Case Architectural Design Parameters Affecting Patients Psychological Requirements in Mental Healthcare Facilities

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Abstract

It has been evident that societal culture/personal behaviour factors have relationships with the usage of buildings and the design processes. This becomes more important for special buildings such as mental healthcare facilities due to the approved linkage between building properties and patients treatment approaches. For such buildings, new ways are needed to evaluate building performance and ensure building compliance. However, one limitation of conventional Code Checking Systems is that they operate with conventional design code compliance logic that lacks the capability to inform the designer of the patients psychological requirements. This paper reviews the patients psychological requirements and their relevant Architectural design parameters in order to develop a framework for a Psychological-Based Code Compliance Checking BIM System for Healthcare facilities (with focus on Thailand as a case study). The paper will discuss the methodology based on the covered relevant literature. The main findings are about the identification of the key psychological factors, the architectural design parameters of healthcare facilities.

KEYWORDS: Code Compliance, Building Information Modelling, Mental Healthcare facilities

1 INTRODUCTION

Traditionally, healthcare and hospital buildings are designed based on past experience with similar projects and architectural standards (Parkin Architect, 2018). However, this lacks the evidence that such experience will be transferrable, especially when locals, patient populations, and equipment become all varied. In addition, staff experiences are often based solely on current conventions, lacking the opportunity to introduce new concepts and explore the design interventions positive and negative impacts on patients and staff (Zimring, 2002; Alfonsi et al., 2014; Parkin Architect, 2018). Local context would have a significant impact on design, as local custom, environment, and socioeconomic status would inform the occupants interaction with the facility and affect the quality, design choice, and other facility management (FM) concerns (Hamilton, 2003; Azizpour et al., 2013; Chungsatiansup et al., 2017).

In Thailand (the special case of this study), the Thai healthcare institutes' design process is similar to international practices. Chungsatiansup et al. (2017; 2020) noted that the traditional Thai hospital design process is managed by a committee of stakeholders from the medical sector and a design team with experience in designing healthcare buildings. This process disregards the opportunity to implement an unconventional design, informed by other stakeholders input, especially the patients.

Aside from relevant conventional building laws, Thai healthcare institution also falls under the Ministry of Public Health, Thailand (MOPH) jurisdiction. In 2015, MOPH declared the 20-Year Thailand National Strategy Roadmap to improve the healthcare system in preparation for Thailand to transition into an aging society within the next decade (Department of Health, 2016; Ministry of Public Health, 2017). The roadmap promotes innovative techniques to improve patient and staff psychological health, whether through service improvement, organisation governance improvement, or facility improvement with emphasis on patient centred practice - where the patients needs inform the design and the operation of the healthcare services and facilities.

With such new design approaches, new ways will be needed to evaluate building performance and ensure building compliance. Building Information Modelling (BIM) offers the potential for a new generation of tools that can automate the checking of compliance with building codes, thus improving building design and procurement (Li, 2015). Unlike graphical Computer-Aided Design (CAD) systems, Code Checking Systems based on object-oriented platforms (such as BIM) allow different building elements to be deciphered and evaluated more efficiently (Khemlani, 2015). As the manual checking of building designs for compliance against building codes is complex and prone to human error with significant cost implications, automated compliance checking would benefit designers (Tan et al., 2010). The Institute of Siamese Architects also surmised that the wide adoption of BIM in Thailand is an inevitable development that must be met for Thailand to maintain international competitiveness in the Architectural, Engineering, and Construction (AEC) industry (Ngowtanasawan, 2016). The wide adoption of BIM also means that there is a potential for adoption of a Thai-specific BIM-Based Code Checking System.

However, one limitation of conventional BIM-Based Code Checking Systems for healthcare facilities is that they operate with conventional design code compliance logic (Dimyadi & Amor, 2013; Martins, 2013). As a result, the Code Checking System could only determine the physical attributes of a building in compliance with the relevant building code and regulation, lacking the capability to inform the designer of the patients psychological requirement (Martins, 2013; Li, 2015).

