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Neuroarchitecture applied to the study of psychological conditions within physical rehabilitation spaces

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Abstract. Neuroarchitecture as a multidisciplinary study science has been influenced in Ecuador at the case study level to buildings without spaces for external interaction with nature or internal spatial development, which has caused poor treatment. The objective of this scientific article is the design of neuroarchitecture parameters applied to architectural and spatial design to improve treatment in rehabilitation spaces. The considerations will be evaluated under a quantitative approach methodology of the architectural spaces and the user's perception through the decision-making scheme of the Kepner and Tregoe Method that analyzed the situation, evaluated results and established potential risks within the study. In conclusion, the characterization of the architectural spaces by shape and color contributed to the perception of tranquility within the space, the contact with the green areas improved the cognitive and sensory conditions of the users, integrating better with their environment, while the design of the Semi-open spaces and open spaces generate greater confidence and tranquility for comprehensive socialization, so it can be determined that the neuroarchitecture focused on the conditional evaluation and decision-making of the user improves the satisfactory treatment of patients by 90%.

Keywords. Neuroarchitecture, psychological conditions, spatial design, decision making, architectural analysis

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1Introduction

Neuroarchitecture is an interdisciplinary field that combines neuroscience, psychology, and architecture to design environments that promote well-being and enhance cognitive and sensory functioning [1]. In the context of physical rehabilitation spaces, neuroarchitecture can play a crucial role in creating environments that support and enhance the recovery of people with psychological conditions. [2].

Studies have shown that the physical environment can significantly affect a person's mood, behavior, and general well-being. For example, spaces with natural light, a view of nature, and comfortable furniture can create a calm and supportive environment. [3], while spaces with poor lighting, clutter, and inadequate ventilation can increase anxiety and stress levels.

Neuroarchitecture can also help address specific psychological conditions by using sensory stimulation to promote relaxation and reduce symptoms of anxiety, depression, and post-traumatic stress disorder (PTSD). For example, incorporating elements such as natural light, water features, and plants can help reduce stress levels and promote a sense of calm, while the use of textures, colors, and patterns can be used to create a sense-rich environment that engages the brain and reduces anxiety symptoms.

In physical rehabilitation spaces, it is also important to consider the needs and preferences of the individual, as well as the type of therapy that is provided [4]. For example, some people may prefer a calm and serene environment, while others may benefit from a more active and attractive space.

In conclusion, the application of neuroarchitecture in physical rehabilitation spaces has the potential to greatly enhance the recovery process of people with psychological conditions. [5]. By creating environments that support well-being, foster a sense of calm, and engage the senses, neuroarchitecture can play a critical role in helping people achieve their rehabilitation goals.

2Materials and methods

A descriptive study of neuro architecture applied to psychological rehabilitation spaces has been carried out where the criteria within the spatial development analyzed by perception and functionality within the rehabilitation are specified and described. Statistical data of the follow-up of the current conditions of the rehabilitation centers and the scheme of operation of decision-making based on the Kepner and Tregoe method were estimated.

2.1 Conditions for psychological rehabilitation

The study of psychological conditions within rehabilitation spaces is an important field of research that focuses on understanding how the physical environment of rehabilitation spaces affects the mental health and well-being of patients.[6].

Physical rehabilitation spaces are designed to help people recover from injuries or illnesses that affect their physical abilities [7]. However, these spaces can also have a significant impact on the psychological well-being of patients. For example, the design of a rehabilitation space can influence patients' perceptions of their progress, motivation levels, and overall satisfaction with their treatment.

The psychological rehabilitation spaces in Ecuador provide a treatment focused on the dissipation of the patient through activities in semi-open spaces, development of periodic tests, prescribed medication and personalized interaction; model which has had a degree of

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effectiveness of 46% distributed in its 42 psychological rehabilitation centers endorsed throughout the country [8].

Research in this field explores the impact of psychological rehabilitation using complementary elements such as the use of natural light, colors, sound, public spaces, green areas, and furniture to reduce stress levels and the general well-being of patients. Other factors that can be explored include the design and organization of the space, the degree of privacy and social interaction, and the presence of visual distractions or stressors.

