels, particularly during the early stages of recovery. In addition, patients may display tendencies toward social withdrawal or, conversely, aggressive behaviour due to psychological pressure and physiological changes. These behavioural conditions require an environment that is not only physically accommodating but also psychologically responsive. Therefore, architectural design must be able to guide behaviour, reduce negative stimuli, and provide a sense of safety and comfort. A well-designed environment can help patients gradually regain emotional control, rebuild confidence, and adapt to structured rehabilitation routines. This can be achieved through visibility arrangements that allow for passive monitoring without pressure, the avoidance of dark corners and hidden spaces that could potentially trigger conflict, and the design of clear, unambiguous circulation patterns. Additionally, gradual spatial zoning (from public to private) helps regulate social interactions and users' emotional states, while ease of spatial orientation (wayfinding) reduces anxiety caused by spatial disorientation.

On the other hand, controlling physical elements such as furniture, materials, lighting, and acoustics is also crucial in shaping behavior. Furniture is designed to be stable and safe to prevent dangerous movements, while materials are chosen to be non-slip, non-sharp, and to provide a warm feel. Even natural lighting and noise control help create a calming atmosphere, while safe design principles (anti-ligature) prevent potential self-harm. Support for retreat spaces, connection with nature, and the provision of productive activity spaces further reinforce architecture's function as a therapeutic medium that not only accommodates but also shapes positive habits and behaviors during the rehabilitation process.

3.2. Architecture as a Behavioural Modifier

In the context of behavioural architecture, space is understood as an active agent that influences human behaviour rather than a passive container. Architectural elements such as spatial configuration, circulation patterns, visual connectivity, and environmental cues play a significant role in shaping how users move, interact, and respond emotionally within a space. In rehabilitation facilities, this role becomes even more critical, as patients are in a vulnerable psychological condition. For instance, clear and legible circulation can reduce confusion and anxiety, while controlled visibility allows for supervision without creating a sense of oppression. The arrangement of spaces can subtly direct user behaviour, encouraging participation in therapeutic activities while minimizing opportunities for isolation or conflict. Thus, architecture serves as a behavioural regulator that supports the rehabilitation process through spatial intervention.

3.3. Spatial Zoning and Behaviour Regulation

Spatial zoning is a fundamental strategy in organizing behavioural patterns within rehabilitation facilities. The division of spaces into public, semi-public, and private zones creates a structured environment that aligns with different levels of interaction and privacy needs. Public areas such as reception and administrative spaces serve as transitional zones that connect the facility with the outside environment. Semi-public areas, including therapy rooms and activity spaces, facilitate controlled social interaction and group-based rehabilitation programs. Meanwhile, private areas such as patient rooms and counselling spaces provide a safe environment for personal reflection and emotional recovery. This hierarchical zoning system helps regulate behaviour by clearly defining spatial functions and boundaries, reducing ambiguity, and supporting emotional stability. It also ensures that patients can gradually transition between different levels of social engagement according to their recovery progress.

3.4. Territoriality and Personal Space

Territoriality is an important concept in behavioural architecture that relates to the human need for personal space and a sense of ownership. In rehabilitation settings, the provision of clearly defined personal and group territories contributes to psychological comfort and behavioural stability. Patients who feel that their personal space is respected are less likely to experience stress or engage in conflict with others. Architectural strategies such as the use of partitions, furniture arrangement, and spatial boundaries can help establish territorial zones without creating a rigid or institutional atmosphere. For example, individual seating arrangements, semi-private niches, and clearly defined room functions can enhance the sense of control and belonging. By addressing territorial needs, the design supports emotional regulation and fosters a more harmonious social environment within the facility.

3.5. Socio-Spatial Interaction (*Sociopetal* and *Sociofugal* Spaces)

The concept of socio-spatial interaction in behavioural architecture distinguishes between *sociopetal* and *sociofugal* spaces, which respectively encourage and discourage social interaction. In drug rehabilitation facilities, both types of spaces are essential and must be carefully balanced. *Sociopetal* spaces, such as group therapy rooms, communal lounges, and activity areas, are designed to promote communication, collaboration, and social bonding among patients. These spaces support therapeutic programs that rely on group interaction and peer support. On the other hand, *sociofugal* spaces, such as meditation rooms, private counselling areas, and quiet zones, provide opportunities for introspection, emotional regulation, and personal recovery. The availability of both spatial types allows patients to choose their level of interaction according to their psychological condition, thereby supporting a more flexible and responsive rehabilitation environment.

3.6. Environmental Stimulus Control

Environmental stimuli, including lighting, acoustics, colour, temperature, and materiality, have a direct impact on human perception and behaviour. In rehabilitation environments, uncontrolled or excessive stimuli can trigger stress, anxiety, or discomfort, potentially hindering the recovery process. Therefore, careful control of environmental factors is essential. Natural lighting, for instance, can improve mood and regulate circadian rhythms, while proper acoustic treatment can minimize noise disturbances that may cause irritation or agitation. The use of calming colour palettes and natural materials can create a soothing atmosphere that supports emotional stability. Additionally, the integration of vegetation and outdoor views can enhance the therapeutic quality of the environment by providing visual relief and connection to nature. Through thoughtful manipulation of environmental stimuli, architecture can create a balanced sensory experience that supports healing and behavioural adaptation.

Table 2. The application of behavioural architecture in rehabilitation is as follows

Behavioural Architecture Strategy	Spatial Implementation	Behavioural Impact	Contribution to Rehabilitation
Spatial Zoning	Clear division of public, semi-public, and private areas	Reduces confusion and anxiety; improves spatial understanding	Enhances emotional stability and independence
Circulation Clarity	Legible pathways and intuitive navigation	Encourages confident movement and reduces stress	Increases participation in daily rehabilitation activities
Territoriality	Defined personal and group spaces (rooms, seating, boundaries)	Provides sense of ownership, privacy, and security	Reduces conflict and supports emotional regulation
Sociopetal Spaces	Group therapy rooms, communal areas	Encourages interaction and social bonding	Supports group therapy effectiveness
Sociofugal Spaces	Private rooms, meditation areas	Allows withdrawal and self-reflection	Supports psychological recovery and emotional control
Environmental Control	Natural lighting, acoustic treatment, calming colours, materials	Minimizes stress triggers and sensory overload	Improves concentration and emotional balance
Supervision & Visibility	Controlled openness and passive monitoring	Prevents aggressive behaviour without pressure	Ensures safety and therapeutic control

4. CONCLUSION

Behavioural architecture provides a comprehensive framework for designing drug rehabilitation facilities that support patient recovery. Through spatial zoning, territorial organization, socio-spatial interaction, and environmental control, architecture can actively influence behaviour and emotional responses.

The study concludes that behavioural architecture is not merely a design approach but a therapeutic strategy that enhances the effectiveness of rehabilitation environments. Future design of rehabilitation facilities should integrate behavioural principles to create adaptive, safe, and supportive spaces.

Further experimental and quantitative studies are needed to objectively measure the impact of architectural design elements on patients' behaviour and psychological responses within rehabilitation facilities. Additionally, comparative research between facilities that apply behavioural architecture principles and those that do not is also important to empirically evaluate the effectiveness of this approach. This approach is expected to strengthen the scientific foundation for the design of rehabilitation facilities that are more responsive, measurable, and evidence-based.

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