2 RESEARCH OBJECTIVES

This study aims to deal with this lacking of capability of Code Checking Systems by considering patients psychological requirements when designing Mental Healthcare buildings with focus on Thailand as a case study. This paper reviews the patients psychological requirements to be taken into account by designers and what architectural design parameters of healthcare facilities should be considered in relation to these psychological factors.

3 LITERATURE REVIEW

In the Thai context, many studies show linkage between architectural design and mental health in healthcare facilities. Some studies also opined that it is helpful to include Buddhist philosophy into design consideration as 95% of the Thai population practise Buddhism (Chungsatiansup & Nakwannakit, 2010; Chungsatiansup & Sativaro, 2018). In addition, Buddhism is a key factor that impacts Thai socio-economic interactions, societal paradigm, and building usage (Prapromkunaporn, 2008). Vorasirisuvimon (2017) reviewed Thai hospital design literature and discussed the Healing Environment (i.e., hospital design features and its effect on healing patient); The results noted that many Healing Environment design choices are based on design patterns found through the Evidence-Based Design methodology.

Ulrich et al. (2004; 2008) stated that design patterns for specific environmental conditions would emerge from examining various databases to define relationships between healthcare outcome (whether physically or psychologically) and the relevant architectural elements. By analysing the frequency of occurrence, a statistically significant pattern would emerge. This methodology is dubbed Evidence-Based Design (EBD). While the strength of the results can be debatable, EBD provides approved statistical results that can be used as guidance for designers especially where the integrated impact of various design parameters on mental health in healthcare facilities cannot be studied or concluded. It has been addressed that conducting controlled trial relating to a building design parameter without effecting other physical parameter and building usage is hardly possible. Therefore, it is surmised that implementing this EBD feature within various building cases would strengthen its repeatability and provide a more accurate response from the increase sample sizes of participants (Claridge & Fabian, 2005). Within the Thai context, Chungsatiansup (2016) and Chungsatiansup et al. (2017; 2020) have implemented few design choices informed by the work of Ulrich et al. (2008) within selected Thai-regional hospitals. Post-implementation survey on patients showed a statistically significant positive impact on mental health and occupants comfort. Their results can serve as a proof of concept for implementation in Thai Healthcare institute design.

Automated code compliance checking using BIM models have been used over the last decades. However, among the limitations identified for the available checkers, is that they do not allow complete customisation of checkable rules (Greenwood et al., 2010; Dimyadi & Amor, 2013; Martins, 2013) especially with the existence of subjective rules. Therefore, several popular BIM modelling Platforms allow plugins to be developed using Visual Programming Languages (VPL) to integrate customised code-checking routines according to specific design needs. This facility is supported by the major venders such as Autodesk (Dynamo), Bentley (Generative Components) or Rhinoceros 3D (Grasshopper) (Martins, 2013).

A typical BIM-based code compliance checking system consists of: Rule Interpretation (i.e. the translation of rules into a machine-interpretable language), Rule Execution (i.e the digital rules are to be processed on the digital building model, which requires BIM element requirement check and level of checkable rules to be defined), and Reporting (i.e. define relevant checking issues and may offer re-modelling or correction of the BIM model (Preidel & Borrmann, 2015). Therefore, in order to consider patients psychological requirements when designing Mental Healthcare buildings using BIM systems, a special ruling system is needed to be developed to represent the relationship between the architectural design parameters and the psychological factors.

4 RESEARCH METHODOLOGY

For this paper, the methodology adopted to identify key psychological factors and the architectural design parameters is based on the reviewed literature.

First component is the significant psychological factors for patients in mental healthcare institutions, a thorough literature review would be conducted for both international and Thai context. The covered literature included publications on: Evidence Based Design, Healthcare, Mental Health, Psychological Factors, Psychological Assessment, Psychological Response, Healthcare Outcome. The relevant psychological responses or factors would be extracted. Healthcare outcomes that are not psychological, such as patient falls, medical errors, and hospital-acquired infections were discarded. A Pareto chart analysis would be conducted to identify the key factors to be included in the study.