Psychological conditions that can be studied within rehabilitation settings include anxiety, depression, post-traumatic stress disorder (PTSD), and adjustment disorder. These conditions based on neuroarchitecture design standards can have a significant impact on the recovery process of patients, as well as their overall quality of life.

2.2 Perceptions of neuroarchitecture

Perception is a central concept in neuroarchitecture, since the design of physical spaces directly influences the way in which people experience the space. Visual perception that manifests interpretations of color, texture, shape, and lighting. As the primary axis, the compositional element of visual perception is contrast, which is used as the tool that shapes this type of perception [3], keeping in mind that contrasting colors or textures can highlight certain features or create a sense of depth in a space.

As a second compositional axis, the design and organization of a space influence the perception of clarity and mental dissipation by using, for example, unobstructed lines of sight that allow the creation of sensations such as order and control, while a more chaotic space packed with items can create feelings of confusion and disorientation [9].

The natural perception is defined within the semi-open and open space in relation to the public space where natural elements such as green areas, bodies of water and their integration with the furniture are distributed, creating a sensation of calm and relaxation [10], while harder industrial materials can create a feeling of tension or unease.

Sound perception is established as an articulating element within neuro architecture. The acoustics of a space can affect how people experience and interpret sound, and the use of soundscapes or background noise can create a specific atmosphere or mood [11].

Spatial perception can affect social behavior. Therefore, the distribution between closed, semi-open and open spaces would encourage social interaction, while a closed space with interior distribution can create a feeling of intimacy or concentration [12].

Perceptions play a fundamental role in the way people experience and interpret physical spaces. By understanding how design affects perception, designers can create spaces that are not only functional and aesthetically pleasing, but also support specific moods, behaviors, and experiences [13].

2.3 Kepner-Tregoe method

The Kepner-Tregoe method (KT Method) as a framework for problem solving and decision making contributes to the correct systematic analysis of complex problems and effective decision making [14]. The KT Method consists of four stages:

Situation analysis: This stage defines the problem or situation and collects and organizes the relevant data. This stage involves asking questions like what is happening, when it started, and how it impacts other areas.

Initial problem analysis: In this stage, the possible causes of the problem are identified and evaluated through a cause and effect analysis [15].

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This stage involves asking questions such as what might be causing the problem, what are the consequences of the problem, and what evidence is available.

Decision analysis: In this stage, possible solutions are identified and their feasibility and possible consequences are evaluated [9]. This stage involves asking questions such as what the available options are, what are the pros and cons of each option, and what are the risks and benefits of each option.

Analysis of Potential Problems: Potential obstacles or risks associated with the chosen solution are identified in this stage and a plan is developed to prevent or mitigate them.

The KT method is often used in conjunction with structured decision-making and problem-solving tools such as SWOT analysis which provides a more comprehensive approach to solutions [16]. The method emphasizes the importance of logic, objectivity, and a systematic approach to decision making.

3Methodology

The methodology used is a quantitative approach, developed through the evaluation of analogous models and the development of design parameters from the perceptive and functional deficiencies analyzed from the axes of neuroarchitecture to establish criteria that improve the treatment conditions of patients stipulating improvements in the design of spaces, going to a next level of decision-making through the Kepner and Tregoe method structured in 4 levels with the analysis of the situation, the problem, the decision and the potential problems found in each one of them. the analogous models studied. The methodology ends in a Kepner and Tregoe matrix that generates solutions from the most relevant to the least relevant, thus obtaining a linear choice approach with the best decision for the design of the guide for perceptual and functional spaces with elements of applied neuroarchitecture.

4Results

4.1 Comparative analysis

As design standards, the cases of 4 psychological rehabilitation centers within Ecuador are analyzed: CIAP Integral Psychological Care Center, Secoya Psychological Center, and Superar Integral Psychology Center; chosen as centers that generate the best effective treatment results. To categorize the type of treatment, the spatial and functional analysis of its infrastructure and the complementary considerations within the design to improve the perception and treatment of patients.