In the second component, architectural design parameters that are noted to impact psychological factors would be identified conducted through Literature review with the same method as the first component. A Pareto chart analysis would be conducted to identify the key parameters to be included in the study.

A Pareto chart is an analysis tool that seeks to determine the most significant factors among a large set of factors. It contains both bars and a line graph, where individual values are represented in descending order by bars, and the line represents the cumulative total. The chart operates on the Pareto principle, which states that roughly 80% of consequences for many outcomes observable in many study cases come from 20% of causes (the "vital few"). Empirical observation has shown that this 80-20 distribution fits a wide range of cases, including natural phenomena and human activities (Box & Mayer, 1986). The left vertical axis is the frequency of occurrence. In contrast, the right vertical axis is the cumulative percentage of the total number of occurrences, total cost, or a total of the particular unit of measurement. The purpose of the Pareto chart is to highlight the most important among a set of factors and help find the most significant variables or factors to observe the most effective overall improvement (Jurand, 1962).

5 RESULTS

5.1 Key Psychological factors

To identify the significant psychological factors for patients in mental healthcare institutions, a thorough literature review was conducted for both international and Thai context. The covered literature included publications on: Evidence Based Design, Healthcare, Mental Health, Psychological Factors, Psychological Assessment, Psychological Response, Healthcare Outcome. This yields 121 bodies of literature. From these sources, the relevant psychological responses or factors were extracted. Healthcare outcomes that are not psychological, such as patient falls, medical errors, and hospital-acquired infections were discarded. Some objective measures were retained as psychological factors, namely: Length of Stay and Medical Consumption as many studies considered them to be indicative of patients psychological response (Beauchemin & Hays, 1996; Wallace-Guy et al., 2002; Walch et al., 2005). Disregarding factors that are reported only once in literature, the initial psychological factors identified were: Stress, Satisfaction, Depression, Pain, Sleep Quality, Length of Stay, Medical Consumption, Anxiety, Anger, Irritation, Nervousness, Fatigue, Resilience, Self-Confidence, Self-Esteem, Eating Disorder.

Pareto chart analysis was then conducted to identify the key factors to be included in the study, as shown in Figure 1. According to Pareto principle (Box & Meyer, 1986), the factors repeatedly observed (eighty percent) in the covered literature were selected as the most significant factors. The results yield seven psychological factors namely: Stress, Satisfaction, Depression, Pain, Sleep Quality, Length of Stay, and Medical Consumption. The selected psychological factors are ordered as shown in Table 1. Numbers of literature are identified to aid in prioritising the psychological factors for further analysis in the study.