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Care Centers	Type of treatment	Spatial and functional analysis	Complementary considerations
Comprehensive Psychological Care Center (CIAP/CPCC)	Psychotherapy Child psychology Couple psychology Rational Emotive Rational Therapy(RERT) Counseling Medical prescription of drugs Psychoanalytic therapy	Distribution in 3 upper floors and upper balcony as a common area, closed space and a single semi-open space. Not green areas. 	Interior color management (white), private areas of personalized attention.
Psychological Center Secoya	Child psychology Couple psychology Neuropsychological therapy Psychology of dependence on psychotropic substances Medical prescription of drugs	Part of the building complex, distribution over 4 upper floors, semi-open spaces configured by balconies. Not green areas. 	Totally private attention space, the interior circulation spaces are open.
Comprehensive Psychology Center Overcome	Psychoanalytic therapy Cognitive behavioral therapy Neuropsychological therapy Gestalt therapy Rational Emotive Rational Therapy(RERT) Cognitive therapy Counseling Schizophrenia Medical prescription of drugs Psychology of dependence on psychotropic substances Child psychology Couple psychology	Complete building, distributed in 3 floors, ground floor for general care and two upper floors for boarding schools and dormitories. Outdoor parking space. Not green areas. 	The totally open attention space, colors used in private areas are warm and in white tones.

Fig. 1. Comparative analysis of Psychological Care Centers in Ecuador.

From the analogous models analyzed, it is obtained that, being care spaces with results above 46% effectiveness in treatment, they do not contemplate interaction with exterior spaces or green areas in their designs, the interior design in terms of color and shape is not adapted accordingly. its totality and the integration between patients in social areas is only fulfilled in one of the three centers analyzed.

4.2 Decision making Kepner and Tregoe

The KT Method of decision making is used as a statistical model based on real estimates (models) to obtain rational processes of the surveyed users (60) in psychological treatment centers structured in 4 levels; analyzing the situation, the problem, the apparent decision, and the potential problems that contribute to the final decision making of the KT methodical model.

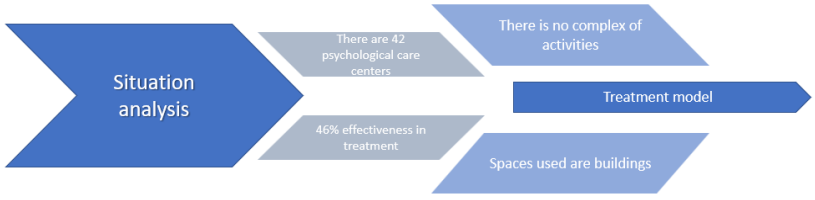

Fig. 2. Situation analysis Kepner and Tregoe method.

It is considered that the treatment model that is managed contemplates a privatized development of treatment that does not generate a space for effective treatment that complements activities for the development of users.

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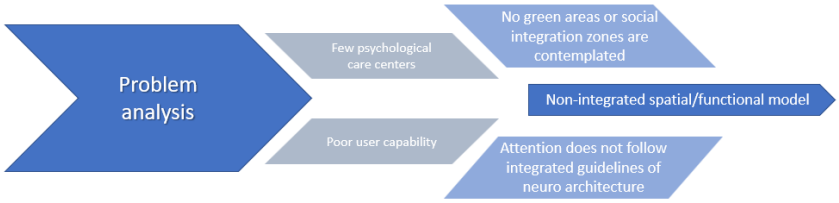

Fig. 3. Problem analysis Kepner and Tregoe method.

The spatial/functional model, because of the situation, is not integrated into complementary spaces such as green areas or social integration zones that show that they contribute to the cognitive development of patients, dismissing neuroarchitecture guidelines seen from the point of analysis of shape and color. of the spaces.

Alternatives		Risk	Description
A	Set open spaces	3	Greater user control
B	Integrate green areas and interior spaces	1	Maintenance and care
C	Shape and color approach	1	Spatial redesign
D	Characterization of treatment by levels	2	Segregation and little social integration
E	Privatized care, with a focus on treatment	3	Non-inclusive faculty model

Fig. 4. Apparent decision analysis Kepner and Tregoe method.

The apparent decision analysis establishes that alternatives B and C constitute a lower risk for treatment in psychological centers, but nevertheless the implementation of this decision would entail spatial redesigns and continuous maintenance of the infrastructure.

Alternatives	Actions	Corrected risk
A	Establish controlled open spaces within the complex	1
D	Characterization of treatment by levels	2
E	Privatized care, with a focus on treatment	3
F	Establish a standardized model of buildings intended for psychological	1

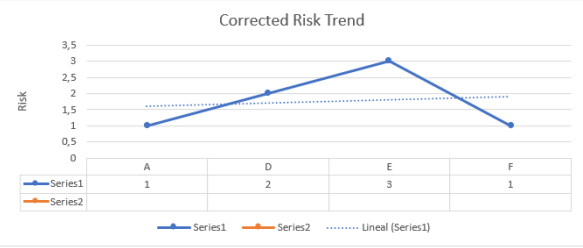

Fig. 5. Analysis of potential problems for final decision Kepner and Tregoe method.

For final decision making, the Kepner and Tegroe Method only selects the options with risk and corrected risk equal to 1 as a solution to potential problems anticipated from the situational analysis phase, refining the alternatives and establishing an additional alternative variable that

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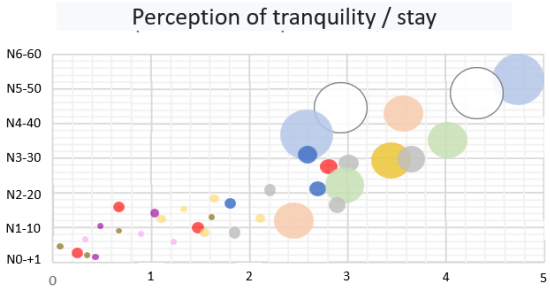
links them to a new treatment model such as the standardization of buildings for psychological treatment.

4.3 Standardized design model – neuro architecture

To establish the standardized model, 4 basic concepts of neuro architecture were considered, being color, shape, interaction with green areas and social integration as the foundations of optimal treatment.

The scatter graph established levels of acceptance by the users surveyed (60), starting from a level 0 to a level 5 in relation to color and its minimum or maximum weighting to form the scatter of choice.



Color	Perception of tranquility / stay
Red	2
White	5
Purple	1
Gray	2
Green	4
Light blue	5
Pink	1
Yellow	1
Peach	4
Mahogany	1
Brown	4
Violet	2
Blue	2

Fig. 6. Scatterplot for color choice.

The proposed colors focused on the perception of the emotional health of the patient and as these colors stimulate the tranquility and stay of the users within a psychiatric center, the established color palette is based on the color trends of treatment spaces in the present. According to the scatter graph, the most appropriate colors are white, blue, green, peach, and brown, as they obtain a higher acceptance score from users (60).

Table 1. Spatial matrix of form by structuring.

Shape spatial matrix			
Spaces	Form	Structuring	Weighing
User attention area	Circular	Concentric	3
	Square	Linear	2
Bedrooms	Square	Linear	1
	Square	Linear with curved corners	3
	Square	With straight additions	2
Hallways	Square	Linear	2
	Square	Linear with curved corners	2
Common zones	Cicular	Excentric and combined with straight sha	3
	Circular	Concentric	3
	Square	Simple	1
Outdoor spaces	Circular	Simple	1
	Circular	Concentric	3
	Square	Simple	1

The determinations of choice of form are based on the conceptualization of form and structuring, if the form is maintained or its combinations generate succession without generating voids, complex transit spaces or spaces with no apparent exit. The options framework is designed according to what exists in the analogous models and design guidelines of neuroarchitecture functional spaces. Weights are set in ranges from 1 to 3, with the highest being the best selection.

Table 2. Positive and negative perceptual selection of choice of green and social areas.

Perceptual selection		
Denominator	Positive	Negative
Interaction with green areas		
Social integration		

The interaction with green areas and social integration generate a positive perception towards this model integrated into buildings as part of the psychological treatment.

5 Discussion and Conclusions

Discussion if the results were relevant or not, what was missing, what types of individuals are intended to be served, aspects to improve and evaluation of results. Conclusions of percentages of improvement in the treatment, improvements in the design, the characterization of the architectural spaces by shape and color contributed to the perception of tranquility within the space, the contact with the green areas improved the cognitive and sensory conditions of the users integrating better with their environment, while the design of semi-open spaces and open spaces generate greater confidence and tranquility for comprehensive socialization, so it can be determined that neuro-architecture focused on conditional evaluation and user decision-making improves treatment satisfactory number of patients, having 90% of the members of the sample in favor of the standardized model of neuro architecture design.

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