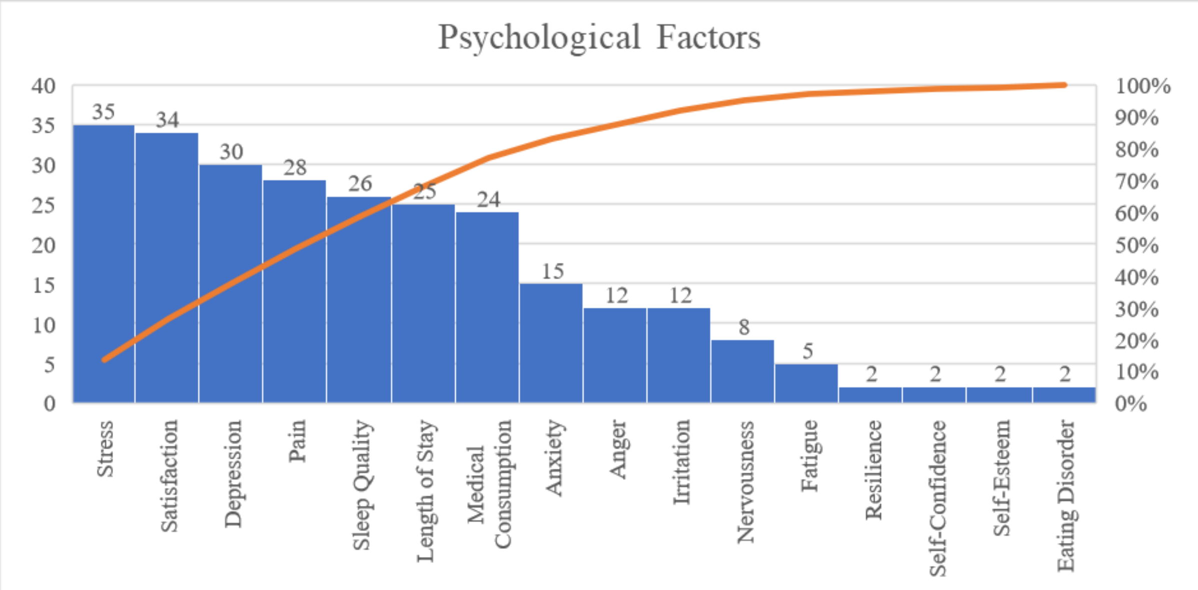

Figure 1: *Psychological factors for patients in mental healthcare institutions*

Table 1: *Selected psychological factors and Numbers of literature*

	Psychological factors	Numbers of literature
1.	Stress	35
2.	Satisfaction	34
3.	Depression	30
4.	Pain	28
5.	Sleep Quality	26
6.	Length of Stay	25
7.	Medical Consumption	24

The measuring tools for each of the psychological factors were also reviewed. Three factors are usually measured subjectively through self-reporting, two factors are measured objectively, and another two are measured using subjective and objective tools. Most factors (i.e., Stress, Satisfaction, Depression, Pain, Sleep Quality) can be measured subjectively through self-reporting by the patient using Psychological Questionnaire such as Profile of Mood States - Short Form, 1983 (POMS-S), and the Multidimensional Personality Questionnaire, 1982 (MPQ) (Bernhofer et al., 2013). Some factors can be observed in objective ways. For example, Sleep Quality can be measure using the number of hours of undisrupted sleep per night per patient, Length of Stay by the number of days from intake to discharge of the patient, and Medical Consumption by the average analgesic medication use per hour (mg/hr) for the entire length of stay (Walch et al., 2005).

5.2 Key Architectural design parameters

The architectural design parameters that are noted to impact psychological factors according to the bodies of literature (the previously selected 121 literature of section 5.1) were identified. Disregarding parameters that are reported only once, the initial design parameters identified are: Natural Light, Nature View, Single Patient Room, Acoustical Quality, Thermal Comfort, Effective Layout / Spatial Disorientation, Family Zoning, Patient Control Choice, Air Quality, Adaptable Room, Floor Finish/Material, Wayfinding, Staff Facility Distance, Access, Visual Privacy, Religious Space, Interior Finish, Handwashing Facility, Water System, Building Footprint.

Pareto chart analysis was also conducted to identify the key parameters to be included in the analysis, as shown in Figure 2. The results yield eight architectural design parameters, namely: Natural Light, Nature View, Single Patient Room, Acoustical Quality, Thermal Comfort, Effective Layout / Spatial Disorientation, Family Zoning, and Patient Control Choice. The selected architectural design parameters are ordered in the frequency of occurrence of numbers of literature, as shown in Table 2. to aid in prioritising architectural design choices.

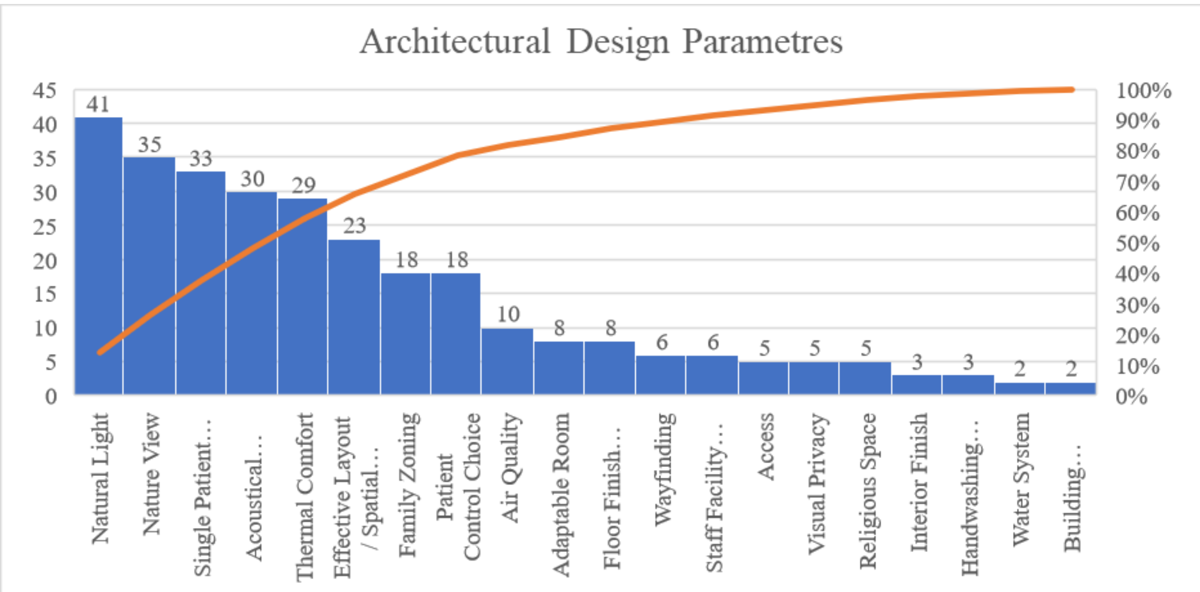

Figure 2: *Architectural design parameters affecting mental health patients*

Table 2: *Selected architectural design parameters and Numbers of literature*

	Architectural design parameters	Numbers of literature
1.	Natural Light	41
2.	Nature View	35
3.	Single Patient Room	33
4.	Acoustical Quality	30
5.	Thermal Comfort	29
6.	Effective Layout / Spatial Disorientation	23
7.	Family Zoning	18
8.	8. Patient Control Choice	18

6 CONCLUSION

This paper analysed relevant literature to identify the key best-fit psychological factors and the architectural design parameters of healthcare facilities that may be relevant to the psychological factors. The methodology identified the most measured psychological factors for mental health patients as: Stress, Satisfaction, Depression, Pain, Sleep Quality, Length of Stay, and Medical Consumption. The order of importance was also identified to help prioritise the design choices when developing the architectural design. The architectural design paraments in relation to these psychological factors were also defined and included: Natural Light, Nature View, Single Patient Room, Acoustical Quality, Thermal Comfort, Effective Layout / Spatial Disorientation, Family Zoning, and Patient Control Choice. The study investigation established that the relationship between the psychological factors and design parameters are to be developed as checkable building rules by correlation analysis yielding discrete/non-discrete and qualitative measurements. The main aim of this literature review is to first identify the factors and the parameters and hence an automated code checking rules based on their relationships. The next stage of this study is to develop a framework to be used as a Psychological-Based Code Compliance Checking BIM System for Healthcare facilities. The framework will also require defining the BIM properties to conduct BIM simulation. In general, the BIM properties requirements for the design parameters are identified to be within Level of Detail (LOD) 300, as suggest by Li (2015) to be the highest LOD for feasible code checking system. The BIM-related requirements will act as the engine of the framework which include Measuring Metrics, BIM properties, and BIM Simulation Engine.

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